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**A Catalog  
of Northwest and Alaska Fisheries Center  
Ichthyoplankton Cruises  
1965-1988**

February 1989

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A CATALOG OF NORTHWEST AND ALASKA FISHERIES CENTER

ICHTHYOPLANKTON CRUISES

1965-1988

by

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INTRODUCTION

This report documents ichthyoplankton cruises conducted by the Northwest and Alaska Fisheries Center (NAFAC) from 1965-1988 (Table 1). For each cruise, this report briefly explains area of sampling, cruise purposes, number of stations occupied, sampling methodology, and associated measurements made, along with a brief assessment of catch composition. This is an update to Dunn (1986).

Additionally, the status of data from each cruise is listed: unpublished in-house data, manuscript reports, NAFAC processed reports, and journal articles. The titles of these reports are listed in the literature cited.

Most fish eggs and larvae collected during these cruises are archived at the NAFAC. Bulk plankton for many, but not all cruises, is archived either at NAFAC or at the Plankton Sorting Center, Szczecin, Poland, as noted herein.

## SOURCES OF INFORMATION

The information presented herein was gleaned from a variety of sources. These include NWAFC cruise reports, particularly for the years 1965-70. Field logs, (especially those of Kenneth D. Waldron, NWAFC, retired) were most valuable for this early period. Archives of raw data in the Recruitment Processes Task, NWAFC, provided additional information, particularly for the years 1971-75. For the period 1976-1988, task computer files, Outer Continental Shelf Environmental Assessment Program (OCSEAP) Reports, NWAFC Processed Reports, cruise reports, and journal articles provided the bulk of the information included herein.

## CURATION PROCEDURES: PAST AND PRESENT

The sorting, processing, and curatorial protocols at NWAFC have changed over the past 20 years. Described are those procedures, both past and present. Variations of these protocols are noted in the text.

Sorting.--From 1965 through about 1970, plankton was sorted in-house, either in the laboratory or (occasionally) at sea. With the establishment of the Marine Monitoring and Assessment Program (MARMAP) in 1971, samples were sorted by an in-house staff. During OCSEAP sponsored studies from 1976-1979, plankton was usually sorted by Texas Instruments, Inc., through contract. Since 1980, most samples were sorted by the Plankton Sorting Center, Szczecin, Poland.

Preservation.--Samples are preserved at sea by adding 50 cc of concentrated formaldehyde to 1 liter of plankton in sea water. Plankton samples were buffered by adding 20 cc of a saturated sodium borate solution. Since 1985, marble chips have been used as a pH buffer by adding 380 g of marble chips to a 5 gallon carboy of formaldehyde.

From 1965 through about 1976, fish eggs and larvae were curated in about 4.7% formalin. This concentration of formalin was reduced to ca 3% in about 1977. Since 1984, (cruise 1P084), fish larvae have been stored in 70% ETOH. A red dot is present on the cap of alcohol preserved samples. Fish eggs continue to be preserved in 3% formalin.

Identification of samples.--For samples of fish larvae collected from 1965-66, only eggs and larvae of Pacific hake (Merluccius productus) were specifically identified, and this was done in-house. The remaining specimens were labeled either ova or larvae. From about 1967 through 1970, fish larvae were identified at NWAFC to lowest possible taxa, but eggs were not identified. During the period 1971-1979, all fish eggs and larvae were identified to lowest taxa

by NWAFC personnel. Beginning in 1980, fish larvae (from most, but not all cruises) were identified at the Polish Plankton Sorting Center and returned to NWAFC. Quality control is maintained in Poland, but all fish larvae are re-examined for accuracy of identification at NWAFC. Fish eggs are identified at NWAFC, except for pollock (Theragra chalcogramma) eggs which, since 1982, are identified and staged in Poland.

Archiving.--The sorted plankton collected prior to 1976 has been disposed. Samples collected from 1976-1980 are stored at NWAFC. Plankton sorted in Poland is archived there.

Fish eggs are archived by cruise. Most fish larvae have been separated into taxonomic groups and incorporated into the reference collection.

Label--Information on labels inside (or on the caps) of vials varies significantly for samples collected prior to 1977. The data on labels during this period are described for each cruise in the text of this paper.

From 1977 to present, information on the labels inside the vials of ichthyoplankton also varied; the type of station occupied is indicated:

G = regular grid station

S = special station (such as use of an epibenthic sled)

D = diel station

B = bay station

V = stations taken during study of vertical distribution (i.e., repetitive tows but not necessarily over a 24-hour period)

A = additional station not normally associated with a fixed grid.

In addition to kind of station and station number, other information may appear on the label. Gear type, mesh size, date of collection, taxon, and number of specimens may be included.

Labeling was somewhat standardized in 1980 (cruise 1P080). The information written is consistent, but the location on the label and the abbreviations used are not. The following information is included:

cruise (e.g., 1P084)

station (e.g., G012A)

gear and mesh size (e.g., B505; 6B5; N505 etc.)

date (as day, month, year)

taxon (e.g., Theragra chalcogramma)

number of specimens (e.g., 64)

In September 1982, station numbers were changed from a four to a five digit number (e.g., G01A to G001A). The use of a "B" indicates the second occupancy of a station (e.g., G001B).

SUMMARY OF ICHTHYOPLANKTON CRUISES BY PROGRAMStudies on distribution of hake eggs and larvae, 1965-1970.

From 1965-1970, ichthyoplankton was sampled (usually on an opportunistic basis) to detect the presence or absence of Pacific hake (Merluccius productus) eggs or larvae. The primary goal was to determine the northern extent of hake spawning.

Sampling procedures followed those utilized in California Cooperative Oceanic Fisheries Investigation (CalCOFI) surveys (Kramer et al. 1972). A 1-m net was fished to a nominal 200 m depth. Mesh size was 30xxx (ca. 500-600 um). Surface water temperatures were taken at each station, and a reversing thermometer was used at certain stations.

Plankton was sorted at NWAFC. Settled volumes were measured and fish eggs and larvae removed. Hake eggs and larvae were then identified. Bulk plankton was disposed of, but most ichthyoplankton is archived at NWAFC. For these cruises, Kenneth D. Waldron conducted the plankton sampling, unless otherwise indicated.

Cruise 1-6501

Cruise 1-6501 aboard the R/V John N. Cobb (cruise 70) was conducted from Puget Sound to southern California, on an opportunistic basis, from February 2-17, 1965. Twenty plankton stations were sampled (Fig. 1).

Labels in vials of fish eggs and larvae read: cruise (1-6501); and haul number (e.g., 5P#1); and sometimes the date (e.g., 9 Feb. 65); station position (e.g., 45°16'N, 124°13'W); and (on the cap) contents (e.g., 4 ova, 1 larva). Sometimes labels are on the cap of the vial only. In the cruise notation used, 1-6501, 1 means the vessel John N. Cobb,

6501 indicates the first plankton sampling cruise in 1965; haul number (e.g., 5P#1) indicates plankton station five (5P), haul one.

On this cruise, hake larvae were collected at station 17, 36°08'N, 121°50.3'W, and hake eggs and larvae at station 20, 32°40.1'N, 118°57.7'W. Information exists for this cruise only as raw data.

#### Cruise 1-6502

Cruise 1-6502 aboard the R/V John N. Cobb (cruise JNC-71) was conducted from March 29 to April 23, 1965. Eighteen stations were sampled in Hood Canal and Puget Sound (Fig. 2) and off coastal Oregon and Washington on an opportunistic basis (Fig. 3).

Sampling procedures followed those used in cruise 1-6501. However, a bathykymograph (BKG) was used to monitor net depth in relation to wire angle. A bathythermograph (Spilhaus 1938) was used to determine water temperatures to a depth of 900 feet. Labels in vials read: cruise (1-6502), station (e.g., 9P), and either ova or larvae and sometimes position (e.g., 46°24'N, 124°15'W), and date (e.g., 15 Apr 65). Labels on caps of vials may also read JNC-71 and station number.

Hake eggs were taken at stations 2, 3, 4, 11, and possibly 12. Hake larvae were taken at stations 3, 11, and 12. Only raw data exist.

#### Cruise 1-6503, 1-6504, 1-6505

These three cruises aboard the R/V John N. Cobb (cruises 72-74) were conducted from July 9 through October 24, 1965. Only 15 plankton stations were occupied during this period (3 during cruise 1-6503; 9 during 1-6504; and 3 during 1-6505). Stations were occupied from near Cape Flattery to south of Point Conception, California (Fig. 4). Herb Shippen, Dick Major, and Kenneth D. Waldron collected the plankton samples on the three cruises, respectively.

Hake eggs or larvae were not encountered. Labels in vials of ichthyoplankton include the cruise number (e.g., 1-6504) and haul number (e.g., 5P).

#### Cruise 1-6601

The R/V John N. Cobb (cruise 75) sampled ichthyoplankton on an opportunistic basis at four stations in Puget Sound on January 12, 1966 (Fig. 5).

Labels in vials of ichthyoplankton read: cruise (1-6601), station (e.g., 5P), position (e.g. 48°03'N, 122°25'W) and date (12 Jan. 66).

#### Cruise 4-6601

The M/V Commando (exploratory cruise no. 13) sampled plankton at four stations in Puget Sound from January 25-28, 1966 (Fig. 6).

Labels in vials of ichthyoplankton read: cruise (4-6601), station (e.g., 2P), position (e.g., 47°18'N, 122°43'W), date (e.g., 26 Jan. 66), and sometimes location (e.g., Carr Inlet), and number of ova and/or larvae. Hake eggs were found at station 1.

#### Cruise 1-6602

The R/V John N. Cobb (cruise no. 76) sampled plankton from February 14-19, 1966. One station was sampled in Puget Sound; subsequent stations extended along the west coast of the U.S. to north of Point Conception, California (Fig. 7). Twelve stations were sampled.

Labels in (or on caps of) vials of ichthyoplankton read: cruise and station number (e.g., 1-6602-3). Archives indicate that ichthyoplankton (plankton?) collected at stations 7-12 were collected for, and given to, Dr. E. H. Ahlstrom, Southwest Fisheries Center (SWFC), La Jolla, CA.

### Cruises 1-6603, 1-6604, and 1-6605

Cruises aboard the R/V John N. Cobb (cruises 78-80) extended from May 16 to August 22, 1966. Plankton was sampled at selected stations in Puget Sound and off coastal Washington to the Columbia River. Twelve stations were sampled on cruise 1-6603 (Fig. 8) from May 16-June 7, six on cruise 1-6604 (July 11-13), and three on cruise 1-6605 from August 15-22 (Fig. 9). Kenneth Waldron collected plankton on cruise 1-6604 and Herb Shippen collected plankton on cruise 1-6605.

Labels in vials of ichthyoplankton read: cruise and station number (e.g., 1-6603-10), and sometimes date. Hake eggs and larvae were encountered at stations 1, 3, 4, 5, 6, 8 during cruise 1-6603; in cruise 1-6604, hake eggs and larvae were found at station 2; and again at station 2, during cruise 1-6605.

### Cruises 1-6701 and K-6703

Research vessels John N. Cobb (1-6701) and George B. Kelez (K-6703) conducted joint ichthyoplankton sampling in Puget Sound (Fig. 10) and off Oregon, Washington, and British Columbia (Fig. 11) from April 12 to May 11, 1967. Eighty-eight stations were occupied in coastal waters and 14 stations were occupied in Puget Sound; a total of 103 plankton samples were collected. Kenneth D. Waldron was chief scientist aboard the Cobb.

Surface temperature and salinity were measured and a bathythermograph was lowered to about 275 m. Fish eggs and larvae were sorted at NWAFC and the remaining plankton sent to the Smithsonian Oceanographic Sorting Center, Washington, D.C. Vials of larvae are labeled C (Cobb), cruise and station (e.g., 1-6701-44), haul (e.g., 1), or K (Kelez), 6703-11, haul (e.g., 1) and sometimes date and position. Station positions, dates, etc., are published in Waldron (1972).

Oceanic samples were dominated by larvae of Scorpaenidae, Myctophidae, and Pleuronectidae. In Puget Sound, larvae of Gadidae (59% hake), Pleuronectidae, and Scorpaenidae were predominant. The results of these cruises were published by Waldron (1972).

#### Cruise 20-6802

Cruise 20-6802 aboard the RV Miller Freeman was conducted on February 13-14 and on March 18, 1968. Fifty-five plankton stations were occupied from Willapa Bay, Washington (Fig. 12) to San Clemente Island, California (Fig. 13).

Labels in (or on caps of) vials of ichthyoplankton read: cruise (20-6802) and station number (e.g., 44), and, at times, haul number. Only raw data exist.

#### Cruises 21-6801 to 21-6806

Cruises 21-6801 through 6806 aboard the MV Curlew sampled plankton in Puget Sound (Port Susan) from May 9 through June 5, 1968. Thirty-six stations were sampled (Fig. 14). Kenneth Waldron and Norman Parks conducted the plankton sampling.

Sampling procedures differed from those utilized on the previous cruises. A Miller (Miller 1961) High Speed net (mouth diameter of 9.85-cm) was fished in a step-oblique manner. One hundred feet (ca. 30.5 m) of wire was payed out and towed for 2 minutes. Then another 100 ft of wire was payed out and towed for 2 minutes. This procedure was continued until 700 ft (ca. 213 m) of wire were let out. Maximum estimated depth sampled was ca. 202 feet (with 700 ft wire-out) based on BKG readings. Towing speed was ca. 4.57 knots (at 900 RPM). A 0.5 m ring net was used at four stations (6801-5 and 6; 6803-1 and 2) for comparative purposes.

Labels in vials of ichthyoplankton include cruise and station number (e.g., 21-6806-02P), or vessel and cruise and haul number. Only raw data exist.

#### Cruise K-7012

Cruise K-7012 aboard the RV George B. Kelez was conducted from northern Washington to near Monterey Bay, California, during October 10-26, 1970.

Thirty-one plankton stations were occupied (Fig. 15).

Standard CALCOFI methods were used. Expendable bathythermograph (XBT) profiles were made at each station. Labels on caps of vials of ichthyoplankton include: cruise and station (e.g., K-7012-8) and sometimes haul number (e.g., 2).

Larvae of Sebastes dominated the catches, followed by myctophid larvae. Only raw data exist.

Transects off Oregon and Washington, 1968-1971

From 1968-1971, seven cruises were conducted off coastal Oregon and Washington. The purpose of these cruises was to investigate the spatial and temporal distribution of ichthyoplankton in the area studied.

Sampling methods followed standard CALCOFI procedures. All samples of ichthyoplankton are archived at NWAFC, but bulk plankton has been disposed of. A partial draft manuscript by Kenneth D. Waldron summarizes the coastal ichthyoplankton work from 1967-1969. Waldron conducted the plankton sampling except as noted below.

Cruise K-6805

Cruise K-6805 aboard the RV George B. Kelez was conducted from October 15-25, 1968. Ten plankton stations were occupied in Puget Sound (Fig. 16) and 22 stations were occupied off Oregon and Washington (Fig. 17).

Labels on the caps of vials of ichthyoplankton read: cruise (K-6805), station (e.g., 22) and either ova or larvae. Tarletonbeania sp. larvae predominated at stations in Puget Sound, and other myctophid larvae predominated offshore.

Cruise F-6901

Cruise F-6901 aboard the RV Miller Freeman was conducted off Willapa Bay, Washington, from January 17-19, 1969. Only thirteen plankton stations were occupied (Fig. 18).

Labels in vials read: cruise (F-6901), station (e.g., 19). Parophrys vetulus and other pleuronectid larvae dominated collections at near-shore stations; myctophids predominated at the oceanic stations.

### Cruise 20-6905

Cruise 20-6905 aboard the RV Miller Freeman was conducted in Puget Sound and off Willapa Bay from November 21-24, 1969. Fifteen stations were occupied (Fig. 19).

Labels on lids of vials read: cruise (20-6905), station (e.g., 33), haul (e.g., #3) and ova or larvae. Bathylagid larvae were most abundant, followed by flatfish larvae.

### Cruise JNC-7101

The John N. Cobb cruise 7101 was conducted from January 18-29, 1971. Thirty-eight plankton tows were made at 15 stations (Fig. 20) in Puget Sound and off coastal Washington.

In addition to fishing the standard 1-m plankton net, nekton was sampled at 25 stations with a 6 ft Issacs-Kidd midwater trawl (IKMT) (Isaacs and Kidd 1953) equipped with a depth telemetering system. Nansen bottles (Sverdrup et al. 1942) were used to obtain salinity and temperature data and XBT'S were deployed. Labels on lids of vials of ichthyoplankton read: cruise (C 7101), station (e.g., 15), and haul (e.g., 6P). Osmerid larvae were the most abundant, followed by cottids and flatfishes.

### Cruises JNC-7103, 7104, and 7105

Cruise 7103 of the R/V John N. Cobb sampled three stations in Port Susan on April 8, 1971 (Fig. 21). Cruise 7104 sampled transects along 46°N during May 3-4, along 46°30'N from May 4-5, and along 47°10.5' during May 5-6, 1971. A total of 46 plankton hauls was taken at stations 28-50 (Fig. 22). Transects along 46°30'N and 47°10.5'N were resampled during June 8-10, 1971. Thirty plankton tows were taken at stations 82-96 (Fig. 22). Kenneth Waldron, Herbert Shippen, and Norman Parks conducted the sampling.

Cruise 7105 sampled six stations (12 tows) along  $47^{\circ}10.5'N$ , off southern Washington, on July 22-23, 1971 (Fig. 23). Miles Alton conducted the ichthyoplankton sampling.

Labels on caps of vials of ichthyoplankton read: cruise (e.g., C7103, 7104), station (e.g., 31) and haul (e.g., 1P, 2P). In April-May, rockfish, myctophid, and flatfish were the most abundant larvae.

MARMAP I Cruises, 1971-1972

Three Marine Monitoring and Assessment Program (MARMAP) cruises were conducted in 1971-1972 in the eastern Bering Sea, off Vancouver Island, and near Kodiak Island. Additionally, plankton samples were collected from the eastern Bering Sea through a cooperative cruise of the International Pacific Halibut Commission in 1971, and experimental cruises were conducted in Puget Sound and off coastal Washington in 1972.

Standard MARMAP procedures were used (Jossi and Marak 1983; Smith and Richardson 1977). Paired 60- and 20-cm bongo (Posgay and Marak 1980) frames were used (505  $\mu$ m and 333  $\mu$ m mesh nets were used on 60-cm frames and 253  $\mu$ m and 167  $\mu$ m mesh on 20-cm frames). Tows were made to a nominal 200 m depth. Open area ratios were 10:1. Continuous conductivity-temperature depth (CTD) profiles were made to near bottom (or to 1500 m) at each station. On some cruises other observations were made, as noted below.

Plankton was sorted at the NWAFC. All fish eggs and larvae were removed from the 60-cm, 505  $\mu$ m samples and identified to lowest taxa. Aliquots from the 60-cm 333  $\mu$ m nets were sorted for major invertebrate taxa.

Subsamples of copepods, euphausiids, amphipods, and chaetognaths were identified to lowest taxa. Bulk plankton from the above cruises was disposed of in about 1975, but all ichthyoplankton is archived at NWAFC.

Cruise K 71-3

Cruise K 71-3, the first MARMAP I cruise conducted by NWAFC, aboard the RV George B. Kelez, sampled ichthyoplankton in a restricted area of the eastern Bering Sea from May 21 through June 11, 1971 (Fig. 24). The purpose of the cruise was to determine diel variation and depth distribution of ichthyoplankton

and zooplankton. Because of equipment failures, only six stations were occupied with a total of 23 plankton tows made (18 tows at station 6). Donald Day was Chief Scientist.

Vials of fish eggs and larvae are labeled with cruise (K71-3), station number, and date of haul, and mesh size.

Sebastes spp. larvae dominated (52%) the collections of fish larvae, followed by bathylagid smelts (24.9%) and pleuronectids (10.4%) Eggs of Theragra chalcogramma accounted for nearly 71% of the fish eggs taken.

The results of the ichthyoplankton portion of this cruise were documented by Dunn and Naplin (1973). Pelagic amphipod crustaceans were reported upon by Sanger (1972), and physical oceanography was reported by Ingraham and Fisk (1973).

#### Cruise DE-4

Through cooperation with the International Pacific Halibut Commission, the chartered motor vessel Don Edwards collected plankton samples at 10 locations in the eastern Bering Sea from July 25 through August 3, 1971 (Fig. 25).

Standard MARMAP procedures were used. Gear used was the same as on cruise K71-3, with the exception that 20-cm bongo frames were not used. The maximum depth of tow was 100 m or less (single tow was made to 300 m) since nearly all stations were over shelf waters. No water column measurements were made. All fish eggs and larvae were sorted from the 505 um and 333 um nets. Labels in vials of fish eggs and larvae read: cruise (DE-4 or HC71), station number (e.g., 5), date of haul, and mesh size (e.g., 60/333).

Gadids (probably T. chalcogramma) dominated the catches, accounting for about 95% of the total. Only raw data exist. Comments on the identification of amphipods taken during this cruise were included in Sanger (1972).

#### Cruise K 71-5

The second MARMAP I cruise was conducted from October 14 to November 4, 1971, aboard the RV George B. Kelez. Thirty-two ichthyoplankton stations were sampled from Willipa Bay, Washington, to Dixon Entrance, British Columbia (Fig. 26). Donald Day was Chief Scientist.

A standard MARMAP bongo array was used. CTD profiles to 1500 m were made at each ichthyoplankton station as well as other locations. An autoanalyzer was used to continuously monitor surface nutrient concentrations.

Ichthyoplankton was sorted from four nets. Labels in vials of fish eggs and larvae read: cruise (K71-5), station number, date, bongo frame size (60 cm or 20 cm) and mesh size.

Myctophid larvae accounted for 83% of the catch, followed by pleuronectid flatfishes (3.0%) and Scorpaenidae (2.3%). Ichthyoplankton from this cruise was documented by Naplin et al. (1973). Sanger (1973) reported on amphipods collected on cruise K 71-5, Threlkeld (1973a,b) on copepods, and Ingraham et al. (1973) on physical oceanography.

#### Cruise K 72-2 (=2KE72) (Phase I)

The third MARMAP cruise was conducted in the Kodiak Island area aboard the RV George B. Kelez. A total of 67 ichthyoplankton stations was sampled from April 19 to May 11, 1972 (Fig. 27). James Ingraham was Chief Scientist.

Standard MARMAP procedures were used. CTD profiles to 1500 m (or near bottom) were made at each ichthyoplankton station (and at other locations). Nutrient chemistry was monitored on an autoanalyzer and chlorophyll standing stock was measured.

Labels inside vials of fish eggs and larvae were relabeled in 1985 and now read: cruise and leg, 2KE72, station number (e.g., G010A), gear and mesh size (B-505), taxon and number of specimens. Walleye pollock eggs accounted for 97.2% of the total number of eggs taken; pollock larvae accounted for 62.3% of the total larvae collected.

The ichthyoplankton portion of this survey was documented by Dunn and Naplin (1974). Threlkeld (1973c, 1977) documented copepods collected, Ingraham and Fisk (1973), Favorite, et al. (1975), and Favorite and Ingraham (1977) analyzed hydrographic conditions. Sanborn (1973) reported surface nutrient concentrations.

#### Cruise K 72-2 (Phase II)

The second phase of RV Kelez cruise K 72-2 was conducted in Puget Sound and off Grays Harbor, Washington (Fig. 28) from May 23-27, 1972. The purpose of the sampling was to evaluate filtering efficiencies of 60-cm bongo nets with various ratios of mesh openings to mouth cross sectional areas (open area ratios) in regions of high plankton abundance. A total of 108 plankton tows was made at stations 1 and 2. Donald S. Day was Chief Scientist.

Ichthyoplankton was sorted at NWAFC, but fish eggs and larvae were only partially identified due to the termination of the MARMAP I program at NWAFC in 1973. Only raw data exist. Labels in vials of fish eggs and larvae include: cruise (K72-2), phase (II), station (B1 or B2), haul number and date.

Cruise K 72-2 (Phase III)

The third phase of RV Kelez cruise K 72-2 was conducted from May 31-June 16 off Grays Harbor, Washington (Fig. 28). The purpose of this phase was to determine an effective bongo tow configuration for use in water depths from 20 to 60 meters. One hundred fifty-two plankton tows were made at stations 3-6. Donald S. Day was Chief Scientist.

Some, but not all, of the plankton samples were sorted for ichthyoplankton, but not identified. Labels in vials of fish eggs read: cruise (K72-2), phase (III), station (B3-B6), haul number (e.g., #6) and date (i.e., June 1, 1972).

A memo by Robert L. Carlson provides a preliminary analysis of net clogging during Phase III (Carlson MS 1972).

Ichthyoplankton from the Strait of Juan de Fuca 1976-1977

Ichthyoplankton samples collected in the Strait of Juan de Fuca in 1976-1977 (called the "Larrance" samples) by the Pacific Marine Environmental Laboratory (PMEL), NOAA, Seattle, were identified by NWAFC through a contract. The ichthyoplankton is archived at NWAFC.

Cruises SF 7601-SF 7706

A series of 13 cruises were conducted by PMEL in the Strait of Juan de Fuca from February 23, 1976, to October 5, 1977. The purpose of these cruises was to describe the seasonal distribution and composition of phytoplankton, zooplankton, and ichthyoplankton. Nine stations were sampled approximately every six weeks during the twenty-one month period (Fig. 29). A total of 666 plankton samples were collected, of which 77 samples were sorted for ichthyoplankton by PMEL, and the samples were identified by NWAFC.

Sampling gear consisted of a variety of nets, but ichthyoplankton was identified from oblique tows of 60-cm bongo nets (333 um mesh) and surface neuston tows (333 um mesh). A single 60-cm net (333 um mesh) was substituted for the bongo nets in 1976. Ichthyoplankton from some vertical tows (60 cm mouth closing net, 0.211 mm mesh) were also identified. A total of 28 bongo samples were analyzed for ichthyoplankton.

Osmerids and hexagrammids dominated the larval samples. Labels in vials read cruise (SF 76-1), station (e.g., 8), type of tow (e.g., V-11 for a vertical tow, O for a oblique tow, and P for a pleuston tow), station (e.g., V-11), taxon and number of specimens (e.g., Osmeridae 3). Raw data exist in NWAFC files, and this study was documented by Chester et al. (1977, 1979).

Ichthyoplankton studies in the eastern Bering Sea, 1976-1980

From 1976-78, ichthyoplankton was sampled in the eastern Bering Sea on three cruises under partial OCSEAP funding. An additional cruise, sponsored by NWAFC, was conducted in 1979. The purpose of these cruises was to delineate the spatial and temporal distribution of walleye pollock eggs and larvae. Kenneth D. Waldron conducted the plankton sampling on the first three cruises.

Standard MARMAP methods were used. Neuston was also sampled, but the kinds of nets used varied as noted below. CTD profiles to 1,500 m (or near bottom at shallow stations) were made on most cruises.

Plankton was sorted through contract with Texas Instruments, Inc. for most cruises. The extent of sorting (other than fish eggs and larvae) varied among cruises, as described below. Bulk plankton and sorted samples are archived at NWAFC.

Cruise MF 76A

Cruise RV Miller Freeman 76A sampled ichthyoplankton in the eastern Bering Sea, on an opportunistic basis, from April 25-May 31, 1976. Fifty-six stations were occupied (Fig. 30).

Standard MARMAP procedures were used, including tows with a MARMAP neuston sampler that measured 1.0-m x 0.5-m and utilized 470 um mesh (Jossi and Marak 1983). A total of 168 plankton samples was collected. Labels inside vials of ichthyoplankton read: cruise (MF 76A), gear, and station (e.g., B36, N06), and mesh size (e.g., 471 or 505 um), taxon and number of specimens. Fish eggs and larvae were sorted from the 505 um net. In the 333 um samples, plankton volume was measured and aliquots were sorted to major invertebrate categories, including decapod larvae. Oceanographic data were not collected.

Pollock eggs were most abundant followed by flathead sole (Hippoglossoides elassodon) and Alaska plaice (Pleuronectes quadrituberculatus). Pollock larvae predominated, followed by cottids, Ammodytidae, liparids, and Sebastes spp. This cruise was documented by Waldron and Favorite (1977), and Waldron (1978a).

MF 77B-5 and 6

Ichthyoplankton of the eastern Bering Sea was sampled aboard legs 5 and 6 of the RV Miller Freeman from April 16 through May 17, 1977. A total of 75 stations was sampled. A number of stations were re-occupied, up to four times, so that a total of 134 stations, distinct in time and/or location was sampled (Fig. 31).

Three different neuston nets were used at various times during the cruise: 1) a Sameoto sampler (Sameoto and Jaroszynski 1969) measuring 0.4 x 0.4-m; 2) a sampler similar to a Sameoto, measuring 0.32-m by 0.47-m wide, which was fabricated at sea when the Sameoto sampler was lost; and 3) a MARMAP neuston net fitted with 471 um mesh. CTD profiles to 1,500 m or to near bottom were taken at 32 stations. Only fish eggs and larvae were sorted from the 505 um net.

Pollock accounted for 97% of the eggs and 59% of the larvae. Labels inside vials read: cruise (e.g., MF 77B5), gear, and station (e.g., B6), haul number (e.g., 1), mesh size (e.g., 505), taxon and number of specimens. This cruise was documented by Waldron and Vinter (1978), and Waldron (1978a).

Cruise MF 78-01

A survey of ichthyoplankton of the eastern Bering Sea, was conducted aboard the RV Miller Freeman from February 11 through March 16, 1978.

Thirty-two stations were sampled (Fig. 32).

Neuston was sampled with a modified Sameoto sampler (0.50 m wide by 0.30 m high, effective mouth area 0.075 m<sup>2</sup>). Environmental data were not collected, as the primary mission of the cruise was to survey herring resources, with plankton sampling being of secondary interest. The plankton was sorted, identified, and pollock eggs staged at NWAFC.

Pollock eggs accounted for about 97% of the total. About 96% of the larval fish taken were Hemilepidotus spp., Hexagrammos spp., and Pleurogrammus sp. Results of this survey are documented in Waldron (1978a,b).

Cruise 3 MF 79 (Legs I, II, III)

Ichthyoplankton was collected from the eastern Bering Sea on a cruise of the Miller Freeman from June 1 through July 23, 1979. The main objective of the cruise was to carry out a trawl and hydroacoustic survey of the adult walleye pollock population; hence ichthyoplankton sampling was rather opportunistic. However, 115 stations were sampled (Fig. 33). Paul Walline was in charge of plankton sampling on Leg I, Jean Dunn on Leg II, and Arthur Kendall on Leg III.

Standard MARMAP procedures were used. CTD profiles were taken at nearly every station. One hundred thirty neuston, 126 bongo, and 104 Tucker trawl (Tucker 1951) tows, and 134 CTD casts were made. Additionally, on Leg I two stations were occupied for 48-h each. At the first station (hauls V1-V8), 8 bongo, 8 neuston, and 48 one-meter Tucker trawl tows were made; the latter sampling depth intervals of 100, 60, 40, 25, 15, and 5 m. At the second station (hauls V9-V16), 15 bongo, 8 neuston, and

40 one-meter Tucker trawl tows were taken (at the same depth intervals sampled at the first station, excluding the 100 m interval).

Plankton was sorted through contract with Texas Instruments, Inc. Invertebrate plankton was not sorted. Labels in vials of ichthyoplankton read: cruise (3MF79), station (e.g., S [regular station] 110A or V [vertical station] 16A), gear (e.g., TT #1 or B-505), haul (e.g., H-8) date (6.06.79), taxon and number of specimens.

Eggs of pollock and Limanda aspera made up 89% of all eggs taken. Pollock larvae, Sebastes spp., and Bathymaster spp. accounted for 79% of the total larvae collected. This cruise was documented in a series of four reports (Walline 1980; 1981a,b; 1985) as well as in a Ph.D. dissertation (Walline 1983).

#### Cruise 1 MF 80

Ichthyoplankton was sampled in the eastern Bering Sea as a secondary objective aboard the Miller Freeman from January 26 through February 12, 1980. Only eight stations were occupied (Fig. 34). Donald Fisk conducted the plankton sampling.

Paired 60-cm bongo tows and a neuston tow were made at each station. Ichthyoplankton was sorted by Texas Instruments, Inc. Invertebrate plankton was not sorted. Only raw data exist from this cruise.

OCSEAP Studies, Kodiak Archipelago, 1977-1979

From 1977-79, five OCSEAP supported plankton cruises were conducted in shelf waters near Kodiak Island. The purpose of these cruises was to assess spatial and temporal distribution of plankton which might be impacted should oil spills occur.

Standard MARMAP methods were used, including the use of a modified Sameoto neuston sampler. On some cruises, additional kinds of gear were used (Tucker trawls, IKMT's, epi-benthic sled, [Tabrey et al. MS] etc.), as detailed below. CTD profiles to near bottom were made at each station and sea bed drifters were released at several locations during each cruise.

Plankton was sorted by Texas Instruments, Inc. All fish eggs and larvae were removed from the 505 um bongo nets, neuston nets, and Tucker trawls. Fishes were sorted from the IKMT. Ichthyoplankton and juvenile fishes were identified at NWAFC. Zooplankton from the 333 um bongo nets were sorted into major categories (e.g., phylum, class, or order) from an aliquot (ca. 500) of organisms, and enumerated. A separate subsample was taken to yield approximately 200 adult euphausiids, which were identified to species, enumerated, measured, and wet weights determined. Samples from the 505 um Tucker trawl were subsampled for about 200 euphausiids, which were handled as above. An additional subsample of about 500 organisms was taken for separation of shrimp (Natantia) and decapod crab (Reptantia) larvae. Further subsampling as necessary was conducted by the Kodiak Laboratory, NWAFC, to provide adequate numbers of decapod larvae for analysis. Bulk plankton samples and sorted invertebrates, other than Natantia and Reptantia, are archived at NWAFC. Larvae of the

latter two groups are maintained at the Kodiak laboratory. Results of these cruises were documented by Dunn et al. (1979), Kendall, et al. (1980a,b), and Kendall and Dunn (1985).

#### Cruise 4 MF 77

The first OCSEAP sponsored plankton survey of waters contiguous to Kodiak Island was conducted aboard the RV Miller Freeman from October 31 through November 14, 1977. Sixty-one stations were occupied; stations 1-53 once, except that stations 36-40 and 43, 45, and 46 were sampled twice (Fig. 35). Jean R. Dunn was Chief Scientist.

At selected stations 1-m Tucker trawls were deployed, and sometimes an epi-benthic sled, fitted with a 1-m Tucker trawl, was tried. Two diel stations were occupied (stations 33 and 35). A total of 369 plankton samples was collected.

Labels in vials of fish eggs and larvae contain the following information: cruise (4MF77), gear (B, N, or TT #1, TT #2) and station (e.g., 1-53). Re-occupied stations are labeled 36-2, 43-2, etc.; diel stations are labeled with station and haul number (e.g., 33A1, 33A7, 35AB, etc). Additionally, 40 CTD casts and 31 XBT probes were taken and 400 seabed drifters were released.

Station numbers were subsequently revised to conform to later numbering systems. Thus, station 1 was renumbered G001A, and station 20 is G020A; reoccupied stations are labeled with a "B" (e.g., G036B, G046B, etc.) Diel stations are labeled D033A-D033L and D35A-D35L. The revised station numbers are used in the NWAFC computer data base, but original numbers remain on the vials of fish eggs and larvae (Table 2).

Capelin (Mallous villosus), hexagrammid, and Hemilepidotus spp. larvae dominated occurrences of larvae. Pollock eggs were also dominant.

#### Cruise 4 DI 78

The second OCSEAP sponsored plankton survey of waters near Kodiak Island was conducted aboard the RV Discoverer from March 28 through April 20, 1978. Eighty regular grid stations were occupied and 33 special stations were sampled (Fig. 36). Jean R. Dunn was Chief Scientist.

Sampling procedures were the same as employed on cruise 4 MF 77. Two diel stations were occupied. In addition, 56 tows were made over slope waters using a 6 ft IKMT. A total of 475 plankton samples was collected. Additionally 117 CTD casts were made and 800 seabed drifters were released. Labels in vials of ichthyoplankton read cruise (4DI78), gear (e.g., B, N, TT#1, TT#2), station (e.g., 1-80) and, taxon (e.g., Mallotus villosus) and number of specimens (e.g., 10).

Regular stations are numbered 1-80 and special stations 81-113. Diel stations are labeled 45-1 through 45-12 and 63-1 through 63-12. As with cruise 4 MF 77, stations occupied during cruise 4 DI 78 were renumbered, as listed in Table 3. Old numbers remain on labels of fish eggs and larvae; "new" station numbers are in the computer data base.

Larvae collected included Mallotus villosus, Theragra chalcogramma, hexagrammids, Hemilepidotus, and Ammodytes. Eggs of T. chalcogramma were predominate, followed by those of Hippoglossoides elassodon.

#### Cruise 2 MF 78

The third OCSEAP sponsored plankton survey of waters contiguous to Kodiak Island was conducted from the RV Miller Freeman from June 19 through July 9, 1978. Eighty-eight stations were occupied (Fig. 37). Kenneth D. Waldron was Chief Scientist.

Procedures were identical to the previous two cruises. Two diel stations were occupied (D01 and D69). Tucker trawl samples were taken at selected stations as were IKMT tows; an epibenthic sled was towed at a few stations. A total of 505 plankton samples was collected. Also, 106 CTD casts were taken and 800 seabed drifters were released. Labels in vials of ichthyoplankton read cruise (2MF78), station (e.g., G78A, G69L), gear (e.g., B505, N, TT#1 etc.), taxon and number of specimens.

Eggs of Limanda aspera, Microstomus pacificus, and Hippoglossoides elassodon were predominate. Larvae of osmerids, Sebastes spp., pleuronectids, and bathymasterids also predominated.

#### Cruise 1 WE 78

The fourth survey of plankton of the Kodiak Island shelf, sponsored by OCSEAP, was conducted aboard the RV Wecoma from October 25 through November 17, 1978. Ninety-four stations were occupied and some stations were sampled more than once (Fig. 38). Kenneth D. Waldron was Chief Scientist.

Procedures used were identical to the previous surveys of the area. One station (D01) was sampled for 24-h to investigate diel migration, and eight stations within Kaiuqnak and Kiliuda Bays were sampled. A total of 397 plankton hauls was taken. Ninety-seven CTD casts were made and 768 seabed drifters were released. Labels in vials of ichthyoplankton include the following information: cruise (1WE78), station (e.g., G21A; B =bay station, or D = diel station) gear (e.g., N, B505, TT#1, TT#2, etc.).

Collections of eggs included those of bathylagids and T. chalcogramma. Predominant larvae were osmerids, bathylagids, bathymasterids, hexagrammids, and cottids.

Cruise 1 MF 79

The final OCSEAP sponsored plankton survey of the Kodiak Island shelf was conducted aboard the RV Miller Freeman from February 13 through March 11, 1979. Eighty-eight stations were occupied (Fig. 39). Chief Scientist was Kenneth D. Waldron.

Sampling procedures used were generally identical to the previous two cruises. Tucker trawls were used at selected stations, but IKMT and epibenthic sleds were not employed. There were no diel stations. Two bay stations were occupied. Three hundred-thirty nine plankton samples were collected, 88 CTD casts made, and 768 seabed drifters were released. Labels in vials read: cruise (1MF79), gear (e.g., B, N, TT#1 etc.), station (e.g., G57A; G41B), taxa, and number of specimens.

Among the fish eggs collected, those of Theragra chalcogramma, Leuroglossus schmidtii, and Pleuronectidae were dominant. Larvae of Mallotus villosus, Leuroglossus, Hemilepidotus spp., and hexagrammids were most abundant.

Additional Ichthyoplankton sampling in the northeastern Gulf of Alaska

In summer and fall, 1978, ichthyoplankton samples were collected aboard the RV Miller Freeman, on an opportunistic basis, in Kodiak Island shelf waters and eastward to the Prince William Sound area. In 1979, in two cooperative U.S.-U.S.S.R. cruises, the Pacific Research Institute of Marine Fisheries and Oceanography (TINRO), Vladivostok, U.S.S.R. sampled plankton in the western Gulf of Alaska, and in the spring of 1980, the RV Miller Freeman sampled plankton near Kodiak Island. Results of most of these cruises are included in Kendall and Dunn (1985). Data on the distribution of pollock eggs and larvae are included in Dunn et al. (1984).

Cruise 3 MF 78

Additional plankton sampling of the Kodiak Island shelf was conducted from September 8-21, 1978. Twenty-seven stations were occupied, on an opportunistic basis, from the RV Miller Freeman (Fig. 40). Ed Nunnallee was Chief Scientist; Jay Clark conducted the plankton sampling.

Sampling methodology generally followed that of previous Kodiak Island OCSEAP work, but only bongo and neuston samplers were used. Labels in vials read cruise (3MF78), station (e.g., 8A), gear (B or N) and taxon and number of specimens.

The dominant eggs collected in neuston nets included those of Limanda aspera, Psettichthys melanostictus, Glyptocephalus zachirus, and Pleuronectidae. In bongo nets, eggs of Macrouridae, Leuroglossus schmidti, and Limanda aspera were predominant. Larvae collected in the neuston net were dominated by Hexagrammos lagocephalus, H. octogrammus, Osmeridae, Bathymaster spp. and H. stelleri. Bongo collections were dominated by larvae of Hexagrammos spp., and Osmeridae.

Cruise 4 MF 78

The Kodiak Island shelf was again sampled from the RV Miller Freeman, on an opportunistic basis, from September 24 through October 7, 1978. Sixty-six stations were sampled (Figs. 41, 42). Richard Bakkala was Chief Scientist.

Sampling procedures used were the same as on the previous cruise (3MF78). Labels in vials of fish eggs and larvae note cruise (4MF78), station (e.g., 9C, 10A), gear (e.g., B; N) and taxon and number of specimens.

No fish eggs were taken in the neuston net. Eggs in the bongo net were dominated by Leuroglossus schmidti and Pleuronectidae. Larvae collected in the neuston net were primarily Hexagrammos lagocephalus, Bathymaster spp., and H. octogrammus. Bongo collections included larvae of Osmeridae, Hemilepidotus spp., Stenobranchius sp., S. leucopsarus, Mallotus villosus, and Hexagrammos lagocephalus.

Cruise 5 MF 78

From October 15 through November 1, 1978, 19 stations were sampled Miller Freeman. These stations were at the east end of the Kodiak Island shelf (Figs. 43, 44). Tom Dark was Chief Scientist.

Sampling methods were as in cruise 4 MF 78. Labels in vials of ichthyoplankton contain the following information: cruise (5MF78), station (e.g., 22D), gear (B; N), and taxon and number of specimen.

Eggs were not taken in the neuston net. Collections of fish eggs in bongo nets were dominated by Leuroglossus schmidti, followed by smaller numbers of macrourid eggs and those of Theragra chalcogramma. Larvae in the neuston net were mainly Hexagrammos stelleri, H. lagocephalus, and

H. octogrammus. Bongo collections were dominated by larvae of Osmeridae, Hemilepidotus spp., Mallotus villosus, and Artedius type I.

#### Cruise 6 MF 78

From November 5-16, 1978, opportunistic sampling of ichthyoplankton was conducted in the Prince William Sound area. Forty-four stations were occupied by the RV Miller Freeman (Fig. 45). Terry Sample was Chief Scientist.

Sampling methodology followed that used in the previous three cruises. Labels in vials of ichthyoplankton provide the following information: cruise (6MF78), gear (B; N), station (e.g., 53A), and taxon and number of specimens.

Eggs taken in the neuston net belonged to Leuroglossus schmidti only. Bongo net collections of eggs were primarily those of L. schmidti, with a few belonging to Macrouridae and Parophrys vetulus. Larvae taken in the neuston net included Bathymaster spp., Hemilepidotus spp., Hexagrammos lagocephalus, H. octogrammus, and H. decagrammus. In the bongo net, larvae included Mallotus villosus, Leuroglossus schmidti, and Stenobranchius sp.

These data are present in the computer files at NWAFC.

#### Cruise 5 TI 79

The Soviet RV Tikhookeanski sampled plankton in the western Gulf of Alaska from May 16-24, 1979. Thirty-five stations were occupied (Fig. 46). N. Fadeev was Chief Scientist.

Only a 60-cm bongo array was used, with each country retaining one 505 um sample. Standard hydrographic casts were made at each station. U.S. plankton samples were sorted by Texas Instruments, Inc. Labels in

vials include cruise (5TI79), station (e.g., 18), gear (B-505), date (e.g., 17.05.79), taxon and number of specimens.

Eggs of pleuronectid flatfish and Theragra chalcogramma were most abundant. Larvae of Theragra were dominant.

#### Cruise 1 PO 79

The Soviet RV Poseydon sampled plankton in the western Gulf of Alaska from September through October 11, 1979. Forty-eight stations were sampled (Fig. 47). V. Vologdin was the Chief Scientist. Dave Tucker and Ralph Honeycutt were U.S. representatives aboard the vessel.

Paired neuston tows and bongo hauls were made at each station. The bongo array was lost at station 19 and a single 60-cm frame, termed a "bong" was fabricated at sea. For the remaining thirty stations, two tows of the "bong" were made at each station. Standard hydrographic casts were made at each station.

Samples were sorted by Texas Instruments, Inc. Labels in vials of ichthyoplankton list cruise (1P079), gear (bongo, bong), station (S65A), taxon, and number of specimens.

Macrourid eggs, those of Leuroglossus schmidti, and those of pleuronectid eggs were most common. Osmerid larvae, followed by those of L. schmidti, were most abundant.

#### Cruise 1 MF 80

Leg II of RV Miller Freeman cruise 1 MF 80 sampled ichthyoplankton in Shelikof Strait and to the west of Kodiak Island from April 2-11, 1980. Forty-one stations were occupied (Fig. 48). Donald Fisk conducted the plankton sampling.

Sorting of samples was done at Texas Instruments, Inc. Not all the samples collected were sorted. However, thirty-three 505 um bongo samples were sorted as were thirteen 333 um bongo samples and 6 neuston samples. Labels inside vials include data on cruise (1MF80), station (e.g., 297), gear and mesh size (e.g., B505), taxon, and number of eggs or larvae. The station numbers were subsequently changed to conform to later numbering systems, hence, in our computer files, station numbers differ from those used in the vial labels (e.g., station 258 is now station G058A). Forty-one CTD casts were taken.

The predominate eggs collected were those of pollock. Pollock larvae were most abundant, followed by Ammodytes hexapterus larvae.

Cooperative Cruises with Poland and the Republic of Korea, 1977 and 1980

In the summers of 1977 and 1980, cooperative cruises were conducted with the Morski Institute Rybacki, Gdynia, Poland, and with the Fisheries Research and Development Agency, Busan, Republic of Korea. Objectives and procedures differed on the two cruises, as noted below.

Cruise SEI 77-9

The Polish research vessel RV Professor Seidlecki conducted cooperative groundfish sampling from northern California to near Kodiak Island, Alaska, from July through September, 1977. Ichthyoplankton was collected by the Polish scientists in the Gulf of Alaska (Fig. 49), from northern California to northern Washington (Fig. 50), and off Vancouver Island (Fig. 51). Ninety-nine stations were occupied. Wojciech Sztajnduchert was in charge of plankton sampling for the Polish side; Jay Clark was the American representative.

Sampling procedures generally followed MARMAP methods. NWAFC bongo and Sameoto samplers were used at most stations. Copenhagen nets (Schmidt 1929) were used at some stations. Extensive CTD casts were made throughout the region sampled. For the U.S., Jay Clark attempted to collect and rear larvae (target taxon Sebastes spp.) from neuston tows.

Plankton was sorted at the Plankton Sorting Center in Szczecin, Poland. Bulk plankton is stored at the Center in Poland, eggs and larvae at NWAFC. Labels in vials read: cruise (Seidlecki 77-9), station (e.g., 071), gear (e.g., 6B5), date (e.g., 13.07.77), taxon and number of specimens.

Gadids, myctophids, osmerids, flatfishes, and scorpaenids were the dominant larvae collected. This cruise was documented (in Polish) by

Grimm and Sztajnduchert (1978). A report of the U.S. rearing efforts was prepared by Clark (1977). Hydrography appears in Polish in Anon. (1978).

#### Cruise 1 OD 80

The Korean research vessel RV Oh Dae San sampled plankton from south of Juneau, Alaska, along the Gulf of Alaska, to just west of Dutch Harbor, Alaska, from July 1 through August 12, 1980. Forty-three stations were sampled (Fig. 52). Jay Clark was the U.S. investigator concerned with plankton sampling.

Oblique tows of 60-cm bongo nets were made at each plankton station. Environmental data were collected at 38 stations (reversing thermometers and bottle casts were employed at 0, 10, 10, 30, 50, 70, 100, 200, 300, 400, and 500 m), and BT's were taken at other stations.

Labels in vials read cruise (1 Oh Dae San 80), station (e.g., 01A), gear (6B5) and date (e.g., 16.07.80). Information from this cruise exist as raw data only.

Coastal Investigations: U.S. and U.S. - U.S.S.R. Cooperative Studies from  
Northern California to Northern Washington, 1980-1988

In 1980 the NWAFC and TINRO began joint ichthyoplankton surveys from the Straits of Juan de Fuca to Northern California (48°N-40°N). The purposes of these cruises were to determine seasonal and spatial distribution of ichthyoplankton in the area. Cruises were scheduled so as to sample all seasons of the year (Fig. 53). Also, there have been cruises conducted independently aboard U.S. vessels. As noted below, special studies were sometimes conducted to determine the distribution of Dungeness crab larvae, sablefish, and saury larvae. Also, cephalopod larvae were removed from all samples.

Standard MARMAP procedures was used. A grid of 125 stations extending from 3-200 miles from shore was normally occupied. Paired 60-cm bongo nets with 505 um mesh were deployed to ca. 200 m. Two simultaneous neuston tows using 0.3-m high by 0.5-m wide Sameoto samplers with 505 um mesh were made at 2 knots for 10 min at each station. The Soviets retained one of the paired neuston and bongo samples, while the Americans retained the other. Hydrographic casts were made at each station to standard depths (0, 10, 20, 30, 50, 75, 100, 150, 200, 250, 300, 400, 500, 600 m) as water depth permitted. On some cruises, temperature, salinity, oxygen, phosphate, and silicate determinations were made aboard ship.

The U.S. plankton samples were processed by the Plankton Sorting Center in Szczecin, Poland, where plankton displacement volumes were determined for bongo samples, fish eggs and larvae and Dungeness crab larvae were removed. The fish eggs were counted; the larvae were identified,

counted and measured. Fish eggs were identified at NWAFC. Bulk plankton samples are stored at the Polish Plankton Sorting Center; ichthyoplankton samples are stored at NWAFC.

#### Cruise 1 TK 80

The first cooperative U.S.-U.S.S.R. ichthyoplankton cruise off coastal Oregon and Washington was conducted aboard the RV Tikhookeanski from April 20 through May 15, 1980 (Fig. 54). M. Stepanenko was Chief Scientist. J. Dunn, E. Dunning, and B. Brinton served as American scientists aboard the cruise.

Eggs taken in the neuston net were dominated by Bothidae, Engraulis mordax, Microstomus pacificus, and Trachipterus altivelis. In bongo nets, dominant eggs belonged to Myctophidae, Bothidae, and Lyopsetta exilis. Larvae collected in the neuston net were dominated by Anoplopoma fimbria, and Hemilepidotus spinosus. Stenobrachus leucopsarus larvae dominated bongo samples, followed by larvae of Osmeridae, Bathylagus ochotensis, Diaphas theta and Sebastes spp. Labels in vials of ichthyoplankton read cruise (1TK80), station (e.g., GO22A), gear (e.g., 6B5; N505), date (e.g., 22.IV.80) and taxon and number of specimens.

This cruise was documented by Kendall and Clark (1982a).

#### Cruise 1 PO 80

The second cooperative U.S.-U.S.S.R. ichthyoplankton survey off the U.S. west coast was conducted aboard the RV Poseydon from August 1-20, 1980. Only 91 stations of the standard grid were occupied (Fig. 55). Yu. K. Demidenko was Chief Scientist. Susan Simon and Ralph Honeycutt served as U.S. scientists.

In the neuston net, egg collections were dominated by Bothidae, with eggs of Pleuronectidae, Tactostoma macropus, and Psettichthys melanostictus also occurring. In the bongo net, eggs of Bothidae and Trachurus symmetricus were the most abundant. Larvae taken in the neuston net were dominated by Engraulis mordax, Sebastes spp., and Ronquilus jordani. In the bongo net, E. mordax larvae dominated the collections followed by larvae of Sebastes spp. Labels in vials of fish eggs and larvae read cruise (1P080), station (e.g., G083A), gear (e.g., 6B5; N505), date (e.g., 20.8.80), and taxon and number of specimens.

This cruise was documented by Kendall and Clark (1982b).

#### Cruise 1 PO 81

The third cooperative U.S.-U.S.S.R. ichthyoplankton survey of waters from northern California to northern Washington was conducted from May 9 to June 2, 1981 by the RV Poseydon (Fig. 56). Igor Zhuteyev was Chief Scientist. Elizabeth Dunning and Susan Simon served as American scientists.

In the neuston net, egg collections were dominated by Sebastolobus spp., Bothidae, Icichthys lockingtoni, Trachipterus altivelis, and Microstomus pacificus. In the bongo net, eggs of Myctophidae and Lyopsetta exilis were most abundant. Larval collections in the neuston net were dominated by Stenobranchius leucopsarus, Cololabis saira, Diaphus theta, Sebastes spp., and Scorpaenichthys marmoratus. In the bongo net, larvae of Stenobranchius leucopsarus, Diaphus theta, Sebastes spp., and Bathylagus ochotensis were most abundant. Labels in vials of ichthyoplankton read cruise (1P081), station (e.g., G083A), gear (e.g., N505; B65), date (e.g., 20.5.81), and taxon and number of specimens.

This cruise was documented by Clark (1984).

Cruise 1 DA 81

The fourth U.S.-U.S.S.R. cooperative ichthyoplankton survey was conducted off northern California to northern Washington from October 24 through November 19, 1981 (Fig. 57) aboard the RV Mys Dalniy. Yu. K. Demidenko was Chief Scientist. American scientists were Jay Clark and Steve Moulton.

In the neuston net, egg collections were dominated by Icichthys lockingtoni, Trachipterus altivelis, Citharichthys spp., and Pleuronectidae. In the bongo net, eggs of Bothidae, Pleuronectidae, Citharichthys spp., Icichthys lockingtoni, Trachipterus altivelis, Parophrys vetulus, and Chauliodus macouni were most abundant. Larvae taken in the neuston net were dominated by Cololabis saira, Engraulis mordax, Hexagrammos decagrammus, Scorpaenichthys marmoratus, and Tarletonbeania crenularis. In the bongo net, larvae of Citharichthys spp., Sebastes spp., T. crenularis, and Protomyctophum crockeri were most abundant. Labels in vials of fish eggs and larvae contain the following information: cruise (1DA81), station (e.g., G083A), gear (N505; B65), date (e.g., 25.10.81), and taxon and number of specimens.

The results of this cruise were documented by Bates (1984).

Cruise 1 PO 82

The fifth cooperative cruise between NWAFC and TINRO was conducted from May 3 through June 1, 1982, aboard the RV Poseydon. One hundred twenty-four stations were occupied (Figs. 58, 59). The Chief Scientist was A. Artemov. Richard Bates, Jay Clark, and Elizabeth Dunning were U.S. scientists.

Objectives of this cruise differed somewhat from the four previous cruises. Because sampling was scheduled during the same time period as cruise 1 PO 81, routine sampling was considered redundant. Paired neuston samples were taken at each station and preserved in alcohol. Only 49 regular bongo tows were made. Additionally, seven experimental deep bongo tows (at stations 5, 8, 15, 23, 29, 37, and 45) were made in attempts to obtain eggs of sablefish, Anoplopoma fimbria.

Neuston samples were sorted for crab larvae at the request of Rick Methot (SWFC). Saury (Cololabis saira) larvae were preserved for age and growth studies conducted by John Butler (SWFC). The sablefish larvae collected were given to George Boehlert (Oregon State University) and Bori Olla (NWAFC, Newport, Oregon) for studies of feeding behavior. Some results of these studies have been published (Boehlert and Yoklavich 1985, Grover and Olla 1986, Shenker and Olla 1986).

Eggs taken in the bongo nets were dominated by Myctophidae and Lyopsetta exilis. Because of preservation techniques there are no egg data for the neuston samples. Larvae collected with the neuston net were dominated by Sebastes spp., Hemilepidotus spinosus, and Anoplopoma fimbria. In the bongo nets, Stenobranchius leucopsarus, Diaphus theta, Sebastes spp., and Myctophidae were the dominant larvae.

Labels in vials of ichthyoplankton include: cruise (1P082), station (e.g., G023A), gear (6B5) and date (e.g., 11.05.82). This cruise has been documented by Clark (1986b).

#### Cruise 1 EQ 83

The next cooperative NWAFC-TINRO cruise was conducted aboard the RV Equator from April 23 through May 15, 1983 (Fig. 60). This cruise was

conducted during an El Nino year and, hence, allowed comparison of collections of ichthyoplankton with a non El Nino year. Chief Scientist was M. Stepanenko. Richard Bates, Scott Leopold, and Robert Francis were U.S. scientists.

Standard methods used in cruises one through four were continued, with bongo and neuston nets being used at each station. Vials of ichthyoplankton are labeled with cruise (1EQ83), station (e.g., G017), and gear (e.g., N505, B505), date (e.g., 26.04.83), taxon, and number of specimens.

Eggs collected in the neuston belonged to Bothidae, Engraulis mordax, Microstomus pacificus, and Trachipterus altivelis. In bongo nets, eggs taken included those of E. mordax, Cololabis saira, Myctophidae and Bothidae. Neustonic larvae were composed primarily of Hemilepidotus spinosus, Anoplopoma fimbria, E. mordax, and Sebastes spp. Larvae in bongo nets included Stenobranchius leucopsarus, Theragra chalcogramma, Bathylagus ochotensis, and Diaphus theta.

This cruise was documented by Clark and Kendall (1985).

#### Cruise 1 MF 83

The RV Miller Freeman was used to sample 113 stations on the standard grid from northern California to northern Washington from November 11 through December 2, 1983 (Fig. 61). This cruise was specifically designed to investigate ichthyoplankton during an El Nino year. Additionally, opportunistic benthic sampling was also conducted to collect Dungeness crab for David Armstrong (U.W.). Jay Clark was Chief Scientist and was assisted by Richard Bates and Laurel McEwen.

Standard sampling methods were used. Labels in vials of ichthyoplankton read cruise (1MF83), station (e.g., G012), gear (e.g., B505 or N), date (e.g., 16 Nov. 83), and taxon and number of specimens.

In the neuston net, egg collections were dominated by Pleuronectidae and Trachipterus altivelis, with Bothidae, Citharichthys spp., and Icichthys lockingtoni also being abundant. In the bongo nets, Pleuronectidae and Trachipterus altivelis were again dominant, with Bathylagidae and Bathylagus spp. present in abundance. Larval collections in the neuston net were dominated by Cololabis saira, Tarletonbeania crenularis, and Scorpaenichthys marmoratus. Larvae in the bongo nets were dominated by Stenobranchius leucopsarus.

This cruise has been documented by Clark (1986a).

#### Cruise 1 PO 84

The seventh cooperative U.S.-U.S.S.R. cruise was conducted aboard the RV Poseydon from March 11 through April 4, 1984. A total of 124 stations were sampled (Fig. 62). Y. Pashenko was Chief Scientist. American scientists were Coreene Stewart and Elliott Menoshe.

Twelve deep bongo tows (normally 570 meters of wire out) were made (stations 2, 12, 19, 30, 44, 50, 70, 84, 90, 104, 110, and 122) in attempts to collect sablefish eggs and early larvae.

Eggs taken in the neuston net were dominated by Microstomus pacificus, Pleuronectidae, and Trachipterus altivelis. In the bongo nets, the egg catch was predominantly Myctophidae. Larvae in the neuston net were dominated by Hemilepidotus spinosus, Glyptocephalus zachirus, and Cololabis saira. Larval catches in the bongo nets were dominated by Stenobranchius leucopsarus.

Labels in vials read cruise (1P084), station (e.g., G069A), gear and mesh size (e.g., B505), date (e.g., 24.03.84), and taxon and number of specimens. Stations at which deep tows were made are labeled with a "B" (e.g., G070B). This is the first cruise in which samples are archived in 70% ethanol, and this preservation medium is listed on the inside jar label.

This cruise was documented by Clark and Savage (1988), and data on the eggs and larvae of sablefish are described in Kendall and Matarese (1987).

#### Cruise 1 BA 85

The R/V Mys Babushkina sampled ichthyoplankton from northern California to northern Washington from April 19 through May 11, 1985. A total of 124 stations was occupied (Fig. 63). Michael Stepenenko was Chief Scientist. Arthur Kendall, George Kautsky, and Kurt Brownell were U.S scientists aboard the vessel.

Data from this cruise have not been entered into our computer as of this writing.

#### Cruise 1 MF 87

The RV Miller Freeman was used to sample ichthyoplankton off the Washington-Oregon-California coast from January 7-31, 1987. The purpose of this cruise was to: 1) collect seasonal and geographical data on the distribution of fish eggs and larvae; 2) collect associated hydrographic data; and 3) collect information for a cooperative study with the Southwest Fisheries Center on sablefish (Anoplopoma fimbria) eggs. Ninety-eight stations were occupied (Fig. 64). Jay Clark was Chief Scientist.

Sampling consisted of eighty-eight 60-cm bongo (505 um mesh) stations, 88 neuston (505 um mesh) stations, and 28 1-m Tucker trawls (505 um mesh). The Tucker trawls were special deep tows for sablefish eggs and larvae.

Labels in the vials of ichthyoplankton list cruise (e.g., 1MF87), station (e.g., G013A), taxon and number of specimens, gear (e.g., 6B5), and date (e.g., 13.01.87). Of these data, only the Tucker trawl data have been processed. These samples were sorted inhouse and at Oregon State University where Doug Markle retained the Microstomus pacificus larvae. The Tucker trawl data have been entered into our computer files.

Gulf of Alaska walleye pollock investigations, 1981-1988

In 1981, the NWAFRC initiated studies of the early life history of walleye pollock in the northwestern Gulf of Alaska. These studies have included cooperative surveys with the U.S.S.R. (TINRO, Vladivostok) which were conducted in 1981, 1982, and 1984-1988. The purpose of these studies was to assess the spatial distribution and abundance of this species. Results from these investigations will be used to evaluate using the abundance of eggs and larvae to estimate spawner biomass of walleye pollock in this area. An understanding of the dynamics of the planktonic stages of walleye pollock in this area is another primary objective.

The distribution of walleye pollock eggs and larvae from cruises conducted during 1981-1984 was documented by Dunn et al. (1984).

Cruises 1 SH 81, 2 SH 81, and 3 SH 81

The Soviet RV Shantar sampled 250 stations during three cruises. The first cruise (stations 1-133), was from March 5-18, 1981 (Fig. 65); the second (stations 134-193) from April 16-24, 1981 (Fig. 66); and the third (stations 194-250) from May 20-28, 1981 (Fig. 67). N. S. Fadeev was Chief Scientist. Steve Moulton and Beverly Brenton were U.S. scientists. Arthur Kendall was aboard the beginning of 1 SH 81.

A bongo (60-cm) tow was made at each station sampled. One 505 um mesh sample was kept by the U. S. and one by the U.S.S.R. Paired simultaneous neuston tows (with Sameoto samplers) were made on two cruises (1SH81 and 2SH81); each country kept one of the samples. The American samples were processed by the Plankton Sorting Center in Szczecin, Poland.

Hydrographic casts to standard depths (0, 10, 20, 30, 50, 75, 100, 150, 200, 250, 300, 400, 500, and 600 m) were made where water depth permitted. After each station temperature, salinity, oxygen, phosphate, and silicate determinations were made aboard ship.

Neuston samples were dominated by eggs of Theragra chalcogramma, Hippoglossoides elassodon, and other pleuronectids. Larvae in the neuston samples included Hexagrammos decagrammus, Hemilepidotus spp., Pleurogrammus monopterygius, and Mallotus villosus during 1 SH 81; Lyconectes aleutensis, Mallotus villosus, and Hemilepidotus spp. were abundant during 2 SH 81.

In bongo nets, eggs were dominated by Theragra chalcogramma during 1 SH 81 and by T. chalcogramma, Hippoglossoides elassodon, and other pleuronectids during 2 SH 81. During 3 SH 81, eggs of Microstomus pacificus and Glyptocephalus zachirus were the dominant species.

Larvae collected in the bongo nets were dominated by Ammodytes hexapterus, Mallotus villosus, and Hexagrammos decagrammus during 1 SH 81. By 2 SH 81, Theragra chalcogramma displaced Ammodytes hexapterus as the dominant species of larva. Bathymaster sp., Hippoglossoides elassodon, and Lepidopsetta bilineata were also abundant. Labels in vials of ichthyoplankton read cruise (1SH81), station (e.g., 206), gear (6B5, N), taxon, number of specimens, and date (e.g., 25.05.81).

These cruises were documented in Bates and Clark (1983).

#### Cruises 1 MF 81, 2 MF 81, 3 MF 81, and 4 MF 81

The RV Miller Freeman sampled 281 stations during four cruises from March 12 through May 24, 1981. The first cruise (1MF81) extended from March 12-20 (Fig. 68), cruise 2 MF 81 was from March 30 through April 8 (Fig. 68), 3 MF 81 from April 26 through May 2 (Fig. 69) and 4 MF 81 from

May 20-24 (Fig. 69). Arthur Kendall, Jay Clark, Ann Matarese, and Jean Dunn directed the plankton sampling.

Bongo tows (60-cm diameter with 0.505 um mesh) were made at each station to a target depth of 200 m. At each station, a CTD cast was made to near bottom. Plankton samples were processed at the Plankton Sorting Center, Szczecin, Poland.

Eggs of Theragra chalcogramma and larvae of Ammodytes hexapterus dominated collections in the neuston net in cruises 1 MF 81 and 2 MF 81 (The neuston net was not used during cruises 3 MF 81 and 4 MF 81). Eggs in bongo samples were dominated by T. chalcogramma in cruises 1 MF 81 and 2 MF 81, and by T. chalcogramma, Hippoglossoides elassodon, and Pleuronectidae during cruises 3 MF 81 and 4 MF 81. Larvae in the bongo nets were dominated by A. hexapterus, Mallotus villosus, and Hexagrammos decagrammus during cruises 1 MF 81 and 2 MF 81. By 3 MF 81, T. chalcogramma replaced A. hexapterus as the dominant form. Labels in vials contain the following information: cruise (e.g., 1MF81), station (e.g., G65A), gear (e.g., B505), taxon, number of specimens, and date (e.g., 01.04.81).

These cruises were documented by Bates and Clark (1983).

#### Cruises 1 DA 82 and 2 DA 82

The Soviet RV Mys Dalniy sampled ichthyoplankton in the vicinity of Kodiak Island, Alaska, from April 4 through May 31, 1982. The ichthyoplankton sampling conducted in Shelikof Strait in 1980 and 1981 yielded large numbers of walleye pollock eggs. The surveys aboard the Mys Dalniy in 1982 were designed to see if there were any other spawning concentrations between Kodiak Island and Unimak Pass. Cruise 1 DA 82 occupied 83 stations

between April 4-23 (Fig. 70) and cruise 2 DA 82 sampled 62 stations from May 21-31 (Fig 71). Stanislav Pismak was Chief Scientist. U.S. scientists were Herb Shippen, Sarah Hinckley, Peter Mullen, and Coreene Stewart.

Sampling procedures followed those used on the R/V Shantar in 1981. Bongo and paired neuston tows were made at each station; each country kept one of the plankton samples. The American samples were sorted by the Plankton Sorting Center in Szczecin, Poland.

Labels in vials of ichthyoplankton read cruise (1MD82), station (e.g., G115A), gear (e.g., 6B5), taxon and number of specimens, and date (e.g., 25.05.82).

These data are in our computer files.

#### Cruise 1 CH 83

The RV Chapman was used to sample ichthyoplankton between southwestern Kodiak Island and the Shumagin Islands from May 16-28, 1983. The purpose of this cruise was two-fold: (1) to chart the distribution of walleye pollock larvae in the area; and (2) to study the vertical distribution, feeding, and growth of walleye pollock larvae during a 48-h station. Sixty-two stations were occupied (Fig. 72); additionally, eleven neuston tows were made enroute to Kodiak from Seattle (Fig. 73). Arthur W. Kendall was Chief Scientist.

At each station, a neuston tow, a 60-cm bongo haul, and an XBT cast were made. At 15 of these stations, CTD casts were also made. One net of the bongo array (each net was 505 um mesh) was preserved entirely for sorting on shore while pollock larvae were picked out of the other sample and preserved in ethanol for otolith aging. At the 48-h station, studies were made to determine the diurnal vertical distribution of pollock larvae and their food. A series of four 20-cm bongo samplers, each with 333 um

and 253  $\mu$ m mesh nets were fished simultaneously at 10-m intervals. After preliminary tows, sampling every 10 m from 10-90 m, it was decided to sample at 20, 30, 40, and 50 m with the 20-cm bongos for 10 min every 4 h (1030, 1430, 1830, 2330, 0230, 0630 local time). At the 1430 and 0230 stations a Tucker trawl was towed at 35 m for 10 minutes and an XBT was cast. During the second 24-h period, a 60-cm bongo was fished approximately 2 m below the deepest 20-cm bongo to stabilize the wire and to allow comparisons of catches between the 20 and 60-cm bongo nets.

All plankton samples were sorted at the Polish Plankton Sorting Center. Stomach contents of larval pollock were also identified at the Center. Labels in vials list cruise (1CH83), station (e.g., G63A or D63B), gear and mesh size (e.g., B333 or TT #1), taxon, number of specimens, and date (e.g., 28.05.83).

Results from this cruise are documented in Kendall et al. (1987).

#### Cruise 1 CH 84 - 5 CH 84

The RV Chapman conducted ichthyoplankton sampling in Shelikof Strait, Alaska, from March 19 through April 14, 1984 (Figs. 74-78). These cruises were divided into 2 legs (Leg I, from March 19 through April 1 [1CH84-4CH84], and Leg II, from April 3-8 [5CH84]). The purposes of the cruise were to: (1) determine the distribution and abundance of walleye pollock eggs, and (2) collect ichthyoplankton samples around one or more drogues to investigate mortality rates of walleye pollock eggs. Arthur W. Kendall was Chief Scientist on Leg I, and Ann C. Matarese was Chief Scientist on Leg II.

In order to determine the onset of spawning, stations were occupied two to four times during leg I. At each station, a 20-cm bongo net (505  $\mu$ m mesh) was fished to 70 m and later to near bottom (or to a maximum depth

of 200 m). One net of the bongo array was preserved, and the majority of these plankton samples were sorted onboard the vessel. Pollock eggs were identified, enumerated, and aged. At an area of high abundance of early stage (about 3 days old) pollock eggs, a drogue was deployed at two stations to track the water and a series of replicate tows were made. The following tows were made in quick succession: five 20-cm bongo tows to 70 m, three 60-cm bongo tows to 70, one 60-cm bongo tow to 200 m and one 20-cm bongo tow to 200 m. During leg I, stations 7, 8, 11, and 12, in an area of high abundance of eggs, were resampled (stations designated S7, S8, S11, and S12).

During leg II the stations occupied during leg I were reoccupied; 20-cm bongo nets were deployed to near bottom or to a maximum depth of 200 m in order to continue monitoring egg abundance. Additionally, another drogue was deployed at the same area of abundance determined during leg I (eggs about 12 days old) and a series of five 20-cm bongo tows were made to 200 m; a second series of tows were made 48 h later.

Samples from this cruise were sorted at NWAFC and these data are in the computer. Labels in vials indicate cruise (e.g., 5CH84), station (e.g., G056A), gear (e.g., 2B5), date (e.g., 08.04.84), taxon and number of specimens. Labels on the lids indicate net number (e.g., 1).

#### Cruise 1 SH 84

The Soviet RV Shantar conducted ichthyoplankton sampling in the western Gulf of Alaska from April 17 through May 9, 1984. A total of 179 stations was sampled (Fig. 79). E. Moiseev was Chief Scientist. Herb Shippen, Janna Gross, and Jim Stark were the U.S. representatives.

The work on the Shantar consisted of surveys in two areas with two separate objectives. A survey between Middleton Island and Kodiak Island, including the Amatuli Trough area, was designed to determine if there was evidence (in terms of eggs and larvae) of a concentration of spawning walleye pollock in the area. Earlier ichthyoplankton surveys, and fishermen's reports, indicated that such concentrations might have been present. The second survey was of the shelf region southwest of Shelikof Strait to the Shumagin Islands. The purposes of this survey were to trace the larvae resulting from the Shelikof Strait walleye pollock spawning, and to determine if any significant spawning had occurred near the edge of the shelf, west of Kodiak Island, as had been observed in earlier years.

Sampling methods included two simultaneous neuston tows at each station. Standard MARMAP paired 60-cm bongo tows (505 um mesh) were made to 200 m (or near bottom at shallower stations). One neuston sample and one bongo sample was retained by each country. Standard hydrographic casts were made at each station.

Eggs in the neuston net were predominantly those of Theragra chalcogramma and Hippoglossoides elassodon. The eggs of Glyptocephalus zachirus, Microstomus pacificus, teleost type A, and Sebastolobus spp. were also abundant. The collections from the bongo nets were dominated by Theragra chalcogramma, Hippoglossoides elassodon, and Glyptocephalus zachirus eggs. In the neuston net, Theragra chalcogramma, Hexagrammos decagrammus, Lyconectes aleutensis, and Ammodytes hexapterus were dominant. Theragra chalcogramma, Ammodytes hexapterus, Gadus macrocephalus, Atheresthes stomias, and Stenobranchius leucopsarus were the dominant species in the bongo nets.

Labels in vials list cruise (e.g., 1SH84), station (e.g., G013A), taxon and number of specimens, gear (e.g., 6B5), and date (e.g., 21.04.84). This cruise has been documented by Bates (1987).

Cruises 1 PO 85 and 2 PO 85

The RV Poseydon sampled ichthyoplankton in the western Gulf of Alaska from March 29 through June 8, 1985. Three-hundred forty stations were occupied (Figs. 80, 81). The purpose was to provide a wide survey of the distribution of walleye pollock eggs and larvae in the Kodiak Island area and to investigate possible spawning of walleye pollock in the Amutuli Trough. V. Pashenko was Chief Scientist. Arthur Kendall, Coreene Stewart, and Tom Morrison were the U.S. representatives. Sampling procedures followed those used on Mys Dalniy in 1982.

On cruise 1PO85, egg abundances in both the neuston and bongo nets were dominated by Theragra chalcogramma. The larval catches in the neuston net were dominated by Hexagrammos decagrammus, while Ammodytes hexapterus and Theragra chalcogramma were the dominant species in the bongo nets.

During cruise 2PO85, egg catches were more diversified. In the neuston net, Clupea harengus pallasii eggs (usually attached to pieces of seaweed) were dominant and Theragra chalcogramma eggs were quite abundant. In the bongo nets, Microstomus pacificus eggs were dominant. Theragra chalcogramma and unidentified pleuronectid eggs were also quite prevalent. Neuston sampling showed Ammodytes hexapterus larvae to be dominant, with Mallotus villosus, Lyconectes aleutensis, and Hexagrammos decagrammus being abundant. In the bongo nets, Theragra chalcogramma, Bathymaster spp., Hippoglossoides elassodon, and Ammodytes hexapterus were the dominant species.

Labels in vials indicate cruise (e.g., 1PO85), station (e.g., G013A), taxon and number of specimens, gear (e.g., B333), and date (e.g., 13.04.85). This cruise has been documented by Kendall and Ferraro (1988).

Cruise 1 GI 86

The Soviet RV Gissar conducted ichthyoplankton sampling in the western Gulf of Alaska from March 30-April 20, 1986. There were 149 stations occupied (Fig. 82). The purpose of this cruise was to complement on-going FOCI walleye pollock investigations and provide a wide survey of the distribution of eggs and larvae. Coreene Stewart and Scott Leopold were the U.S. representatives.

Sampling procedures followed those used on the Shantar in 1981. Labels in vials of ichthyoplankton list cruise (e.g., 1GI86), station (e.g., G013A), taxon and number of specimens, gear (e.g., 6B5), and date (e.g., 13.04.86). The data from this cruise have been entered in our computer files.

Cruise 1 BB 87

The Soviet RV Babagevsk was used for ichthyoplankton sampling between Prince William Sound and Unimak Pass, Alaska, from April 9-27, 1987. The objective of this cruise was to compliment FOCI investigations and provide a wide survey of the distribution of walleye pollock eggs and larvae in the western Gulf of Alaska. Valerie Pashenko was Chief Scientist and Tom Morrison was the U.S. representative.

Sampling procedures followed those used on the Shantar in 1981. Samples were collected at 117 stations (Fig. 83). The samples from this cruise have been sorted but no data from this cruise have been entered into our computer files.

Cruise 1 DN 88

The Soviet RV Darvin conducted ichthyoplankton sampling in the western Gulf of Alaska and the eastern Bering Sea from March 18-May 8,

1988. The objectives of this cruise were to: 1) study wide scale distribution of pollock eggs and larvae; 2) look for evidence of pollock spawning in the eastern Bering Sea; 3) sample plankton in the vicinity of the satellite tracked drifters released during cruise 10C88. N. Fadeev was Chief Scientist, and Scott Leopold and Jay Clark were the U.S. representatives.

Samples were collected at 203 stations using 60-cm bongo samplers (505 um mesh) (Fig. 84). Each country kept one of the samples. The samples from this cruise have not yet been sorted.

FOX and FOCI Investigations, 1985-1988

In 1985, NWAFC and the Pacific Marine Environmental Laboratory (PMEL) began a cooperative program to investigate the physical and biological factors affecting recruitment processes of the walleye pollock in the Gulf of Alaska. This project, called FOX (Fisheries-Oceanography Experiment), led to a newly funded initiative, FOCI (Fisheries-Oceanography Cooperative Investigations). FOCI was formed to study recruitment mechanisms of commercially important fishery stocks in relation to the biotic and abiotic environment associated with their reproductive patterns. Currently, FOCI is studying the walleye pollock stocks in the Gulf of Alaska and eastern Bering Sea.

Investigations in the Bering SeaCruise MF 86-02

The RV Miller Freeman conducted ichthyoplankton sampling in the eastern Bering Sea and CTD casts on FOX line 8 in Shelikof Strait, Alaska, between February 2 and March 3, 1986. This was the first FOCI cruise of Recruitment Investigations in the Bering Sea (RIBS). The main objective of this cruise was to locate and sample aggregations of spawning pollock over the Aleutian Basin in order to examine reproductive biology and the physical regimes that might influence transport and survival of the early life stages. Kevin Bailey was the Chief Scientist.

Ichthyoplankton was collected at forty-six stations with a 60-cm bongo sampler (333 um mesh), and at seven stations with a 1 m Tucker trawl (505 um mesh)(Fig. 85). Bongo stations are denoted with the letter G or S, while Tucker trawls are denoted by letter V. CTD casts were made at fifty stations, including seven on FOX line 8 in Shelikof Strait.

Labels in vials list cruise (e.g., MF8602), station (e.g., G2), taxa, number of specimens, gear (e.g., Tucker trawl .505), haul number, and in the case of Tucker trawls, depth sampled. These data have been entered into our computer files.

#### Cruise 1 OC 88

The RV Oceanographer was utilized for sampling in the eastern Bering Sea, for FOCI 88-I from March 11-April 4, 1988. The objectives of this cruise were to: 1) conduct a search for pollock eggs and larvae along the continental slope; 2) collect CTD data to study exchange of water properties between shelf and slope waters; 3) recover and deploy bottom pressure recorders for PMEL tsunami project; and 4) deploy 6 satellite tracked drifters. Judith Gray was the Chief Scientist and Sarah Hinckley was in charge of biological sampling.

Fifty-seven stations were sampled with a 60-cm bongo sampler (333 um mesh) deployed to 400 m or as close to bottom as possible, and one Tucker trawl series (333 um mesh) was done (Fig. 86).

The samples from this cruise have not yet been sorted.

#### Gulf of Alaska Investigations

##### Cruise 1 DI 85

The RV Discoverer conducted zooplankton sampling from Shelikof Strait westward to about 158° W during the first cruise of FOX (FOX 85-I) from March 11 through April 2, 1985. Sixty-nine stations were sampled (Fig. 87). The objectives of zooplankton sampling were twofold: 1) to determine the community composition and standing stock in various water masses; and 2) to provide initial conditions for the estimation of population growth rates based on data collected during subsequent cruises. Jim Schumacher was Chief Scientist and Sara Maupin conducted the biological sampling.

Zooplankton samples were collected using a 333 um mesh net on a 60-cm bongo frame deployed in standard MARMAP tows to near bottom. Microzooplankton were collected using 10 liter Niskin bottles; water from the bottles was filtered through 60 um mesh nets. Thirteen stations were sampled at six depths. Nutrient and chlorophyll samples were collected at multiple depths at 25 and 23 stations, respectively, and 188 CTD casts were made.

Data from this cruise have been entered into our computer files, and zooplankton communities and abundances have been documented in Siefert et al. (1988).

#### Cruise 1 MF 85

The RV Miller Freeman conducted ichthyoplankton sampling in Shelikof Strait, Alaska, from April 1-12, 1985. A total of 98 stations was sampled (Fig. 88). This cruise was the second FOX cruise (FOX 85-II). The purposes of this cruise were twofold: 1) to determine the horizontal distribution and abundance of walleye pollock eggs and to locate the "patch" of maximum concentration; and 2) to investigate the vertical distribution and mortality rates of walleye pollock eggs by sampling around drogues located in the patch of maximum egg densities. Ann C. Matarese was Chief Scientist.

Sampling equipment consisted of 20-cm bongo samplers (333 um mesh), and for stability, 60 cm bongo nets, which were for stability, fished in oblique MARMAP style tows to near bottom. A 24-h study was conducted around a drogue to determine the vertical distribution of eggs. Every 6-h a series of four Tucker trawl tows were made: two tows at intermediate depths (50-110 m and 110-170 m) and two tows in deeper water (170-230 m

and 230-270 m). CTD profiles and water samples for nutrient analysis were taken at selected transects.

Data from this cruise have been entered into our computer files, and zooplankton communities and abundances documented in Siefert et al. (1988).

#### Cruise 2 MF 85

The RV Miller Freeman sampled ichthyoplankton in Shelikof Strait from May 1-12, 1985, as FOX 85-III. A total of 154 stations was sampled (Fig. 89). The purposes of this cruise were as follows: 1) locate and measure the high abundance patch of pollock larvae; 2) examine the vertical distribution of pollock larvae through two 24-h periods; 3) conduct additional sampling of ichthyoplankton west of Shelikof Strait; and 4) sample net zooplankton, microzooplankton, chlorophyll, and nutrients. Lew Incze was Chief Scientist.

Sampling equipment consisted of 60-cm bongo samplers (505 and 333  $\mu$ m mesh) deployed in standard MARMAP tows to near bottom. Microzooplankton was sampled at 10 m intervals to 60 m using 10 liter Niskin bottles. Water from the bottles was filtered through 60  $\mu$ m mesh nets. Separate deployments of the Niskin bottles were used to collect water samples for measurement of chlorophyll and nutrient concentrations. CTD data were collected at selected stations.

The data from this cruise have been entered into our computer files, and the zooplankton communities and abundances have been documented in Siefert et al. (1988).

#### Cruise 2 DI 85

The RV Discoverer was used for FOX 85-IV from July 23 through August 2, 1985, from western Shelikof Strait to the Semidi Islands. The principal

objective of the cruise was recovery of seven current meters mooring deployed 1 yr earlier for FOX. Zooplankton samples (60-cm bongo, 333 um mesh) were collected at 11 stations (Fig. 90) so as to continue the 1985 time series on zooplankton community composition and abundance. Fourteen nutrient and chlorophyll stations were sampled and 36 CTD casts were made. Jim Schumacher was Chief Scientist and Lew Inze conducted the biological sampling.

These samples have not been sorted for ichthyoplankton, but the zooplankton communities and abundances have been documented in Siefert et al. (1988).

#### Cruise 3 MF 85

The RV Miller Freeman was used for the fifth FOX cruise in the calendar year 1985 and the first cruise of the fiscal year 1986 (hence the cruise designation of FOX 86-I). The cruise lasted from October 1 through November 2, 1985, and extended from the Kenai Peninsula, through Shelikof Strait, west to the Shumagin Islands and seaward to the continental slope. The principal objectives of the cruise were the deployment of current meter arrays at eight locations and the collection of CTD data at 193 stations. Nutrient and zooplankton samples were collected at a few stations to extend the annual data set evolving from the four earlier cruises in 1985. Poor weather conditions permitted sampling at only six locations (Fig. 91) of the 14 originally planned. Jim Schumacher was Chief Scientist.

Zooplankton samples were collected with double oblique tows using a 60-cm bongo sampler fitted with 333 um mesh nets. The samples collected during this cruise have not been sorted for ichthyoplankton. The

zooplankton communities and abundance have been documented by Siefert et al. (1988).

#### Cruise 1 MF86

The RV Miller Freeman was used for FOX 86-II from April 2-13, 1986. Ichthyoplankton was collected at 97 stations in the Shelikof Strait, Alaska (Figs. 92a, 92b). The main objectives of this cruise were to: 1) survey the distribution and abundance of walleye pollock eggs in the FOX study area; 2) measure the specific gravity of planktonic pollock eggs; 3) collect stomachs from adult pollock to assess the impact of cannibalism on egg mortality; 4) collect and freeze a length-sex stratified sample of adult pollock to study reproductive biology; 5) collect temperature and salinity data at selected stations; and 6) investigate the vertical distribution of pollock eggs. Arthur W. Kendall was Chief Scientist.

Horizontal distribution of ichthyoplankton was investigated with 60-cm bongo samplers (505 um mesh) towed in standard MARMAP tows to near bottom. Vertical distribution was studied with large and small Clark-Bumpus samplers (505 um mesh).

Labels in vials of ichthyoplankton list cruise (e.g., 1MF86), station (e.g., G013A), taxon and number of specimens, gear (e.g., 6B5), and date (e.g., 13.04.86). These data have been entered into our computer files.

#### Cruise 2 MF 86

The RV Miller Freeman conducted sampling in Shelikof Strait, Alaska, from May 1-19, 1986, on FOX 86-III. The objectives of this cruise were to: 1) collect zooplankton, hydrographic, and nutrient data at FOX time-series stations; 2) conduct a survey of the FOX study area to map the distribution and abundance of larval walleye pollock; 3) conduct a 2-4

day drogue study at the area of greatest abundance, examining vertical distribution of ichthyoplankton, net zooplankton and microzooplankton; 4) examine horizontal shears at MOCNESS tow sites with a ship-mounted doppler current profiler; 5) examine small-scale plankton patchiness (larval feeding environments) with Ortnet net-camera; 6) deploy satellite tracked drifters; 7) obtain live larval specimens with minimum damage for aging, shrinkage and dry weight studies; 8) conduct CTD casts at FOX current meter moorings; and 9) obtain ground-truth wind speed and direction and atmospheric data in the vicinity of remote weather station on Ugaishak Island. There were 166 stations occupied (Fig. 93). Lew Incze was the Chief Scientist.

Sampling equipment consisted of 20-cm and 60-cm bongo samplers (150  $\mu$ m and 333  $\mu$ m mesh respectively) deployed in standard MARMAP tows to near bottom. The MOCNESS (multiple opening-closing net and environmental sampling system)(Weibe et al. 1976) was equipped with 153  $\mu$ m mesh. Microzooplankton, nutrients and chlorophyll were sampled with Niskin bottles deployed on the CTD array. There were 77 CTD casts on this cruise.

Labels in the vials of ichthyoplankton collected with the bongo samplers list cruise (e.g., 2MF86), station (e.g., G013A), taxon and number of specimens, gear (e.g., 6B3), and date (e.g., 13.05.86). Labels in vials of ichthyoplankton collected with the MOCNESS list FOX86-III sample number, station and MOCNESS number(e.g., Sta. 78/MOC1), taxon and number of specimens, MOCNESS net number, Julian date and GMT of sample (e.g., 128-1612).

These data have been entered into our computer files.

Cruise 1 OC 86

The RV Oceanographer was used for the FOX 86-IV cruise in Shelikof Strait, Alaska, from July 28-August 16, 1986. The principal objective of this cruise was the recovery and deployment of long-term current-meter moorings in the FOX region and to occupy the FOX CTD grid to continue long-term monitoring of water properties in Shelikof Strait. Nutrients and zooplankton were also collected at time-series stations, and two satellite drifters were deployed. Judith Gray was the Chief Scientist.

Ichthyoplankton was collected at 7 stations (Fig. 94). The 60-cm bongo sampler (333 um mesh) was used at six stations and 20-cm bongo sampler (150 um mesh) at three.

Cruise 2 MF 87

The RV Miller Freeman was used for FOX 87-1 from April 2-17, 1987, to sample ichthyoplankton in Shelikof Strait, Alaska. The objectives of this cruise were to: 1) investigate horizontal and vertical distribution of walleye pollock eggs; 2) collect adult pollock to investigate egg predation and reproductive biology; 3) collect plankton samples to investigate invertebrate predation on pollock eggs; 4) collect CTD data and Niskin bottle samples at selected stations; 5) deploy satellite tracked drifters; and 6) deploy a current meter array. One hundred forty-three stations were occupied on this cruise (Fig. 95). Arthur W. Kendall was Chief Scientist.

Sampling gear consisted of 20-cm and 60-cm bongo samplers (150 um and 505 um mesh respectively), deployed in standard MARMAP tows to near bottom, the MOCNESS to investigate vertical distribution of larvae and eggs (153 um and 505 um mesh respectively) and Ortner net-camera.

Labels in vials list cruise (e.g., 2MF87), station (e.g., GO13A), taxon and number of specimens, gear (e.g., 6B5), and date (e.g., 13.04.87). These data have not yet been entered onto our computer files.

### Cruise 3 MF 87

The RV Miller Freeman was utilized for the FOX 87-II cruise in Shelikof Strait, Alaska, from May 18-29, 1987. One hundred eleven stations were occupied (Fig. 96). The objectives of this cruise were to 1) conduct physical and biological time-series measurements along FOX station lines 8, 16, and 17; 2) deploy satellite tracked drifters for a circulation study and then examine their transit with CTD transects; 3) study distribution and abundance of larval walleye pollock; 4) investigate fine scale vertical distribution of zooplankton and larval pollock in the upper water column; 5) investigate small scale patchiness with camera tows; and 6) collect samples for various studies on larval pollock growth (i.e. shrinkage with net handling and morbidity/mortality, shrinkage and dry weight loss during preservation, larval fresh dry weights, otolith examination, and RNA/DNA ratios). Lew Incze was Chief Scientist.

Sampling consisted of the MOCNESS sampling (153 um mesh), 20-and 60-cm bongo samplers (150 um and 333 um respectively) deployed in standard MARMAP tows to near bottom, the Ortner net-camera, experimental vertical tows using the bongo sampler with taped cod ends for the collection of live pollock larvae, and Niskin bottle samples for nutrient, microzooplankton, and chlorophyll studies. Fifty-seven CTD casts were performed.

Labels in vials of specimens collected with the bongo samplers list cruise (e.g., 3MF87), station (e.g., GO13A), taxon and number of species, gear (e.g., 683), and date (e.g., 25.05.87). Labels in vials of ichthyoplankton

collected with the MOCNESS sampler list cruise (e.g., 3MF87), station and sample number (e.g., St. 0077 sample 78), taxon and number of specimens, MOCNESS tow number and net number (e.g., MOC:10 NET-3), and date (e.g., 25.05.87). Samples collected on this cruise have been sorted, and a manuscript on the dynamics of growth in the early stage walleye pollock has been drafted (Yoklavich and Bailey, MS1988)

#### Cruise 4 MF 87 (Legs I and II)

The RV Miller Freeman was used for the FOX 87-III cruise which sampled in the western Gulf of Alaska from June 17-July 16, 1987. The objectives of this cruise were to: 1) survey the region for late larval walleye pollock; 2) recover 12 and deploy 4 current meter array moorings; and 3) collect CTD data at each of the moorings and at other selected stations along the sampling grid. Pollock were removed from the samples on board and preserved for studies on aging, stomach analysis, RNA/DNA studies of growth, and larval dry weights. Samples were collected at 148 stations (Fig. 97). Sarah Hinckley was Chief Scientist on leg I and Kevin Bailey was Chief Scientist on leg II.

Gears used on this cruise were the Methot mid water frame trawl (Methot 1986) towed in either an oblique or stepped fashion, 20- and 60-cm bongos (150  $\mu$ m and 333  $\mu$ m mesh respectively) fished in standard MARMAP oblique tows, and Tucker trawls (505  $\mu$ m mesh). Only data on the pollock sorted out of the samples on board, or fish mistakenly removed as pollock, have been entered into our computer files. Some of the data are reported by Hinckley et al. (in press) and in a manuscript by Yoklavich and Bailey (MS1988). The remainder of each sample was preserved in the usual fashion and these samples have not yet been sorted.

Cruise 1 MF 88

The RV Miller Freeman was utilized for ichthyoplankton sampling on FOCI 88-I, in Shelikof Strait, Alaska, from March 31- April 13, 1988. Samples were collected from a grid of 105 stations (Fig. 98). The purposes of this cruise were to: 1) conduct an ichthyoplankton survey in Shelikof Strait to determine horizontal patterns of distribution and abundances of walleye pollock eggs; 2) locate the "patch" of maximum concentration of pollock eggs; 3) collect samples of adult pollock to investigate egg predation; 4) collect special plankton samples to investigate invertebrate predation on pollock eggs; 5) perform live experiments on predation; and 6) collect time series data for zooplankton on FOX line 8. Ann C. Matarese was Chief Scientist.

Sampling of the 105 grid stations was conducted in three stages; the presurvey, main survey, and postsurvey. The purpose of three "surveys" was to try to define the length of spawning time. On the presurvey, stations 1-37 were sampled. These samples are distinguished by the suffix A. On the main survey, stations 1-105 were sampled. These are distinguished by the suffix B. The stations sampled on the postsurvey (1-31) have the suffix C. There were 7 CTD casts performed.

Sampling gear consisted of 20-cm and 60-cm bongo samplers (with 150 um and 505 um mesh respectively) deployed in standard MARMAP tows to near bottom, 1 m Tucker trawls (505 um mesh), and Diamond and Marinovich trawls.

The samples from this cruise have not yet been sorted.

Cruise 2 MF 88

The RV Miller Freeman conducted sampling for FOCI 88-II in Shelikof Strait, Alaska, from April 16-May 2, 1988. Two hundred six stations were occupied during this cruise (Fig. 99). The objectives of this cruise

were to: 1) examine variability of hydrographic conditons at the southwestern end of Shelikof Strait at the time walleye pollock eggs were hatching; 2) survey the vertical and horizontal distribution of pollock eggs and yolk-sac larvae; 3) obtain fresh yolk-sac larvae for otolith reading, histological examination, RNA/DNA ratios, and electron transport system analysis; 4) collect potential predators for larvae immunoassay examination; 5) obtain fresh pollock eggs for hatching and subsequent on board experimentation; 6) obtain time-series data for zooplankton on FOX line 8; and 7) test operation of in situ grazing chamber and "searchlight sonar" package in front of the Ortner net-camera. Lew Incze was Chief Scientist.

Sampling equipment consisted of 20- and 60-cm bongo samplers (150  $\mu$ m and 333  $\mu$ m meshes respectively) deployed in standard MARMAP tows to near bottom, the MOCNESS sampler (153  $\mu$ m mesh), 1 m Tucker trawls (505  $\mu$ m), and Niskin bottles for the collection of microzooplankton, chlorophyll, and nutrient samples. There were 147 CTD casts performed.

These samples have not yet been sorted.

#### Cruise 3 MF 88

The RV Miller Freeman was used for work on FOCI 88-III, in the western Gulf of Alaska from May 5-14, 1988. The purposes of this cruise were to collect 3 current meters in the Aleutian passes and locate the walleye pollock larvae patch for 4MF88. The larvae collected are to be used for histological examination at a later date. Thirteen stations were sampled with a 60 cm bongo sampler (333  $\mu$ m mesh) deployed in standard MARMAP tows to near bottom (Fig. 100). Andrew Roach was Chief Scientist and Noli Navaluna conducted the biological sampling.

Larval walleye pollock were sorted out of these samples on board ship, and the rest of the sample preserved in the usual fashion. The remainder of the samples have not been sorted.

Cruise 4 MF 88

The RV Miller Freeman was utilized for sampling during FOCI 88-IV, in the western Gulf of Alaska from May 20-June 6, 1988. One hundred ninety-eight samples were collected on this cruise (Fig. 101). The principal goals of this cruise were to: 1) acquire long-term time series data on transport and water properties at FOX line 8, distribution of walleye pollock larvae, and currents at FOX moorings 2,5,8, and 14; 2) try to estimate larval pollock mortality; 3) field test Loran-C tracked drifters; 4) conduct comparative gear tests to determine how larval growth affects catchability by different gears; 5) conduct CTD survey in vicinity of valley south of the Semidi Islands; 6) investigate fish and seabirds as predators on larval pollock; and 7) moor a bottom pressure gauge on the shelf between Chirikof and Kodiak Island. James Schumacher was Chief Scientist and Sarah Hinckley conducted the biological sampling.

Sampling equipment consisted of 60-cm bongo samplers (333 um mesh), 1 m Tucker trawls (505 um mesh), 3 m Tucker trawls (1500 um mesh), the Methot mid-water frame trawl (2x3 mm mesh), and Diamond and Marinovich trawls. The samples from this cruise have not yet been sorted.

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- Figure 13.--Station locations off California during cruise 20-6802, February 18-March 11, 1968.
- Figure 14.--Station locations of cruises 21-6801 through 21-6806, May 9-June 5, 1968.
- Figure 15.--Station locations of cruise K-7012, October 10-26, 1970.
- Figure 16.--Station locations in Puget Sound during cruise K-6805, October 15-17, 1968.
- Figure 17.--Station locations off Oregon and Washington during cruise K-6805, October 18-25, 1968.
- Figure 18.--Station locations of cruise F-6901, January 17-19, 1969.
- Figure 19.--Station locations of cruise 20-6905, November 21-24, 1969.
- Figure 20.--Station locations of cruise JNC-7101, January 18-29, 1971.

- Figure 21.--Station locations in Puget Sound during cruise JNC-7103, April 8, 1971.
- Figure 22.--Station locations off Oregon and Washington during cruise JNC-7104, May 3-6, 1971.
- Figure 23.--Station locations off Washington during cruise JNC-7105, July 22-23, 1971.
- Figure 24.--Station locations of cruise K71-3, May 21-June 11, 1971.
- Figure 25.--Station locations of cruise DE-4, July 25-August 3, 1971.
- Figure 26.--Station locations of cruise K71-5, October 14 to November 4, 1971.
- Figure 27.--Station locations of cruise K72-2 (Phase I), April 19 to May 11, 1972.
- Figure 28.--Station locations of cruise K72-2 (Phases II, III), May 23-27, and May 31-June 16, 1972.
- Figure 29.--Station locations of cruises SF7601 to SF7706, February 23, 1976 to October 5, 1977.
- Figure 30.--Station locations for cruise MF76A, April 25-May 31, 1976.
- Figure 31.--Station locations for cruises MF77B5 and 6, April 16-May 17, 1977.
- Figure 32.--Station locations for cruise MF78-01, February 11-March 16, 1978.
- Figure 33.--Station locations for cruise MF79-03, June 1-July 23, 1979. Dots indicate locations of diel stations (V1-V8 and V-9-V16).
- Figure 34.--Station locations of cruise 1MF-80, January 26-February 12, 1980.
- Figure 35.--Cruise track and station locations for cruise 4MF-77, October 31-November 14, 1977.
- Figure 36.--Cruise track and station locations for cruise 4DI-78, March 28-April 20, 1978.
- Figure 37.--Cruise track and station locations for cruise 2MF-78, June 19-July 9, 1978.
- Figure 38.--Cruise track and station locations for cruise 1WE-78, October 25-November 17, 1978.
- Figure 39.--Cruise track and station locations for cruise 1MF-79, February 13-March 11, 1979.

- Figure 40.--Station locations for cruise 3MF-78, September 8-21, 1978.
- Figure 41.--Neuston station locations for cruise 4MF-78, September 24-October 7, 1978.
- Figure 42.--Bongo station locations for cruise 4MF-78, September 24-October 7, 1978.
- Figure 43.--Neuston station locations for cruise 5MF-78, October 15-November 1, 1978.
- Figure 44.--Bongo station locations for cruise 5MF-78, October 15-November 1, 1978.
- Figure 45.--Station locations for cruise 6MF-78, November 5-16, 1978.
- Figure 46.--Station locations for cruise 5TI-79, May 16-24.
- Figure 47.--Station locations for cruise 1PO-79, September 2-October 11, 1979.
- Figure 48.--Cruise track for cruise 1MF-80, April 2-11, 1980.
- Figure 49.--Station locations in the Gulf of Alaska during cruise SEI77-9, July 5-27, 1977.
- Figure 50.--Station locations from Northern California to Northern Washington for cruise SEI77-9, August 16-September 6, 1977.
- Figure 51.--Station locations off Vancouver Island during cruise SEI77-9, August 16-September 6, 1977.
- Figure 52.--Station locations for cruise 1OD-80, July 1-August 12, 1980.
- Figure 53.--Timing of NWAFC-TINRO ichthyoplankton surveys off Washington, Oregon, and California.
- Figure 54.--Station locations for cruise 1TK-80, April 20-May 15, 1980.
- Figure 55.--Station locations and cruise track for cruise 1PO-80, August 1-20, 1980.
- Figure 56.--Station locations for cruise 1PO-81, May 9-June 2, 1981.
- Figure 57.--Station locations for cruise 1DA-81, October 24-November 19, 1981.
- Figure 58.--Neuston station locations for cruise 1PO-82, May 3-June 1, 1982.
- Figure 59.--Bongo locations for cruise 1PO-82, May 3-June 1, 1982.
- Figure 60.--Station locations for cruise 1EQ-83, April 23-May 15, 1983.

- Figure 61.--Station locations for cruise 1MF-83, November 11-December 2, 1983.
- Figure 62.--Station locations for cruise 1PO-84, March 11-April 4, 1984.
- Figure 63.--Station locations for cruise 1BA-85, April 19-May 11, 1985.
- Figure 64.--Station locations for cruise 1MF-87, January 7-31, 1987 ( . denotes stations where special deep Tucker trawls were performed).
- Figure 65.--Locations of neuston stations (above) and bongo stations (below) for cruise 1SH-81, March 5-18, 1981.
- Figure 66.--Locations of neuston stations (above) and bongo stations (below) for cruise 2SH-81, April 16-24, 1981.
- Figure 67.--Locations of bongo stations for cruise 3SH-81, May 20-28, 1981.
- Figure 68.--Locations of bongo stations for cruise 1MF-81, March 12-March 20, (left) and for cruise 2MF-81, March 30-April 8, 1981 (right).
- Figure 69.--Locations of bongo stations for cruise 3MF-81, April 26-May 2, (left), and for cruise 4MF-81, May 20-24, 1981 (right).
- Figure 70.--Station locations for cruise 1DA-82, April 4-23, 1982.
- Figure 71.--Station locations for cruise 2DA-82, May 21-31, 1982.
- Figure 72.--Station locations for cruise 1CH-83, May 16-28, 1983. Dot indicates location of diel station.
- Figure 73.--Locations of neuston stations from Seattle to Kodiak Island for cruise 1CH-83, May 14-19, 1983.
- Figure 74.--Station locations for cruise 1CH-84, March 20-23, 1984.
- Figure 75.--Station locations for cruise 2CH-84, March 24-26, 1984.
- Figure 76.--Station locations for cruise 3CH-84, March 27-28, 1984. Dot indicates location of droque station.
- Figure 77.--Station locations for cruise 4CH-84, March 29-31, 1984. Dot indicates location of droque station.
- Figure 78.--Station locations for cruise 5CH-84, April 4-8, 1984. Dot indicates location of droque station.
- Figure 79.--Station locations for cruise 1SH-84, April 17-May 9, 1984.
- Figure 80.--Station locations for cruise 1PO-85, March 29-April 21, 1985.

- Figure 81.--Station locations for cruise 2PO-85, May 16-June 8, 1985.
- Figure 82.--Station locations for cruise 1GI-86, March 30-April 20, 1986.
- Figure 83.--Station locations for cruise 1BB-87, April 9-27, 1987.
- Figure 84a.--Station locations in the Gulf of Alaska for cruise 1DN-88, March 18-May 8, 1988 (inset is enlargement of Shelikof Strait area).
- Figure 84b.--Station locations in the Bering Sea for cruise 1DN-88, March 18-May 8, 1988.
- Figure 85.--Station locations for cruise MF86-02, February 2-March 3, 1986. Inset is of sampling area farther to the northeast (v denotes Tucker trawls, G and S denote bongos).
- Figure 86.--Station locations for cruise 10C-88, March 11-April 4, 1988.
- Figure 87.--Station locations for cruise 1DI-85, March 11-April 2, 1985.
- Figure 88.--Station locations for cruise 1MF-85, April 1-12, 1985. Dot indicates location of droque station.
- Figure 89.--Station locations for cruise 2MF-85, May 1-12, 1985.
- Figure 90.--Station locations for cruise 2DI-85, July 23-August 2, 1985.
- Figure 91.--Station locations for cruise 3MF-85, October 1-November 2, 1985.
- Figure 92a.--Bongo station locations for cruise 1MF-86, April 2-13, 1986.
- Figure 92b.--Large and small Clarke-Bumpus station locations for cruise 1MF-86, April 2-13, 1986.
- Figure 93.--Stations locations for cruise 2MF-86, May 1-19, 1986.
- Figure 94.--Station locations for cruise 10C-86, July 28-August 16, 1986.
- Figure 95.--Station locations for cruise 2MF-87, April 2-17, 1987.
- Figure 96.--Station locations for cruise 3MF-87, May 18-29, 1987.
- Figure 97.--Station locations for cruise 4MF-87 (legs I and II), June 17-July 16, 1987.
- Figure 98.--Station locations for cruise 1MF-88, March 31-April 13, 1988 (0 denotes stations sampled 3 times, denotes stations sampled twice, + denotes stations sampled once. The black border encases the presurvey area).
- Figure 99.--Station locations for cruise 2MF-88, April 16-May 2, 1988.
- Figure 100.--Station locations for cruise 3MF-88, May 5-14, 1988.
- Figure 101.--Station locations for cruise 4MF-88, May 20-June 6, 1988.



Table 1.--Summary of Northwest and Alaska Fisheries Center ichthyoplankton cruises, 1965-1988.

Program/ Year	Cruise number	Area sampled	Months sampled	Number of stations occupied	Number of samples collected	Status of ichthyoplankton data	Hydrographic Data		
							Origin	Status	Abode
<u>Hake Investigations</u>									
1965	1-6501	Puget Sound and Coastal WA, to Southern CA	Feb	20	20	Raw data		None	
1965	1-6502	Puget Sound, Coastal WA	Mar-Apr	18	18	Raw data	BT	Raw data	
1965	1-6503, 04-05	Coastal WA to Southern CA	Jul-Oct	15	15	Raw data		None	
1966	1-6601	Puget Sound	Jan	4	4	Raw data		None	
1966	4-6601	Puget Sound	Jan	4	4	Raw data		None	
1966	1-6602	Puget Sound to Central CA	Feb	12	12	Raw data	BT	?	
1966	1-6603, 04-05	Puget Sound Coastal WA	May-Aug	21	21	Raw data	BT	?	
1967	1-6701, K-6703	Puget Sound Coastal WA, OR	Apr-May	102	103	Waldron (1972)	BT Hydrocasts	?	Partial in Waldron (1972)
1968	20-6802	Coastal WA to Southern CA	Feb-Mar	55	55	Raw data		None	
1968	21-6801- 21-6806	Puget Sound	May-Jun	36	37	Raw data		None	
1970	K70-12	Coastal WA to Southern CA	Oct	31	31	Raw data	XBT	?	

Table 1.--Continued.

Program/ Year	Cruise number	Area sampled	Months sampled	Number of stations occupied	Number of samples collected	Status of ichthyoplankton data	Hydrographic Data		
							Origin	Status	Abode
Coastal Investigations									
1968	K-6805	Puget Sound Coastal WA, OR	Oct	32	32	Raw data		None	
1969	F-6901	Coastal WA	Jan	13	13	Raw data		None	
1969	F-20.6905	Puget Sound, Coastal WA	Nov	15	16	Raw data		None	
1971	JNC-7101	Puget Sound, Coastal WA	Jan	15	65	Raw data	XBT Hydro-casts	?	
1971	JNC-7103, 04,05	Puget Sound, OR, WA	Apr-Jul	85	92	Waldron MS		None	
MARMAP I									
1971	K71-3	Bering Sea	May-Jun	6	46	Dunn and Naplin (1973)	CTD	Complete	Ingraham and Fisk (1973)
1971	DE-4	Bering Sea	Jul-Aug	10	20	Raw data		None	
1971	K71-5	SE Alaska	Oct-Nov	32	128	Naplin et al. (1973)	CTD	Complete	Ingraham et al. (1973)
1972	K72-2 (I)	Kodiak Is.	Apr-May	67	134	Dunn and Naplin (1974) Kendall and Dunn (1985)	CTD	Complete	Ingraham and Fisk (1973) Favorite et al. (1975)
1972	K72-2 (II)	Puget Sound,	May	2	234 (?)	Raw data		None	
1972	K72-2 (III)	Coastal WA	June	4	304 (?)	Raw data		None	

Table 1.--Continued.

Program/ Year	Cruise number	Area sampled	Months sampled	Number of stations occupied	Number of samples collected	Status of ichthyoplankton data	Hydrographic Data		
							Origin	Status	Abode
Strait of Juan de Fuca									
1976-1977	SF7601- SF7706	Str. Juan de Fuca	Feb 76 - Oct 77	9	77	Raw data, Chester et al. 1977, 1979	CTD	?	Chester et 1977, 1979
Bering Sea									
1976	MF76A	Bering Sea	Apr-May	56	168	Waldron (1978a) Waldron and Favorite (1977)		None	
1977	MF77B5, B6	Bering Sea	Apr-May	75	396	Waldron (1978a) Waldron and Vinter (1978)	CTD XBT	Complete	R2D2
1978	MF78-01	Bering Sea	Feb-Mar	32	59	Waldron (1978 a,b)		None	
1979	3MF79	Bering Sea	Jun-July	115	282	Walline (1980, 1981 a,b, 1983)	CTD	Complete	R2D2
1980	1MF80	Bering Sea	Jan-Feb	8	24	Raw data			
Kodiak/OCSEAP									
1977	4MF77	Kodiak Is.	Oct-Nov	61	369	Dunn, et al.(1979) Kendall et al.(1980) Kendall and Dunn(1985)	CTD	Complete	R2D2
1978	4DI78	Kodiak Is.	Mar-Apr	121	475	As above	CTD	Complete	R2D2
1978	2MF78	Kodiak Is.	Jun-July	88	505	As above	CTD	Complete	R2D2
1978	1WE78	Kodiak Is.	Oct-Nov	94	397	As above	CTD	Complete	R2D2
1979	1MF79	Kodiak Is.	Feb-Mar	88	339	As above	CTD	Complete	R2D2
1980	1MF80	Kodiak Is.	Apr	41	123	In computer	CTD	Complete	?

Table 1.--Continued.

Program/ Year	Cruise number	Area sampled	Months sampled	Number of stations occupied	Number of samples collected	Status of ichthyoplankton data	Hydrographic Data		
							Origin	Status	Abode
Kodiak/NWAFK									
1978	3MF78	Kodiak Is.	Sept.	27	81	Computer files	CTD	Recorded	Tape
1978	4MF78	Kodiak Is.	Sept-Oct	66	177	Computer files	CTD	Recorded	Tape
1978	5MF78	Kodiak Is.	Oct-Nov	19	49	Computer files	CTD	Recorded	Tape
1978	6MF78	Prince William Sound	Nov	44	132	Computer files	CTD	Recorded	Tape
1979	5TI79	Gulf of Alaska	May	35	70	Kendall and Dunn (1985)	Hydro- casts	Recorded	Tape
1979	1PO79	Gulf of Alaska	Sept-Oct	48	144	Kendall and Dunn (1985)	Hydro- casts	Recorded Recorded	Tape Tape
Poland/ROK									
1977	SEI 77-9	Northern CA- Gulf of Alaska	Jul-Sept	99	126	Grimm and Sztajnduchert (1978)	Hydro- casts	Complete (1978)	Anon.
1980	1OD80	Gulf of Alaska	Jul-Aug	43	?	Raw data	Hydro- casts	?	?
WA-OR-CA/US-USSR									
1980	1TK80	Coastal WA-CA	Apr-May	125	500	Kendall and Clark (1982)	Hydro- casts	Recorded	Tape
1980	1PO80	Coastal WA-CA	Aug	91	364	Kendall and Clark (1982)	Hydro- casts	Recorded	Tape
1981	1PO81	Coastal WA-CA	May-Jun	123	492	Clark (1984)	Hydro- casts	Recorded	Tape
1981	1DA81	Coastal WA-CA	Oct-Nov	125	500	Bates (1984)	Hydro- casts	Recorded	Tape

Table 1.--Continued.

Program/ Year	Cruise number	Area sampled	Months sampled	Number of stations occupied	Number of samples collected	Status of ichthyoplankton data	Hydrographic Data		
							Origin	Status	Abode
<u>WA-OR-CA/US-USSR</u>									
1982	1P082	Coastal WA-CA	May-Jun	124	360	Clark (1986b)	Hydro- casts	Recorded	Tape
1983	1EQ83	Coastal WA-CA	Apr-May	124	496	Clark and Kendall (1985)	Hydro- casts	Recorded	Tape
1983	1MF83	Coastal WA-CA	Nov-Dec	113	226	Clark (1986a)	CTD	Complete	R2D2
1984	1P084	Coastal WA-CA	Mar-Apr	124	496	Clark and Savage (1988)	Hydro- casts	Recorded	Tape
1985	1BA85	Coastal WA-CA	Apr-May	124	496	Sorted	Hydro- casts	Raw data	----
1987	1MF87	Coastal WA-CA	Jan	98	203	Sorted	CTD	Recorded	Tape
<u>Pollock/Gulf of Alaska</u>									
1981	1SH81 2SH81 3SH81	Gulf of Alaska	Apr-May	133 60 57	532 240 111	Bates and Clark (1983); Dunn et al. (1984)	Hydro- casts	Recorded	Tape
1981	1MF81 2MF81 3MF81 4MF81	Gulf of Alaska	Mar-May	31 91 79 80	62 182 158 160	Bates and Clark (1983); Dunn et al. (1984)	CTD	Complete	R2D2
1982	1DA82 2DA82	Gulf of Alaska	Apr-May	83 62	332 248	In computer	Hydro casts	Recorded	Tape
1983	1CH83	Gulf of Alaska	May	62	257	Kendall et al. (1987)	CTD	Complete	R2D2
1984	1CH84	Gulf of Alaska	Mar	59	59	Computer file	CTD	Complete	R2D2
1984	2CH84	Gulf of Alaska	Apr	60	60	Computer file	CTD	Complete	R2D2
1984	3CH84 4CH84 5CH84	Gulf of Alaska		23 56 73	44 56 73	Computer files	CTD	Complete	R2D2
1984	1SH84	Gulf of Alaska	Apr-May	179	756	Bates (1987)	Hydro- casts	Recorded	Tape
1985	1P085- 2P085	Gulf of Alaska	Apr-May	343	1372	Kendall and Ferraro (1988)	Hydro- casts	Raw Data	----
1986	1GI86	Gulf of Alaska	Mar-Apr.	149	596	Computer file	Hydro- casts	Recorded	Tape

Table 1.--continued.

Program/ Year	Cruise number	Area sampled	Months sampled	Number of stations occupied	Number of samples collected	Status of ichthyoplankton data	Hydrographic Data		
							Origin	Status	Abode
1987	1BB87	Gulf of Alaska	Apr	117	468	Raw Data	Hydro- casts	Recorded	Tape
1988	1DN88	Gulf of Alaska- Bering Sea	Mar-May	203	406	Not sorted	Hydro- casts	Recorded	Tape
FOCI/FOX									
1985	1DI85	Gulf of Alaska	Mar-Apr	69	69	Computer files	CTD	Complete	R2D2
1985	1MF85	Gulf of Alaska	Apr	98	128	Computer files	CTD	Complete	R2D2
	2MF85		May	154	154	Computer files	CTD		
1985	2DI85	Gulf of Alaska	Jul-Aug	10	10	Not sorted	CTD	Complete	R2D2
1985	3MF85	Gulf of Alaska	Oct-Nov	6	6	Not sorted	CTD	Complete	R2D2
1986	MF8602	Bering Sea	Feb-Mar	53	58	Computer files	CTD	Complete	R2D2
1986	1MF86	Gulf of Alaska	Apr	97	115	Computer files	CTD	Complete	R2D2
	2MF86		May	166	252	Computer files	CTD	Complete	R2D2
	10C86		July-Aug	7	9	Not sorted	CTD	Complete	R2D2
1987	2MF87	Gulf of Alaska	Apr	143	157	Raw data	CTD	Complete	R2D2
	3MF87		May	111	223	Raw data	CTD	Complete	R2D2
	4MF87		Jun-Jul	148	218	Raw data	CTD	Complete	R2D2
1988	10C88	Bering Sea	Mar-Apr	57	68	Not sorted	CTD	Complete	R2D2
1988	1MF88	Gulf of Alaska	Mar-Apr	173	205	Not sorted	CTD	Recorded	Tape
	2MF88		Apr-May	206	190	Not sorted	CTD	Recorded	Tape
	3MF88		May	13	13	Not sorted	CTD	Recorded	Tape
	4MF88		May-June	156	194	Not sorted	CTD	Recorded	Tape

Table 2.--Revised station numbers for cruise 4 MF 77.

<u>Old Code</u>	<u>New Code</u>	<u>Old Code</u>	<u>New Code</u>
1	----- G001A	43	----- G043A
2	----- G002A	44	----- G044A
3	----- G003A	45	----- G045A
4	----- G004A	46	----- G046A
5	----- G005A	47	----- G047A
6	----- G006A	48	----- G048A
7	----- G007A	49	----- G049A
8	----- G008A	50	----- G050A
9	----- G009A	51	----- G051A
10	----- G010A	52	----- G052A
11	----- G011A	53	----- G053A
12	----- G012A	36-2	----- G036B
13	----- G013A	37-2	----- G037B
14	----- G016A	38-2	----- G038B
15	----- G017A	39-2	----- G039B
16	----- G018A	40-2	----- G040B
17	----- G019A	43-2	----- G043B
18	----- G020A	45-2	----- G044B
19	----- G021A	46-2	----- G046B
20	----- G022A	33A1 (33-1)	-- D033A
21	----- G023A	33A2 (33-2)	-- D033B
22	----- G024A	33A3 (33-3)	-- D033C
23	----- G025A	33A4 (33-4)	-- D033D
24	----- G026A	33A5 (33-5)	-- D033E
25	----- G027A	33A6 (33-6)	-- D033F
26	----- G028A	33A7 (33-7)	-- D033G
27	----- G029A	33A8 (33-8)	-- D033H
28	----- G030A	33A9 (33-9)	-- D033I
29	----- G031A	33A10 (33-10)	-- D033J
30	----- G032A	33A11 (33-11)	-- D033K
31	----- G033A	33A12 (33-12)	-- D033L
32	----- G034A	35A1 (35-1)	-- D035A
33	----- G035A	35A2 (35-2)	-- D035B
34	----- G036A	35A3 (35-3)	-- D035C
35	----- G037A	35A4 (35-4)	-- D035D
36	----- G038A	35A5 (35-5)	-- D035E
37	----- G039A	35A6 (35-6)	-- D035F
38	----- G040A	35A7 (35-7)	-- D035G
39	----- G041A	35A8 (35-8)	-- D035H
40	----- G042A	35A9 (35-9)	-- D035I
41	----- G043A	35A10 (35-10)	-- D035J
42	----- G044A	35A11 (35-11)	-- D035K
		35A12 (35-12)	-- D035L

Table 3.--Revised station numbers for cruise 4 DI 78.

<u>Old Code</u>	<u>New Code</u>	<u>Old Code</u>	<u>New Code</u>	<u>Old Code</u>	<u>New Code</u>
1	G001A	453	G045C	69	G069A
2	G002A	454	G045D	70	G070A
3	G003A	455	G045E	71	G071A
4	G004A	456	G045F	72	G072A
5	G005A	457	G045G	73	G073A
6	G006A	458	G045H	74	G074A
7	G007A	459	G045I	75	G075A
8	G008A	4510	G045J	76	G076A
9	G009A	4511	G045K	77	G077A
10	G010A	4512	G045L	78	G078A
11	G011A	45	G045A	79	G079A
12	G012A	46-2	G046A	80	G080A
13	G013A	47-2	G047A	81	S001A
14	G014A	48-2	G048A	82	S002A
15	G015A	49-2	G049A	83	S003A
16	G016A	50	G050A	84	S004A
17	G017A	51	G051A	85	S005A
18	G018A	52	G052A	86	S006A
19	G019A	53	G053A	87	S007A
20	G020A	54	G054A	88	S008A
21	G021A	55	G055A	89	S009A
22	G022A	56	G056A	90	S010A
23	G023A	57	G057A	91	S011A
24	G024A	58	G058A	92	S012A
25	G025A	59	G059A	93	S013A
26	G026A	60	G060A	94	S014A
27	G027A	61	G061A	95	S015A
28	G028A	62	G062A	96	S016A
29	G029A	631	D063A	97	S017A
30	G030A	632	D063B	98	S018A
31	G031A	633	D063C	99	S019A
32	G032A	634	D063D	100	S020A
33	G033A	635	D063E	101	S021A
34	G034A	636	D063F	102	S022A
35	G035A	637	D063G	103	S023A
36	G036A	638	D063H	104	S024A
37	G037A	639	D063I	105	S025A
38	G038A	6310	D063J	106 (22A)	S026A
39	G039A	6311	D063K	107 (27A)	S027A
40	G040A	6312	D063L	108 (28A)	S028A
41	G041A	63	G063A	109 (51A)	S029A
42	G042A	64	G064A	110 (49A)	S030A
43	G043A	65	G065A	111 (33B)	S031A
44	G044A	66	G066A	112 (33C)	S032A
451	G045A	67	G067A	113 (33A)	S033A
452	G045B	68	G068A	113A, B (33A)	S034A

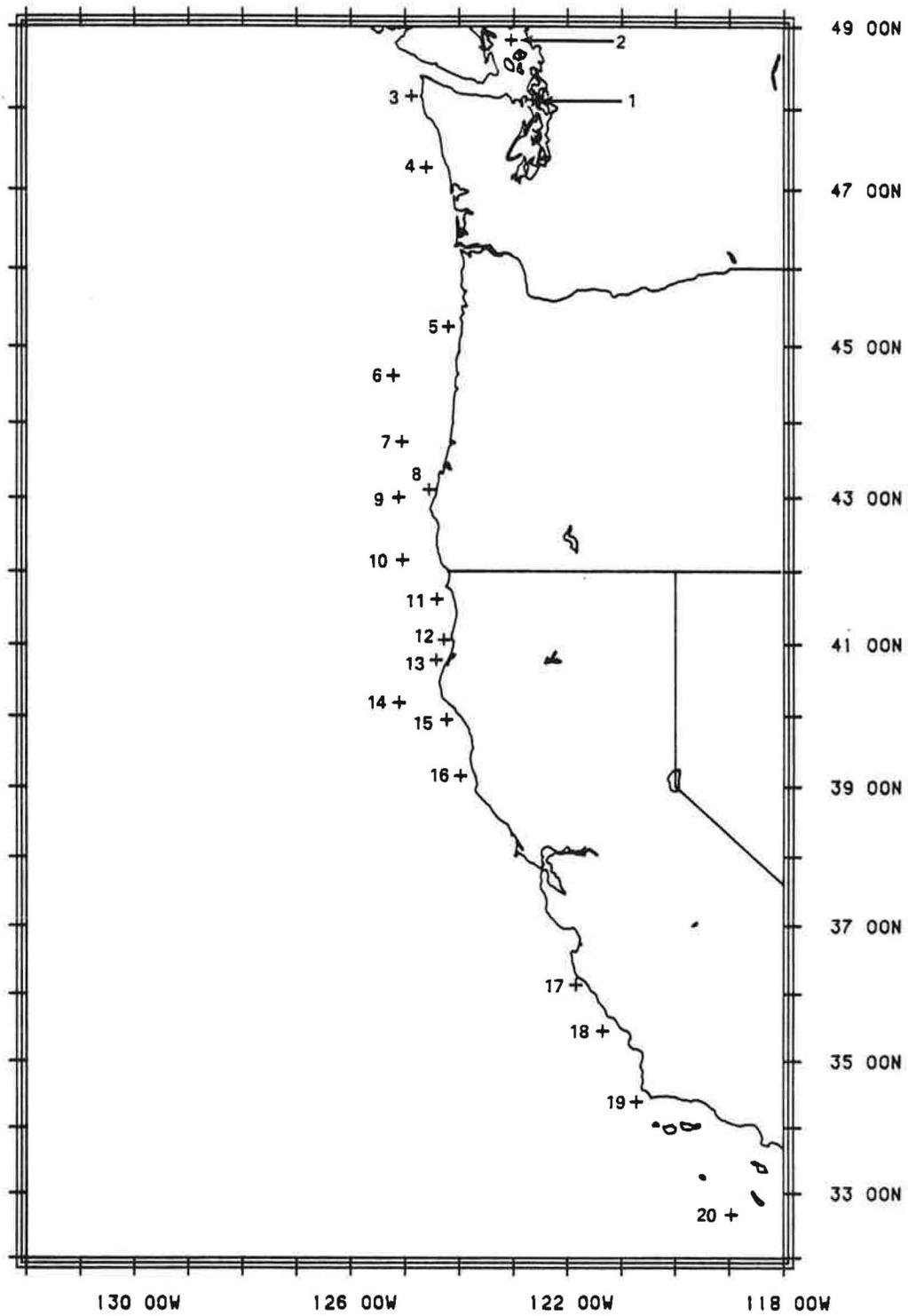


Figure 1.--Station locations for cruise 1-6501, February 2-17, 1965.

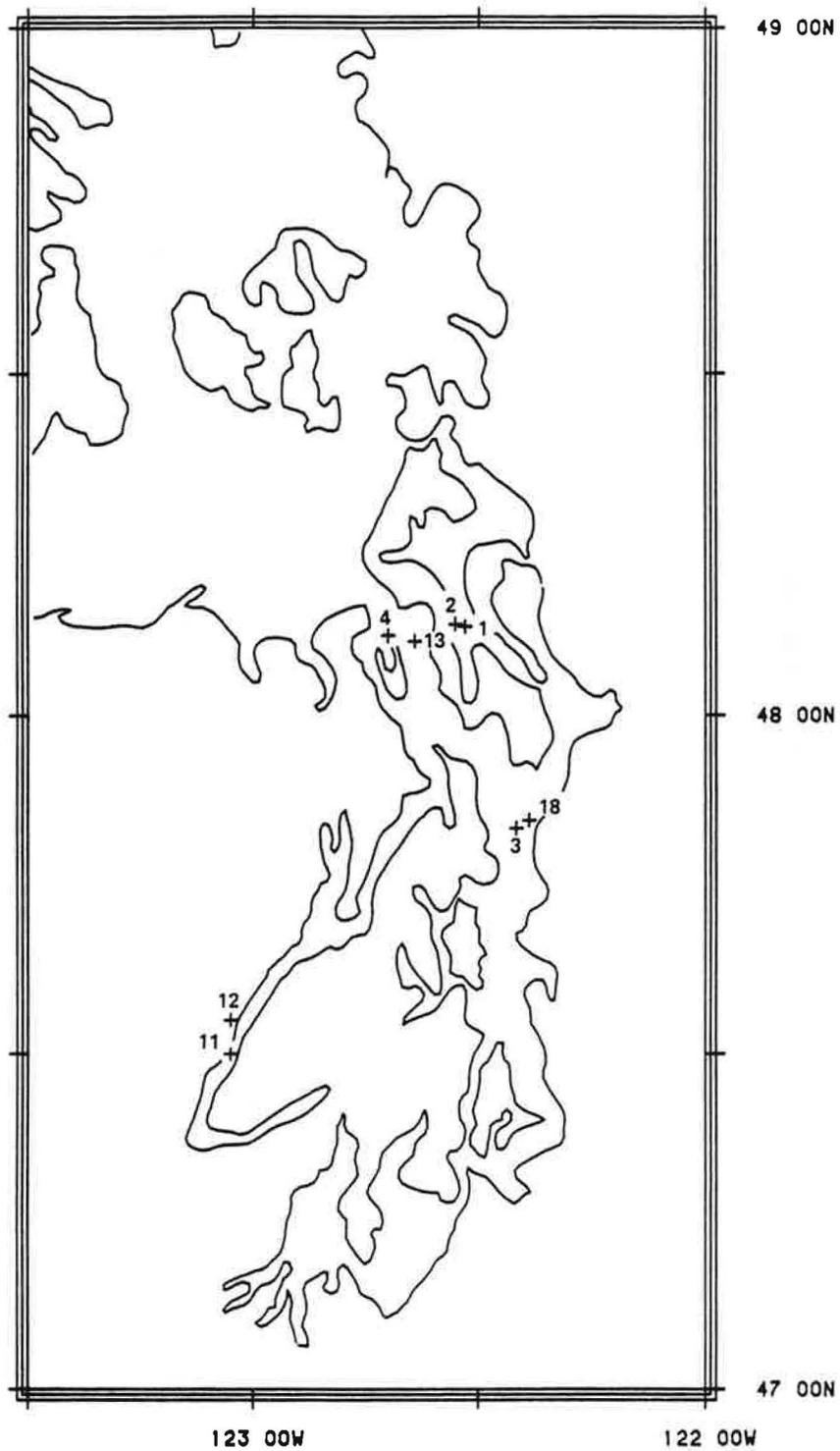


Figure 2.--Station locations in Puget Sound for cruise 1-6502, March 29-31, 1965.

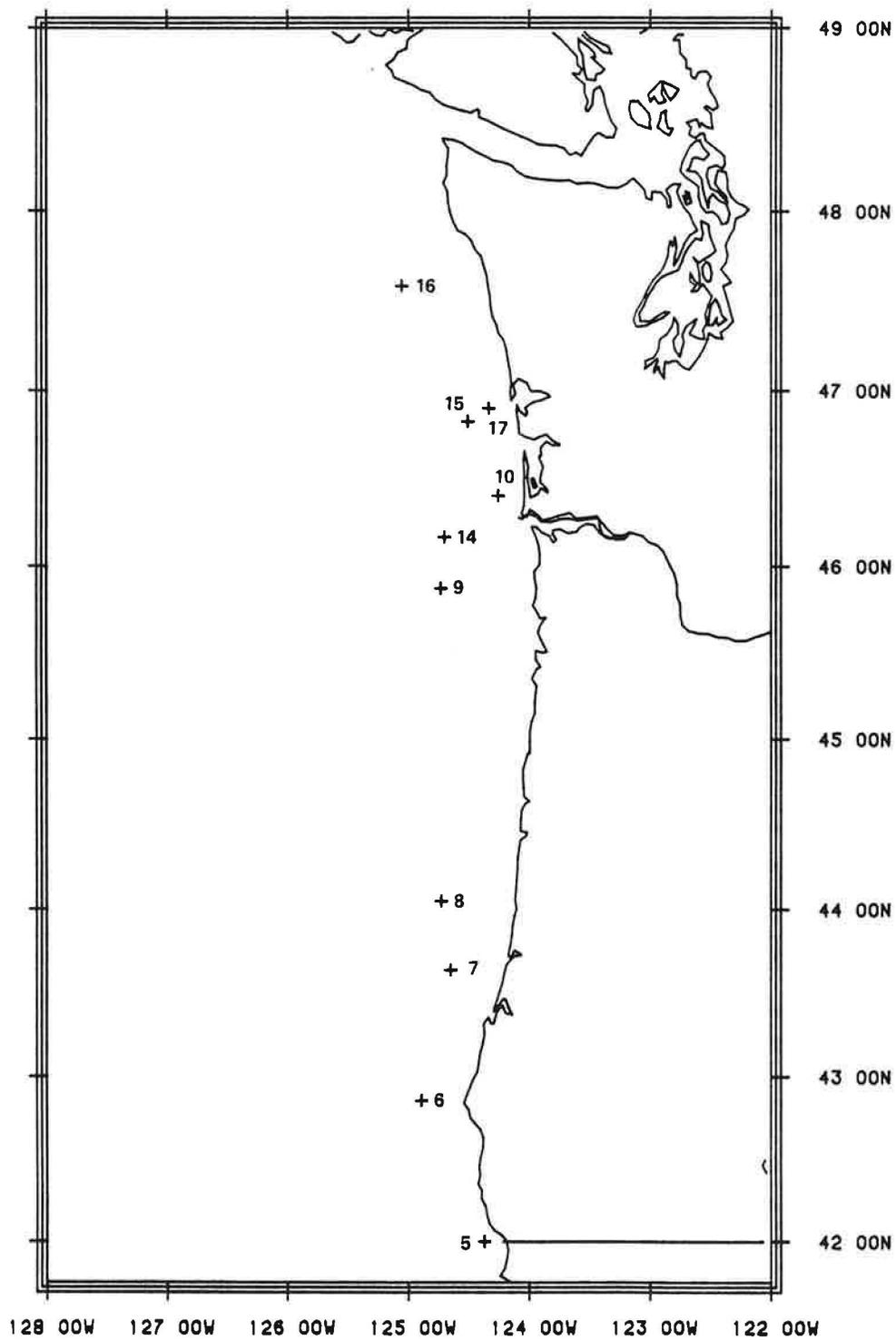


Figure 3.--Station locations for cruise 1-6502, April 8-23, 1965.

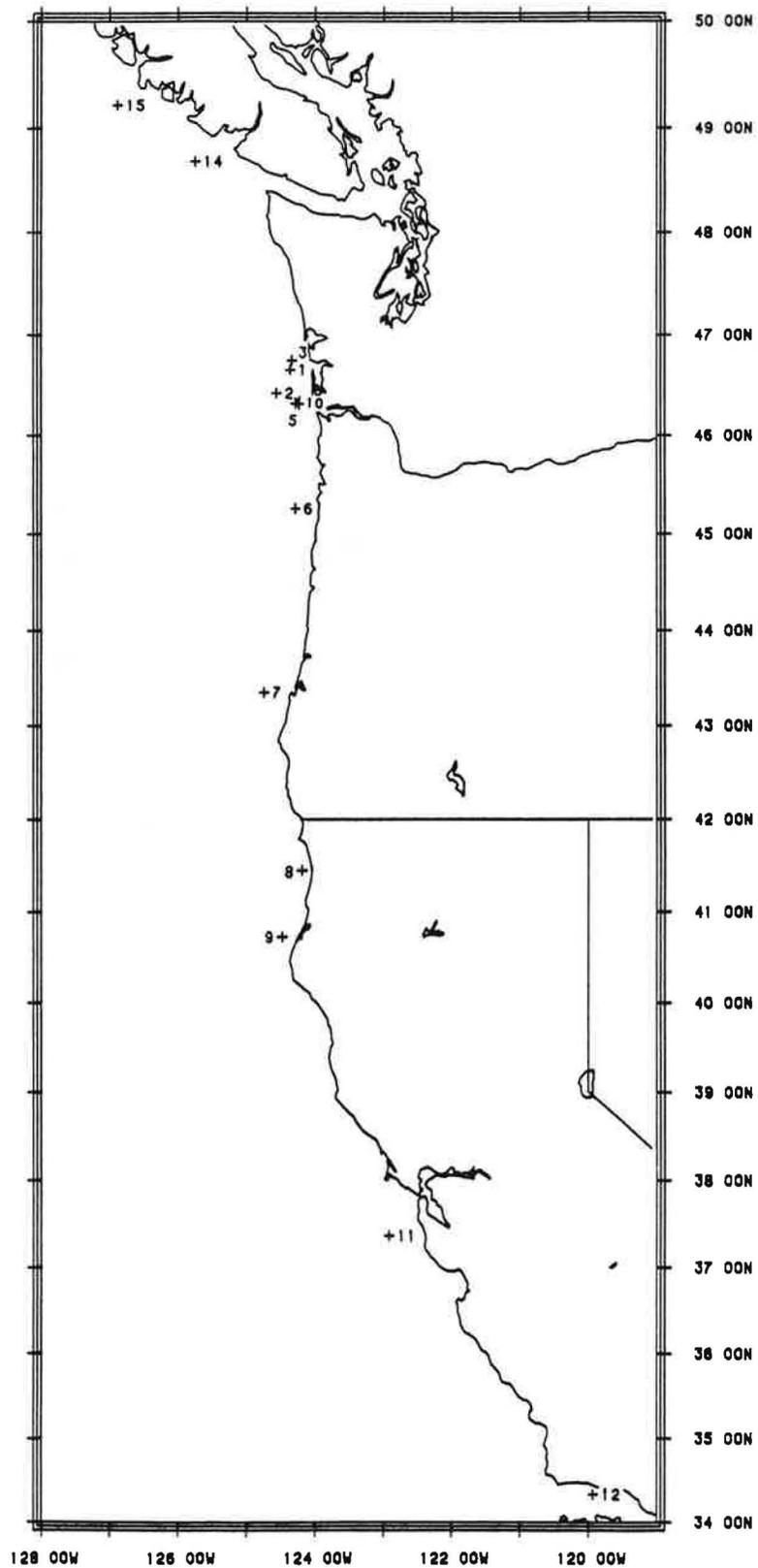


Figure 4.--Station locations for cruises 1-6503, 1-6504, and 1-6505, July 9-October 24, 1965.

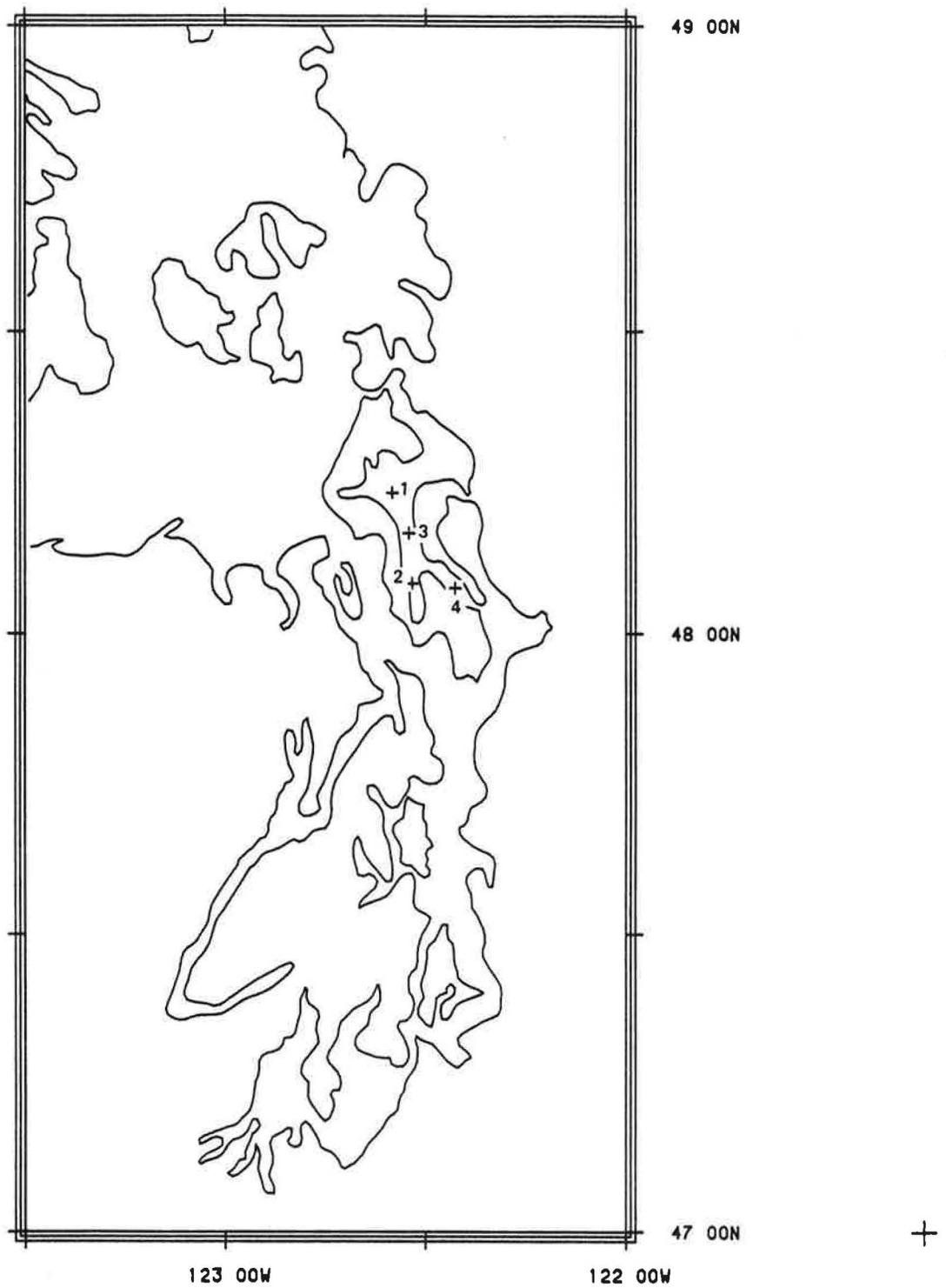


Figure 5.--Station locations in Puget Sound for cruise 1-6601, January 12, 1966.

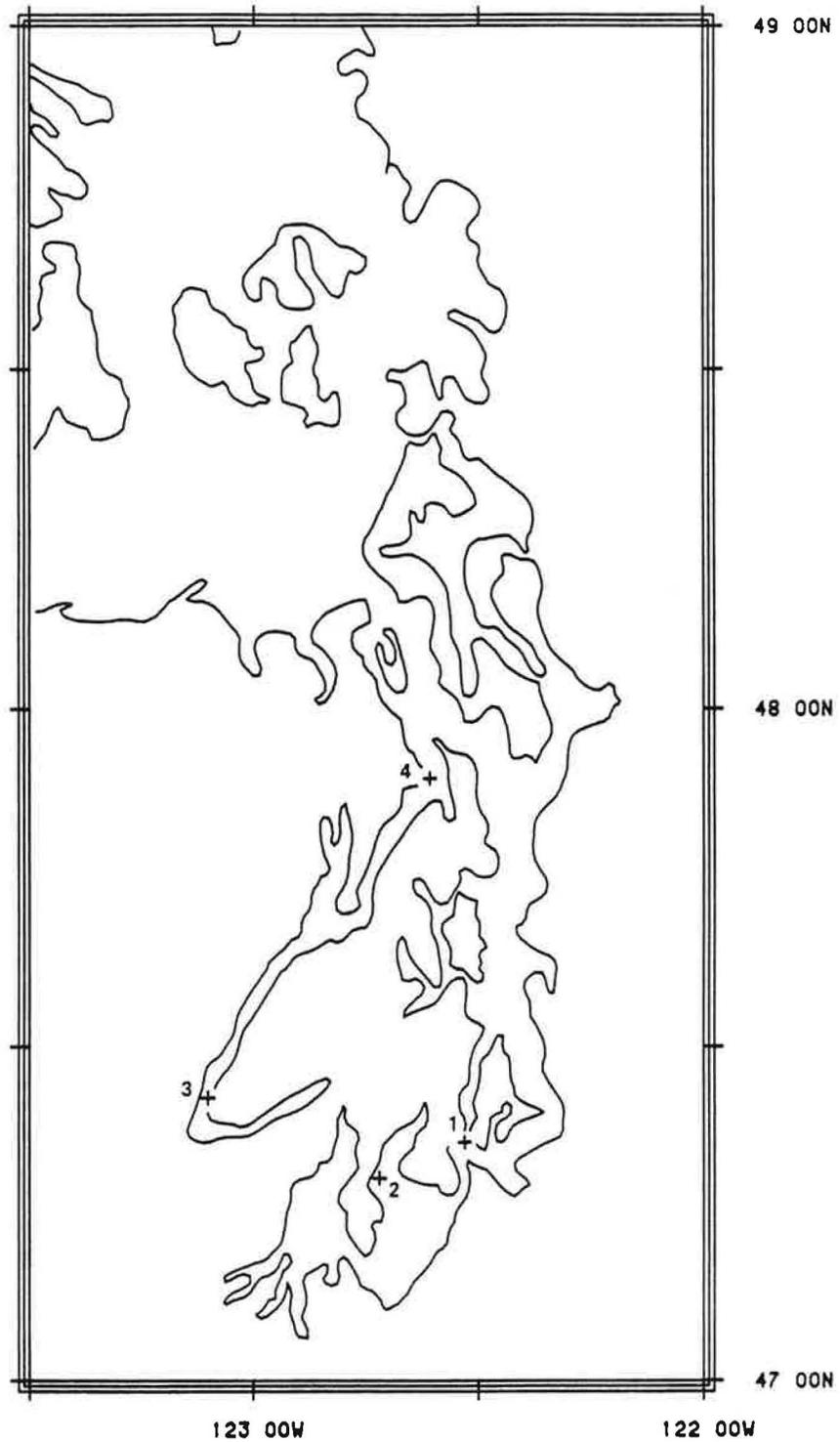


Figure 6.--Station locations in Puget Sound for cruise 4-6601, January 25-28, 1966.

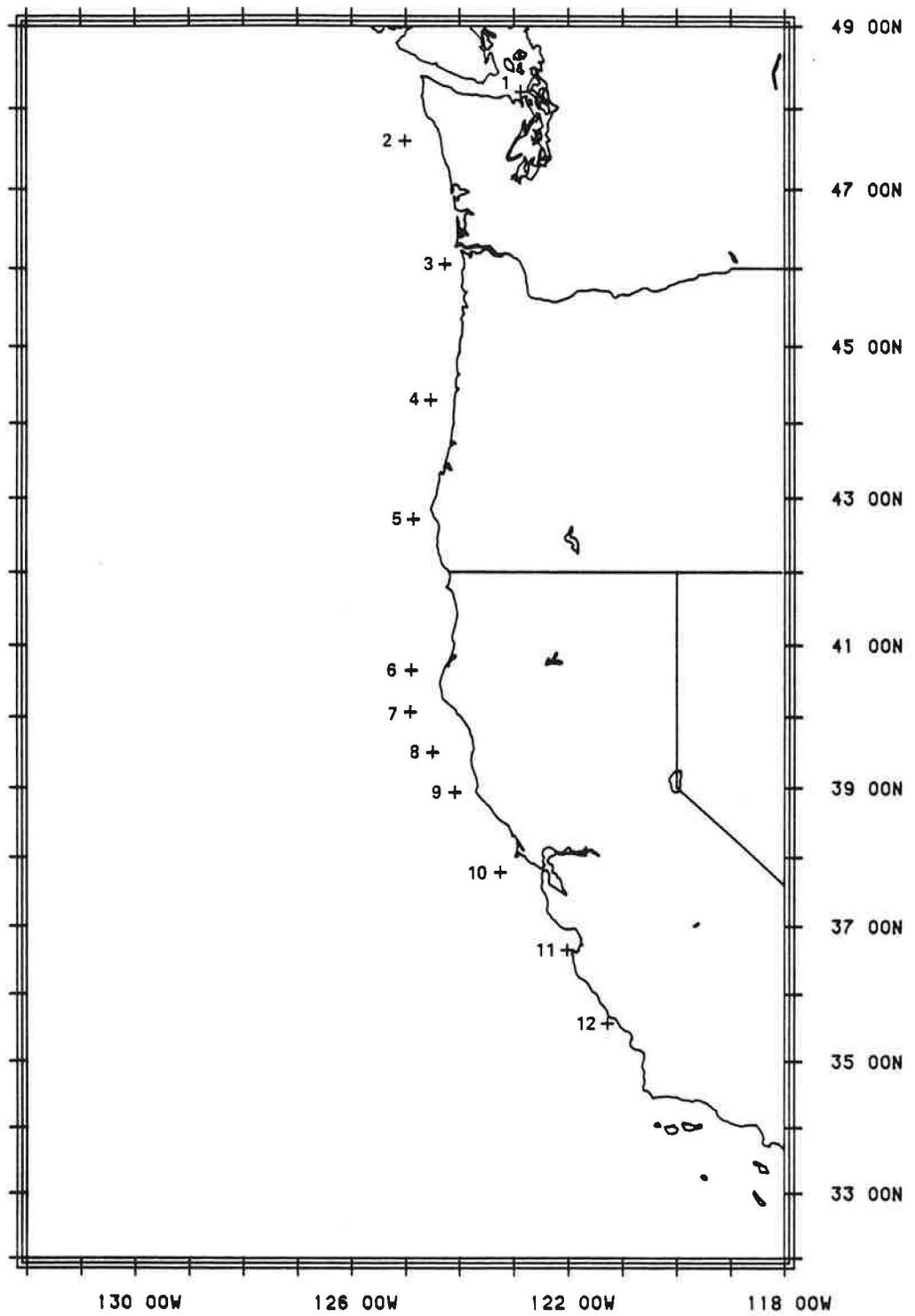


Figure 7.--Station locations for cruise 1-6602, February 14-19, 1966.

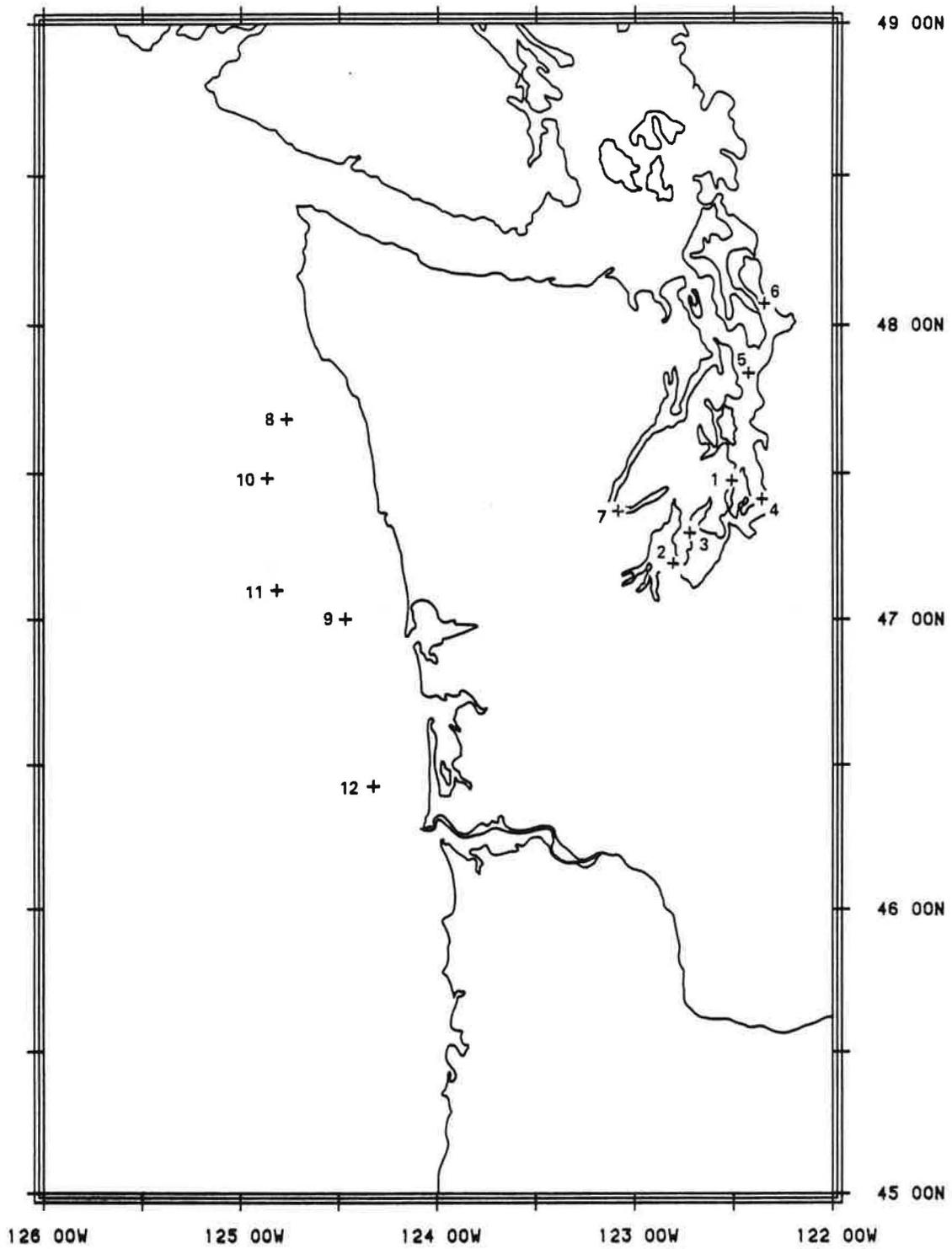


Figure 8.--Station locations for cruise 1-6603, May 16-June 7, 1966.

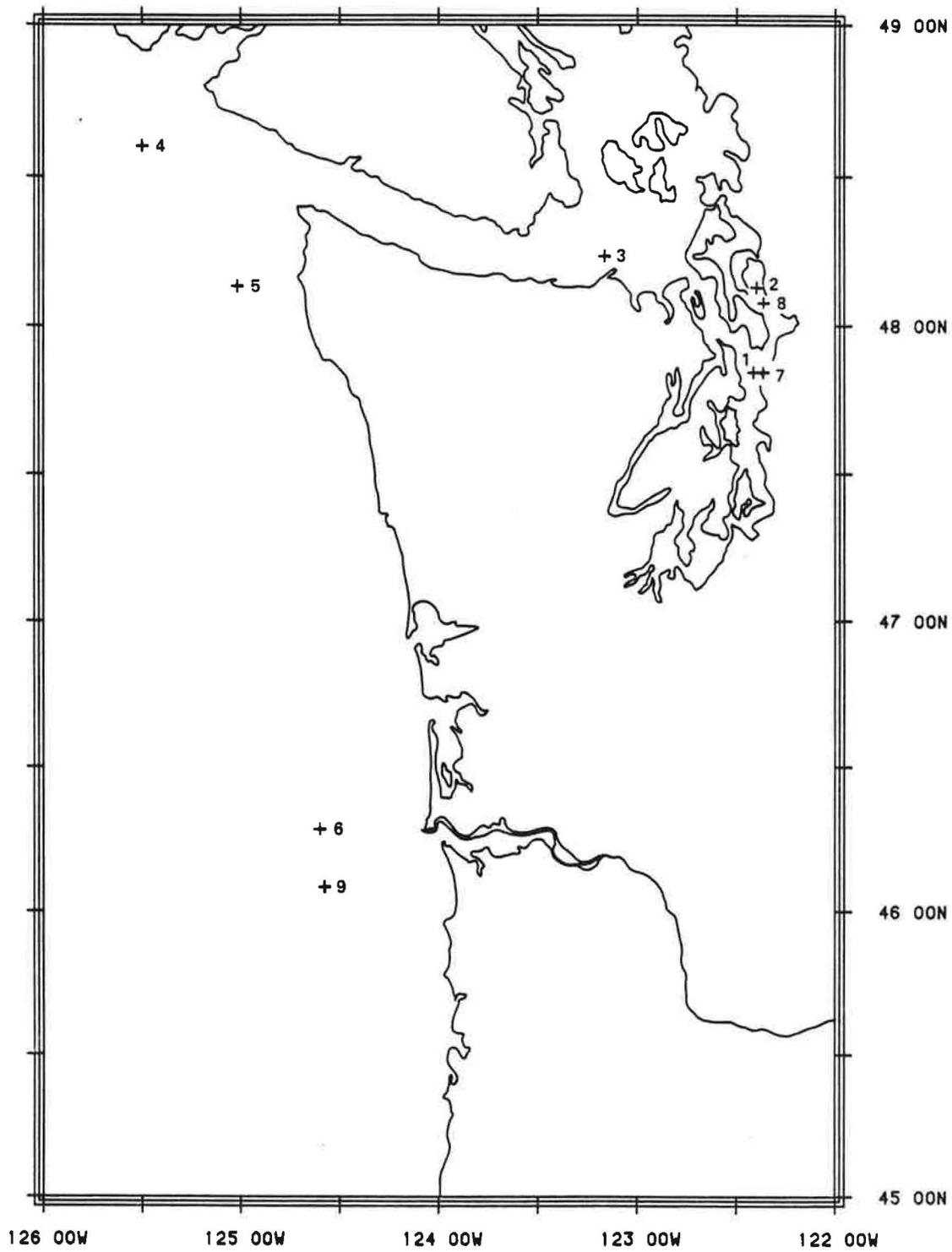


Figure 9.--Station locations for cruises 1-6604 (July 11-13) and 1-6605, August 15-22, 1966.

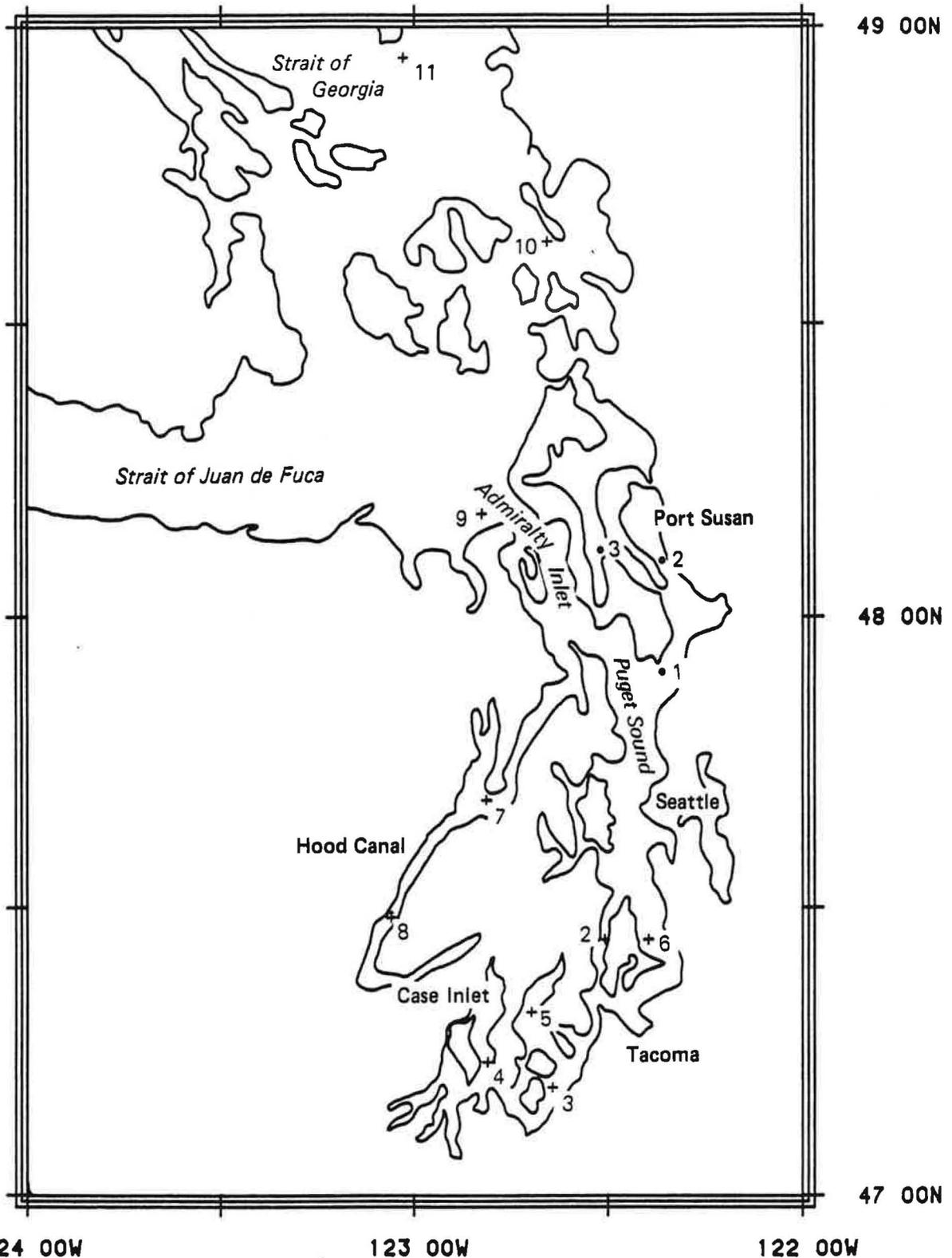


Figure 10.--Station locations in Puget Sound and adjacent waters, April 10-22, 1967. Stations are designated by dots for the RV John N. Cobb and by pluses for the RV George B. Kelez (after Waldron 1972).

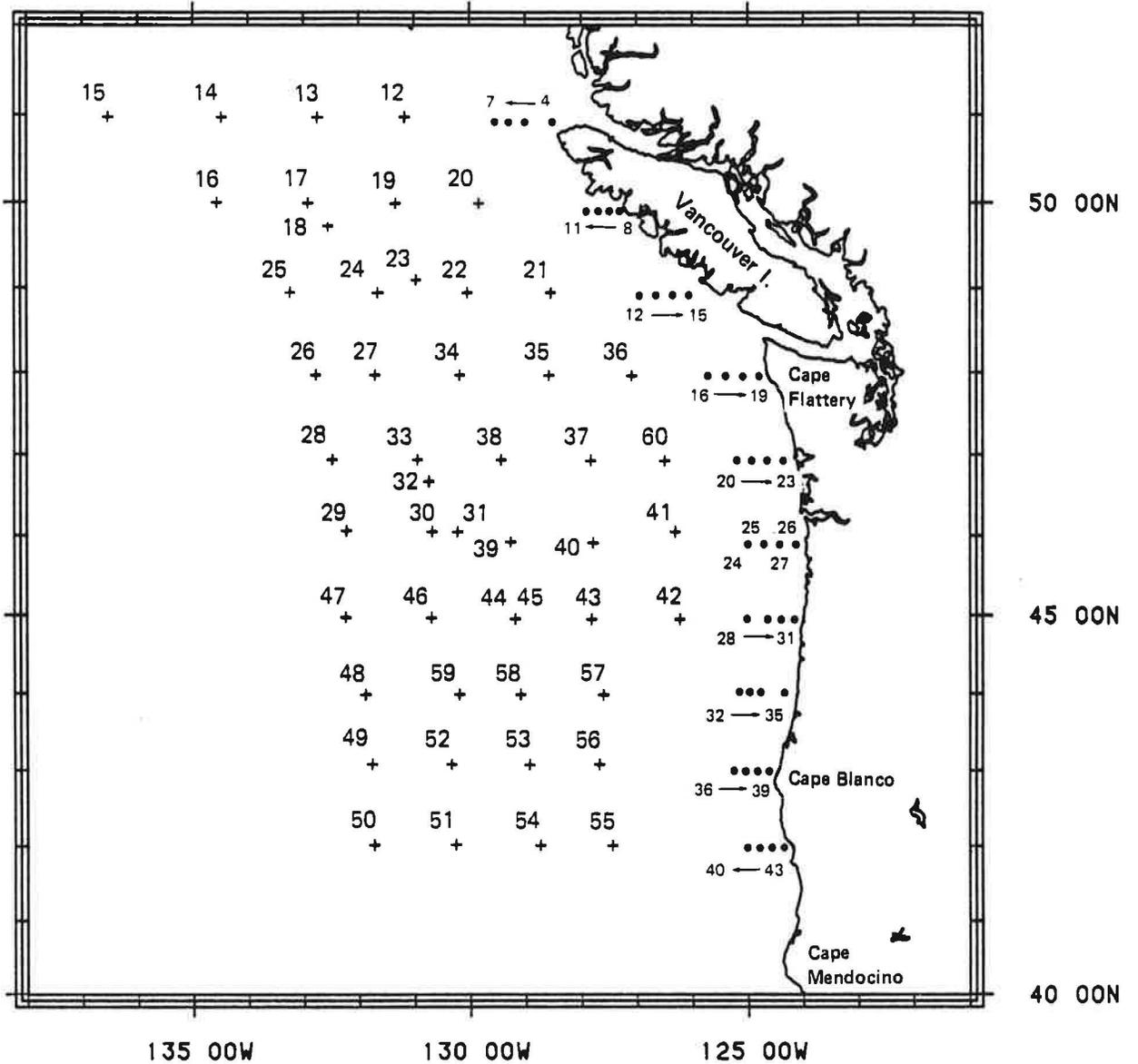


Figure 11.--Station locations off Oregon, Washington, and British Columbia, April 12 to May 11, 1967. Stations are designated by dots for the RV John N. Cobb and by pluses for the RV George B. Kelez (after Waldron 1972).

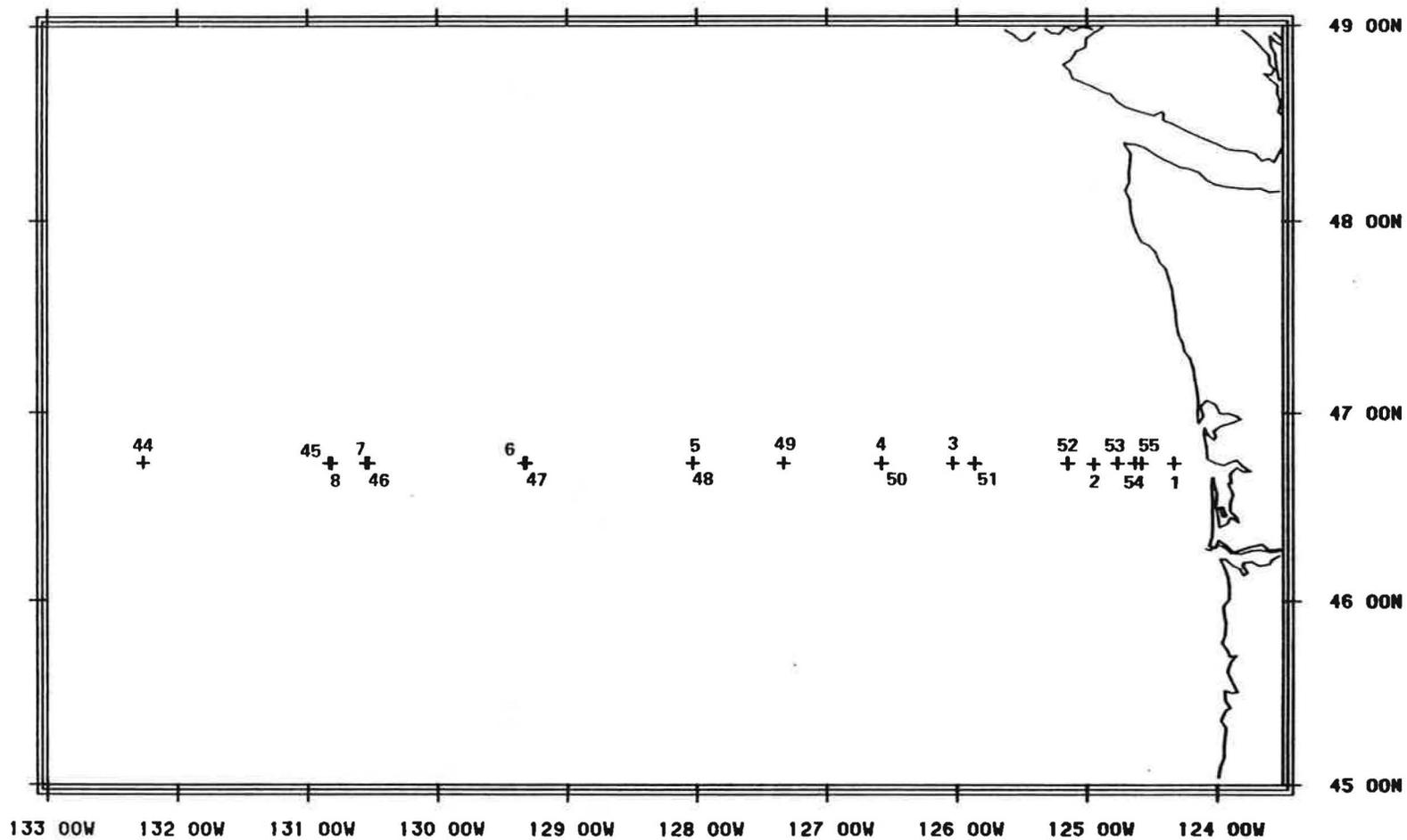


Figure 12.--Station locations off Willipa Bay during cruise 20-6802, February 13-14, and March 18, 1968.

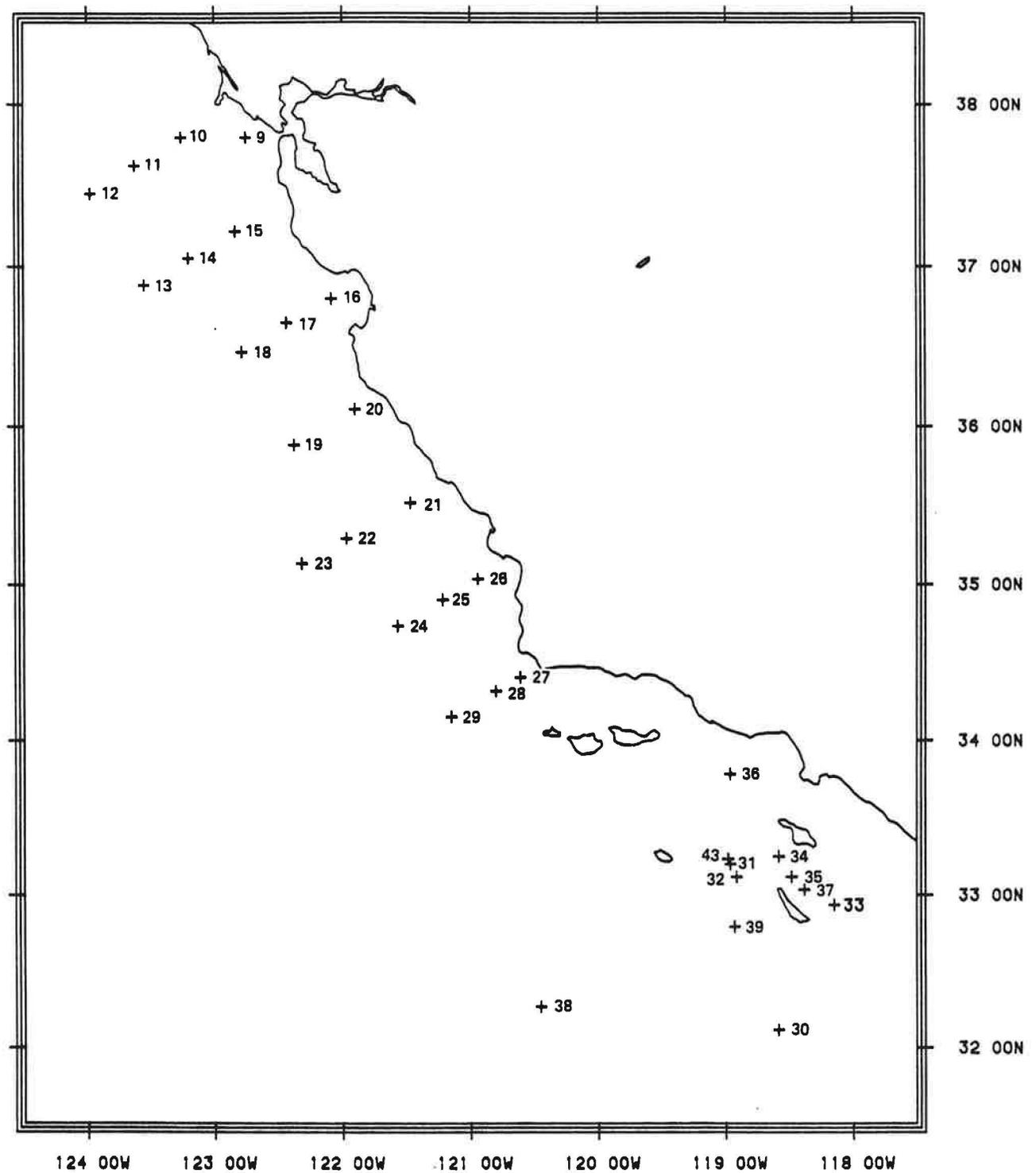


Figure 13.--Station locations off California during cruise 20-6802, February 18-March 11, 1968.

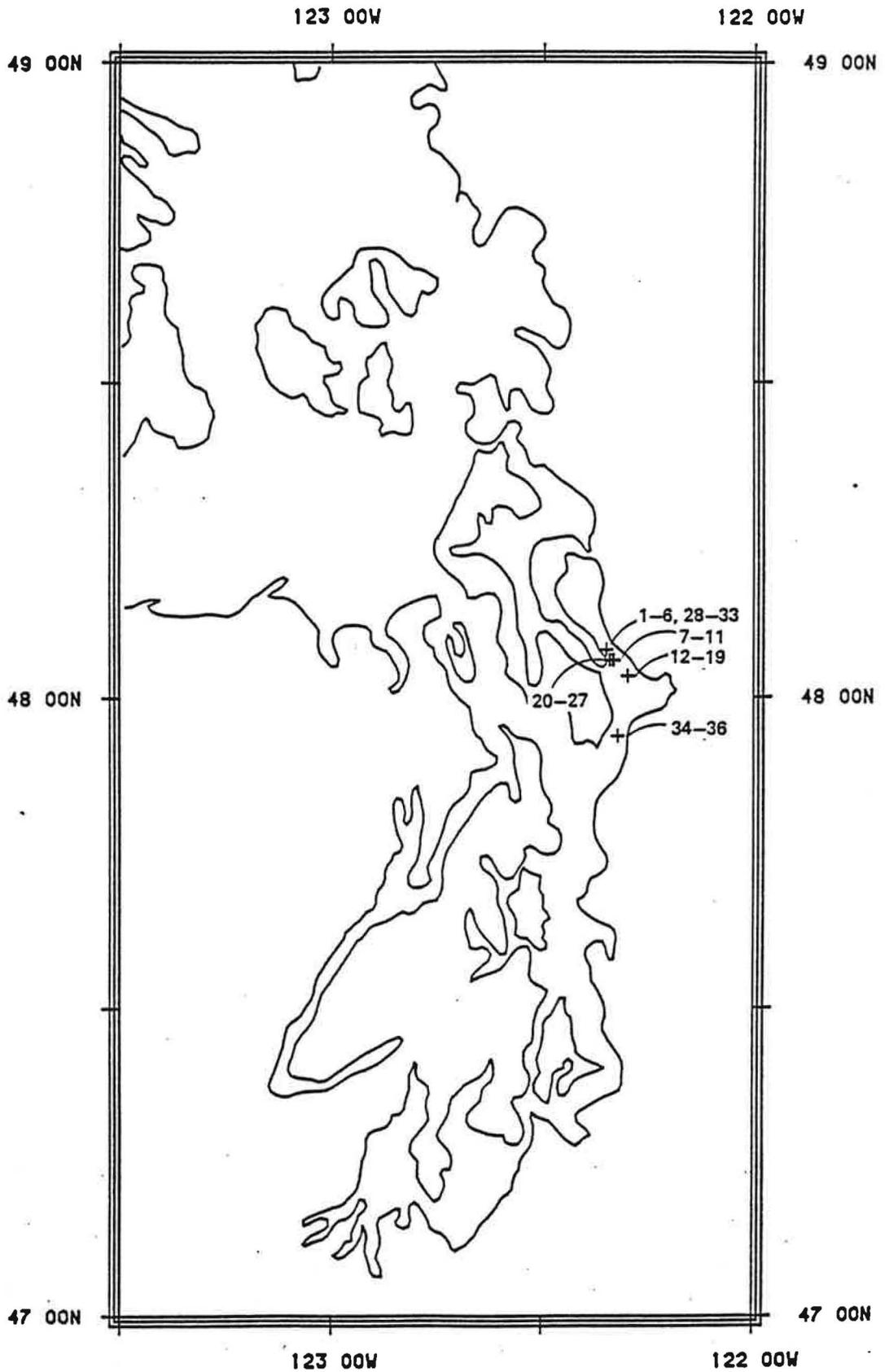


Figure 14.--Station locations of cruises 21-6801 through 21-6806, May 9-June 5, 1968.

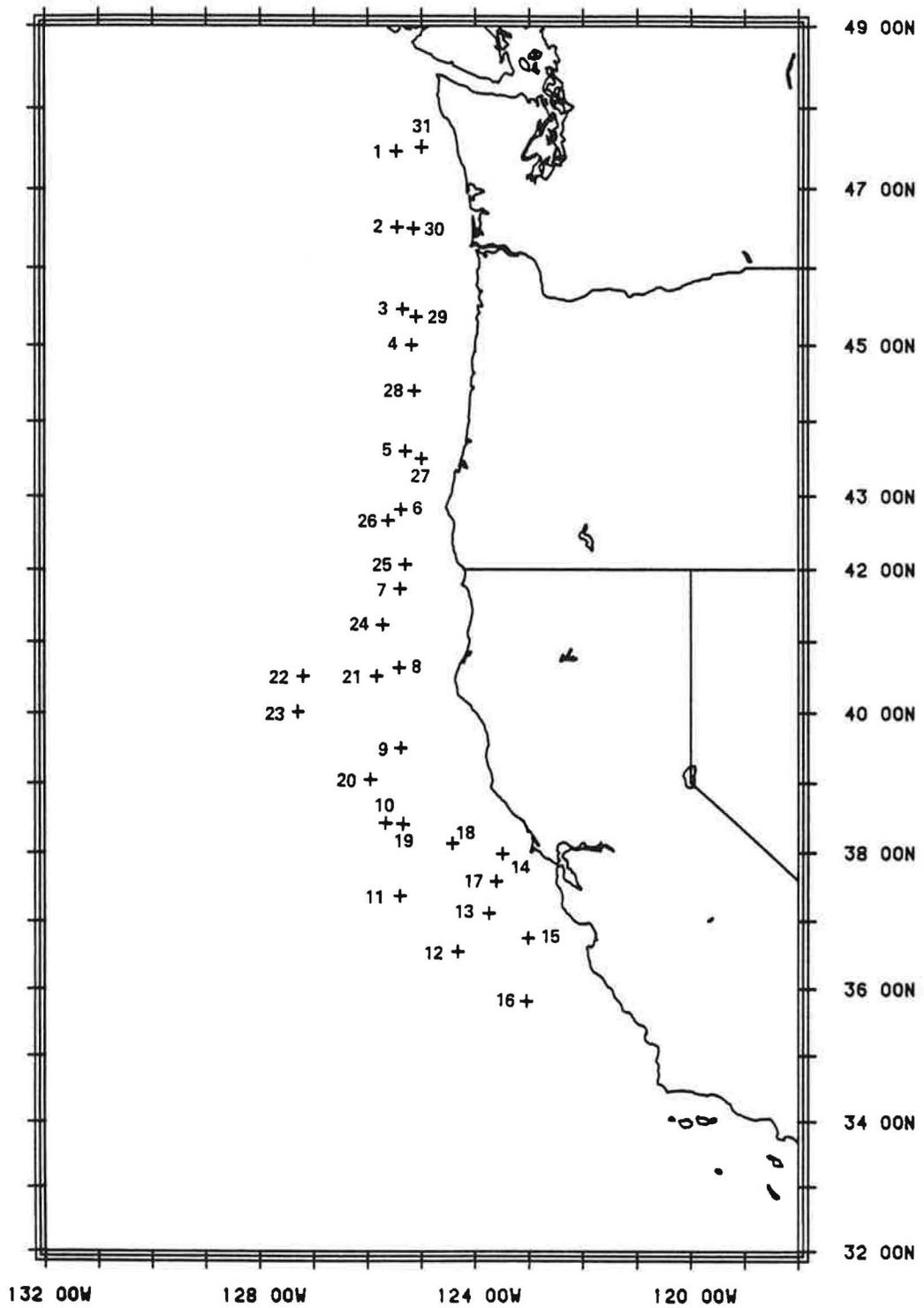


Figure 15.--Station locations of cruise K-7012, October 10-26, 1970.

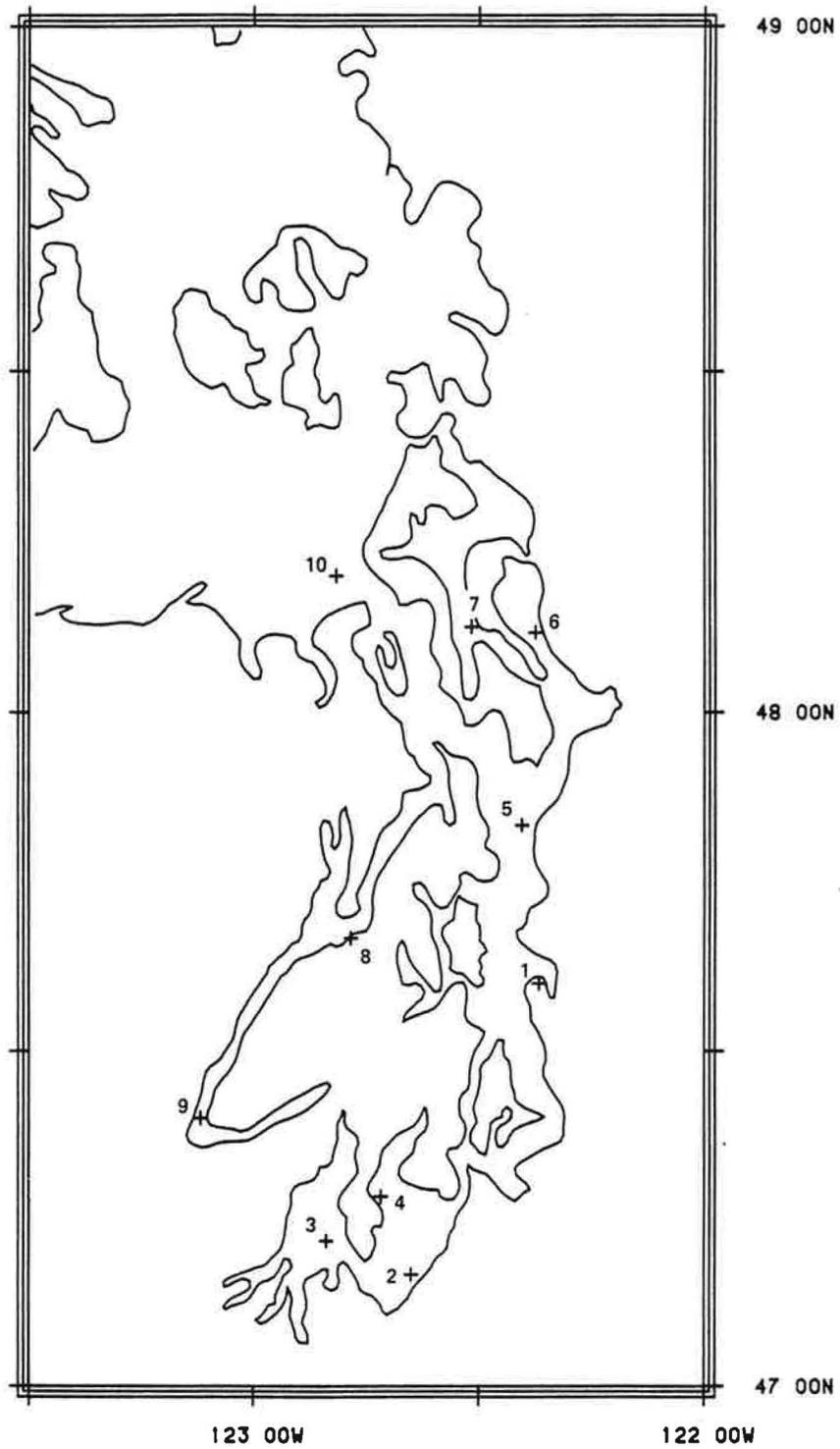


Figure 16.--Station locations in Puget Sound during cruise K-6805, October 15-17, 1968.

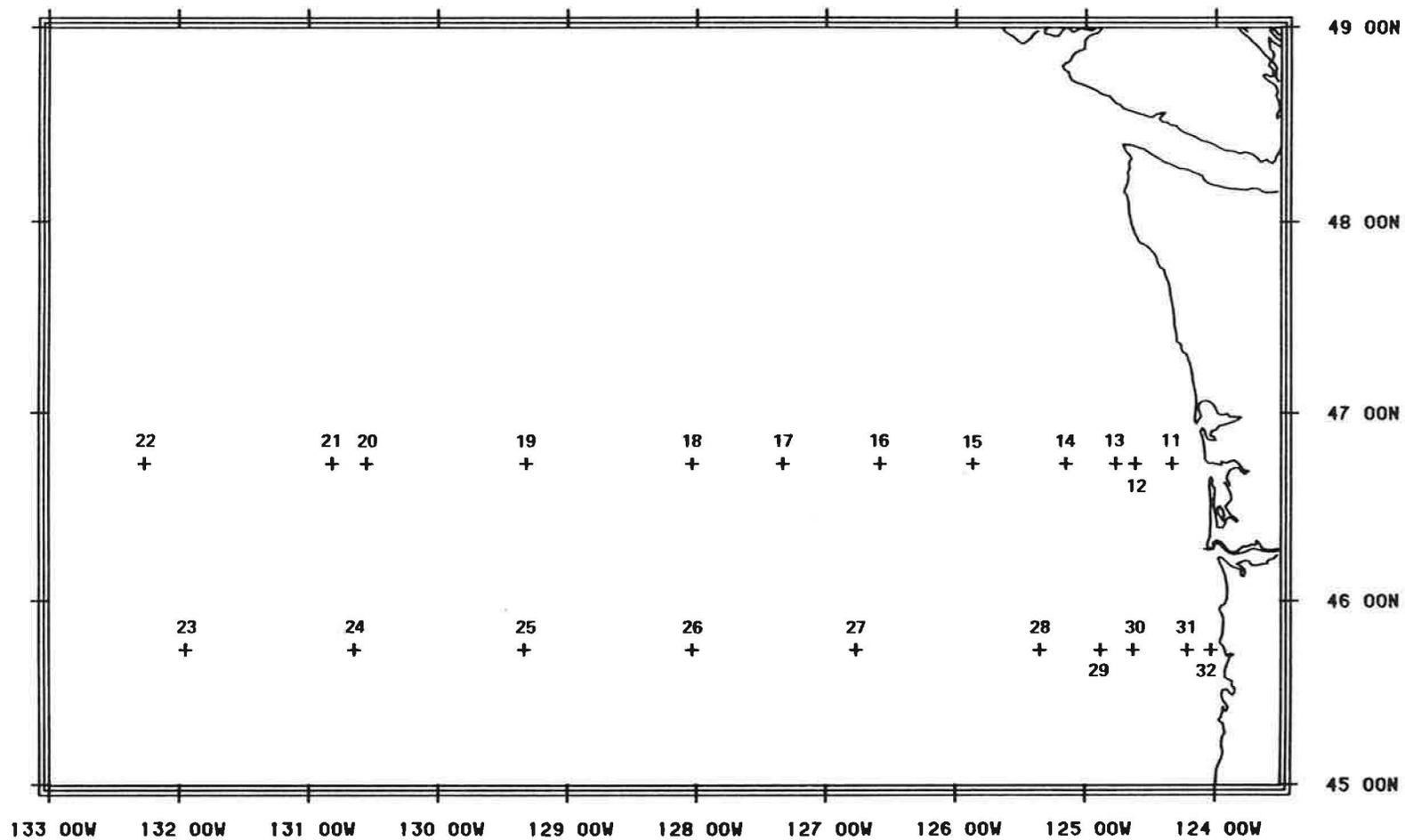


Figure 17.--Station locations off Oregon and Washington during cruise K-6805, October 18-25, 1968.

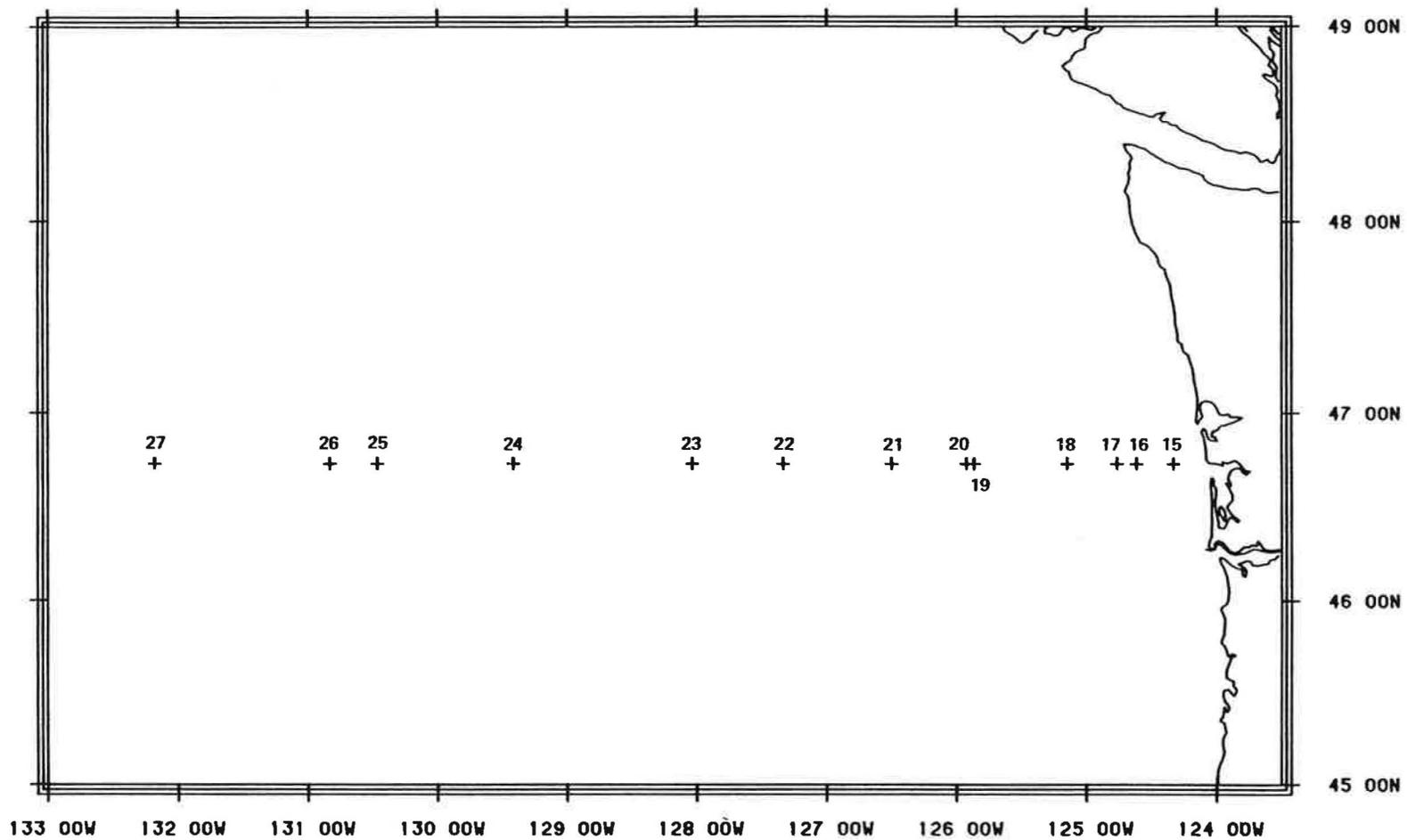


Figure 18.--Station locations of cruise F-6901, January 17-19, 1969.

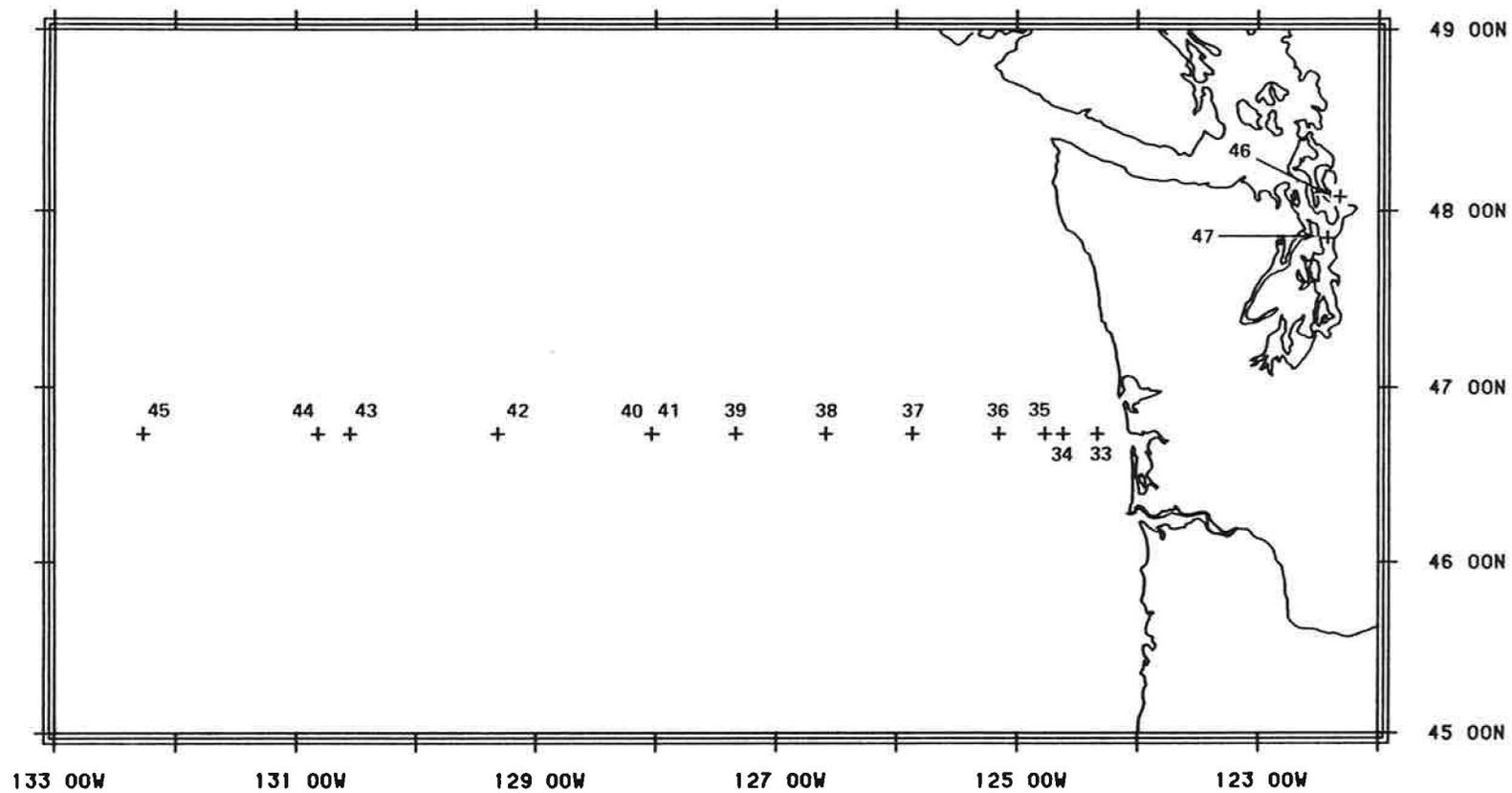


Figure 19.--Station locations of cruise 20-6905, November 21-24, 1969.

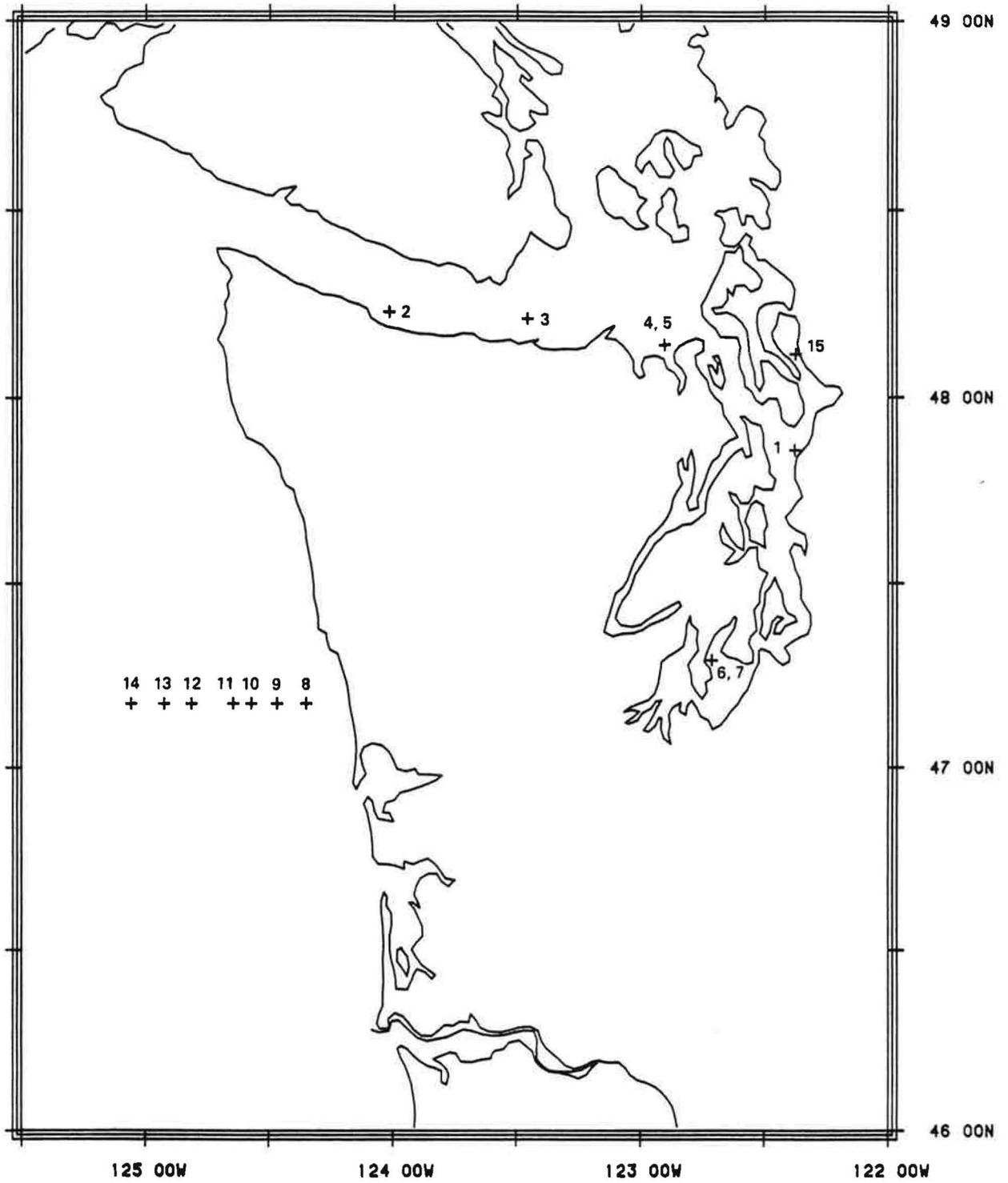


Figure 20.--Station locations of cruise JNC-7101, January 18-29, 1971.

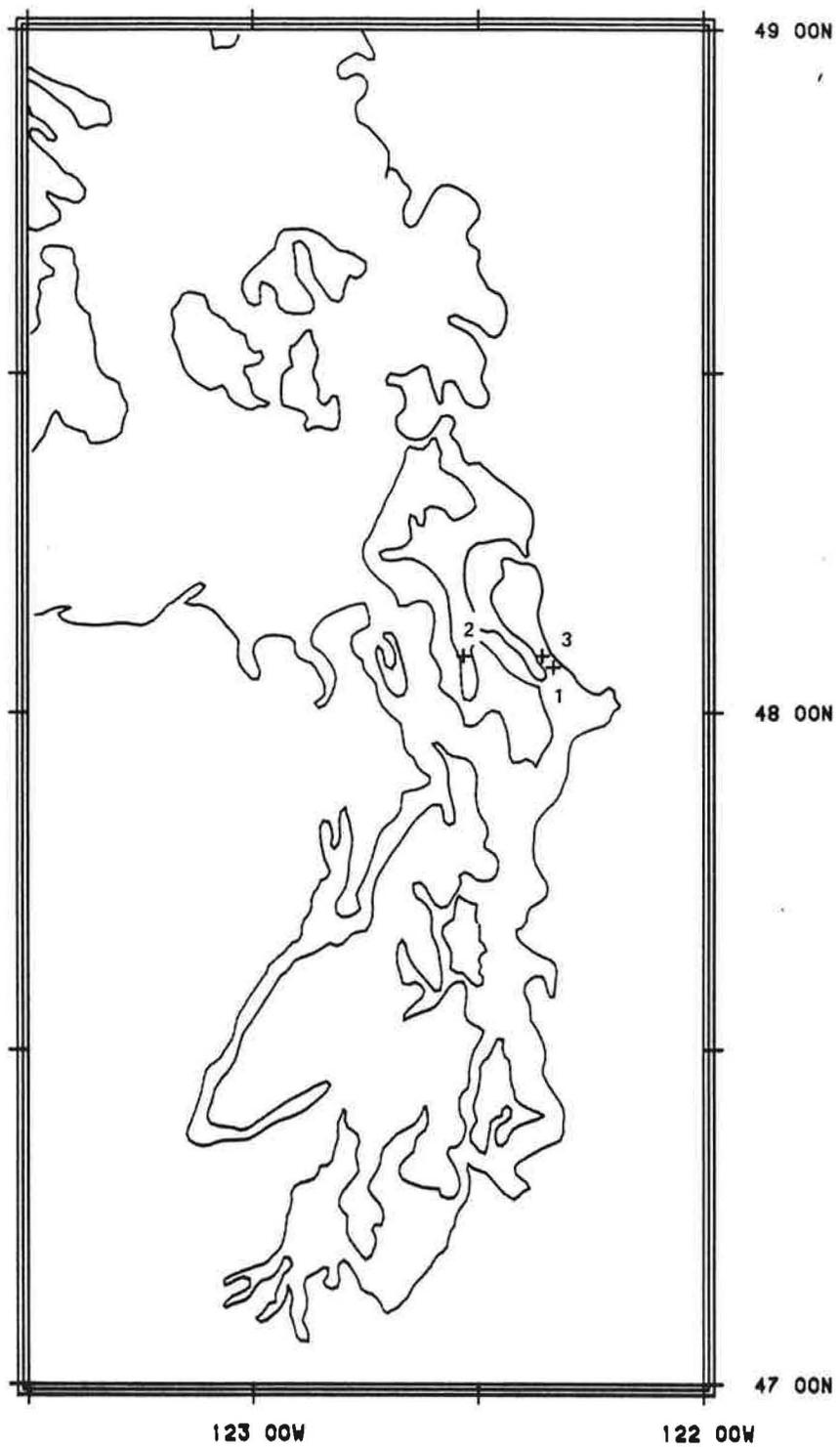


Figure 21.--Station locations in Puget Sound during cruise JNC-7103, April 8, 1971.

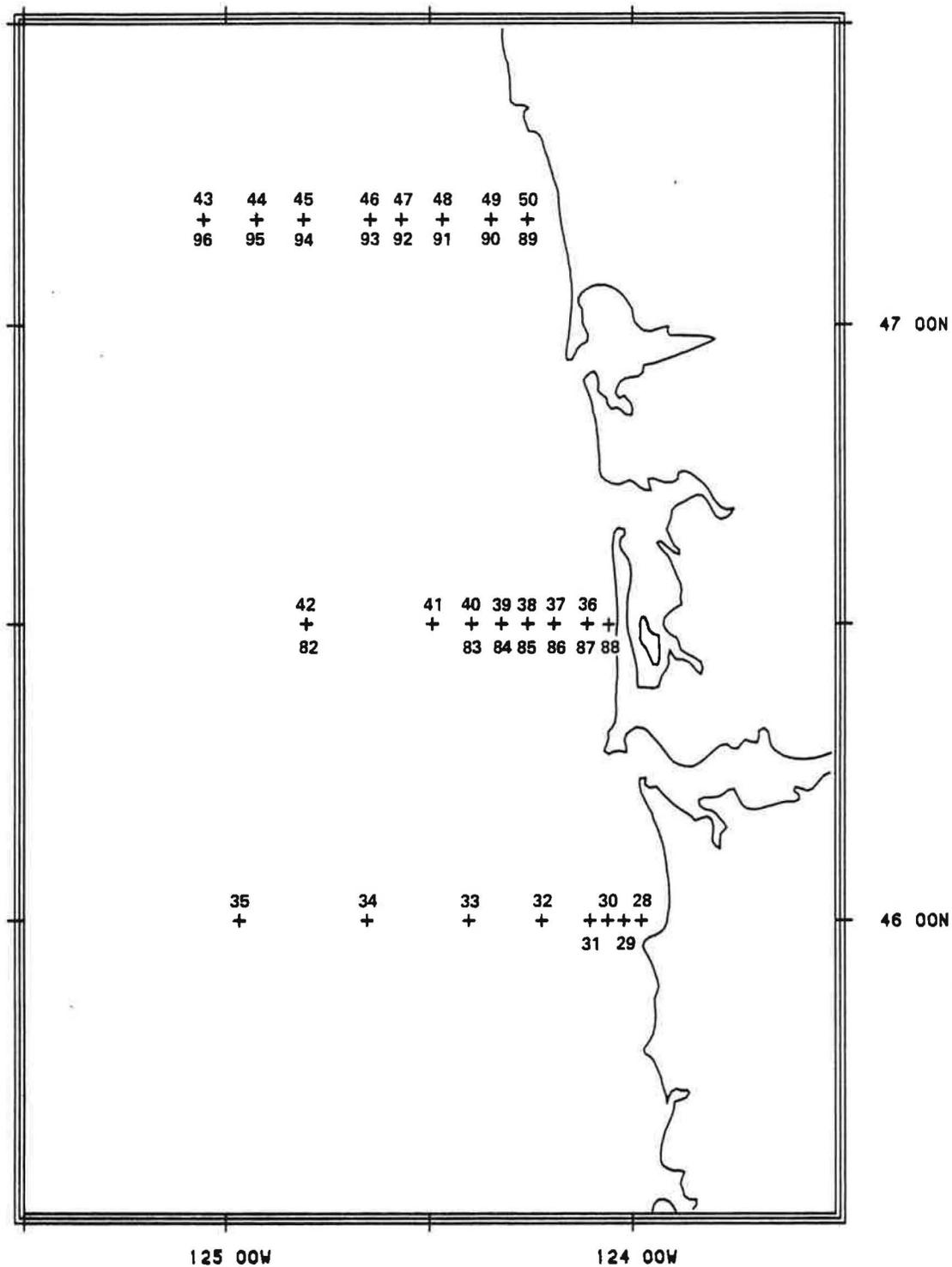


Figure 22.--Station locations off Oregon and Washington during cruise JNC-7104, May 3-6, 1971.

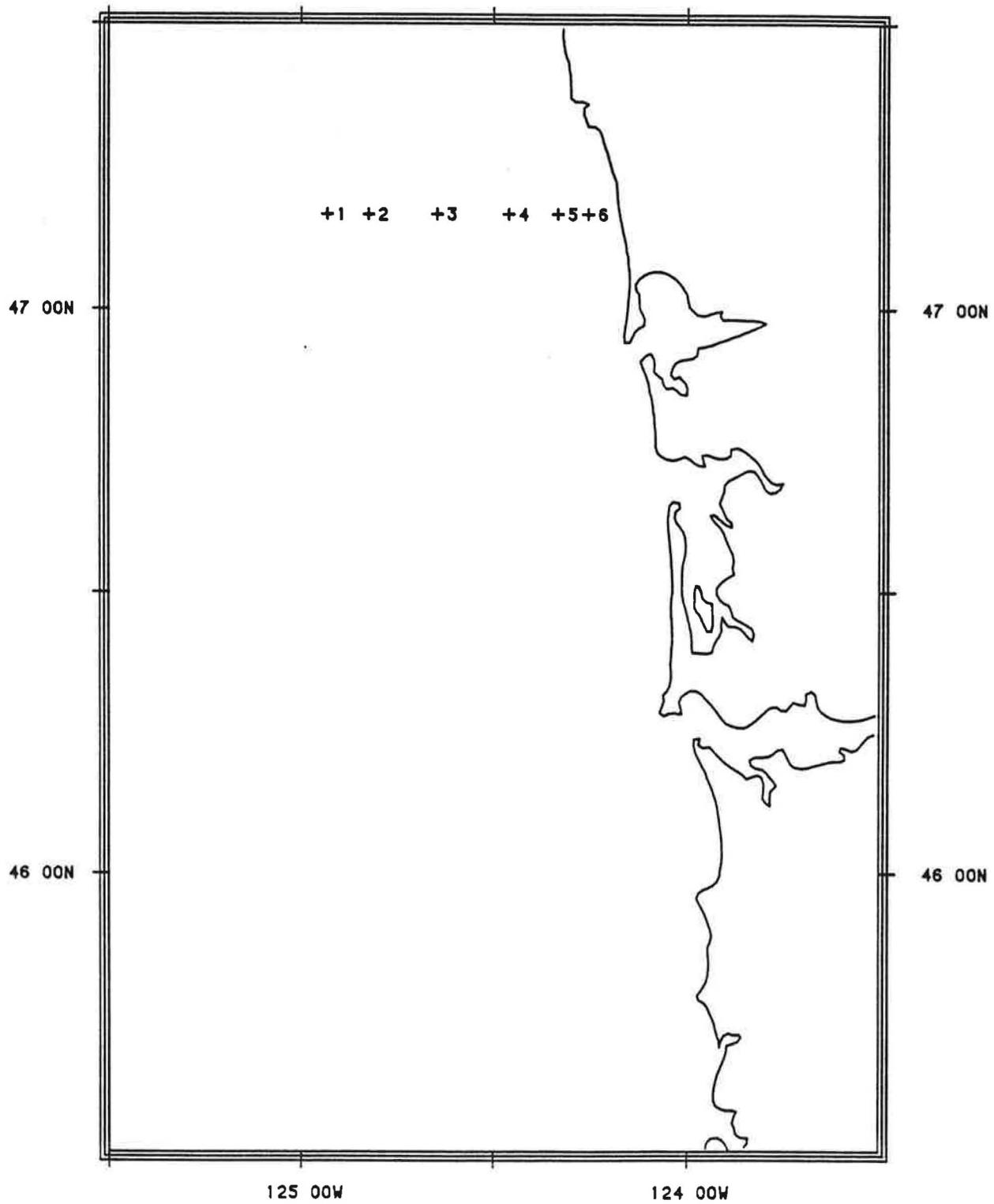


Figure 23.--Station locations off Washington during cruise JNC-7105, July 22-23, 1971.

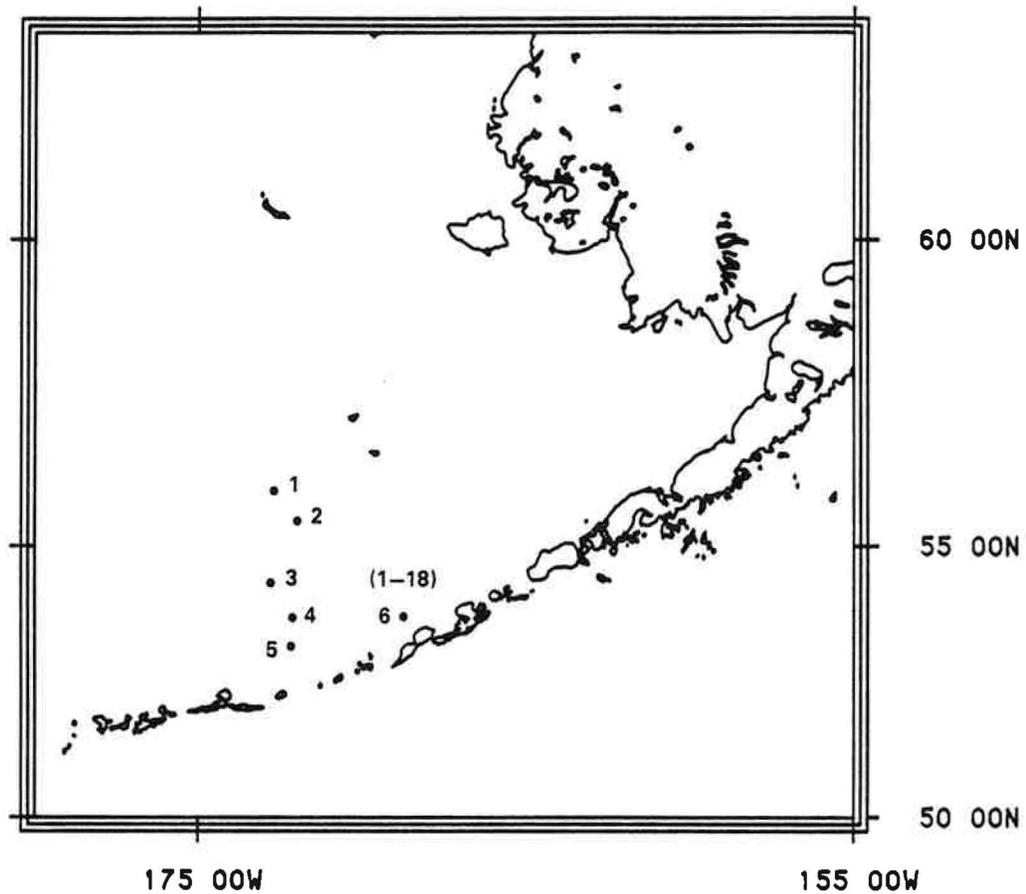


Figure 24.--Station locations of cruise K71-3, May 21-June 11, 1971.

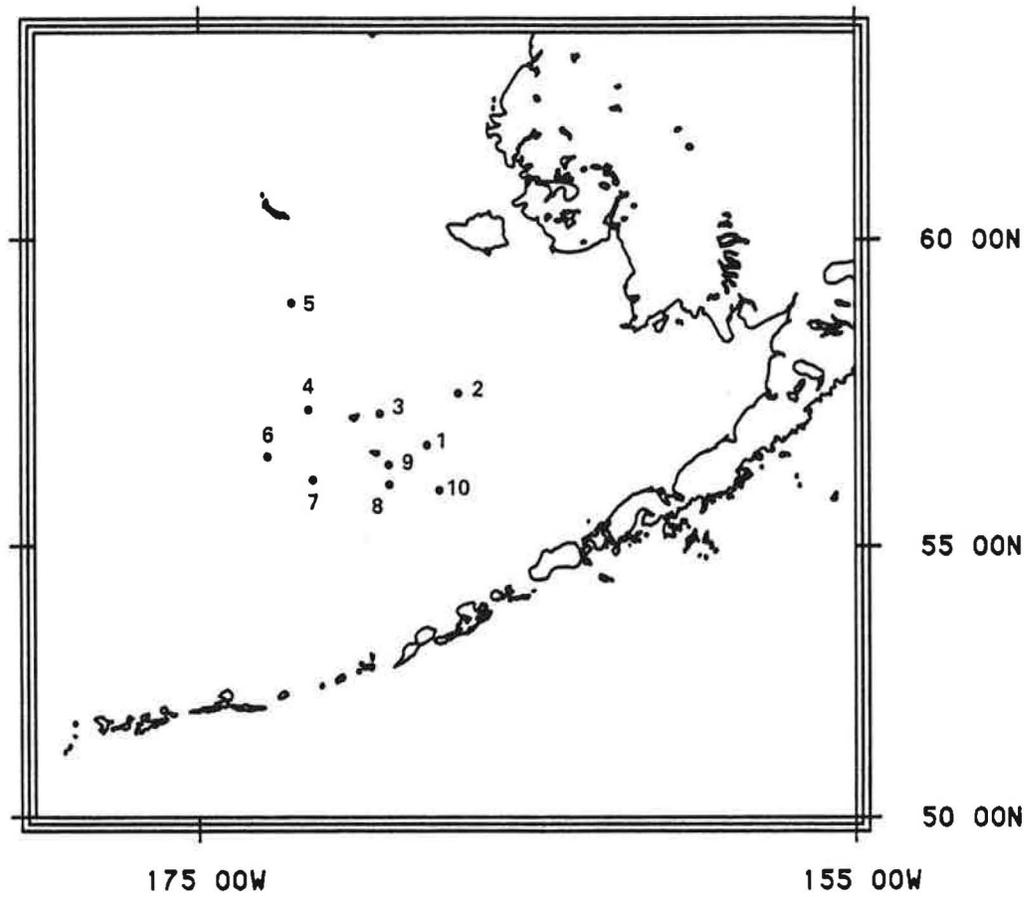


Figure 25.--Station locations of cruise DE-4, July 25-August 3, 1971.

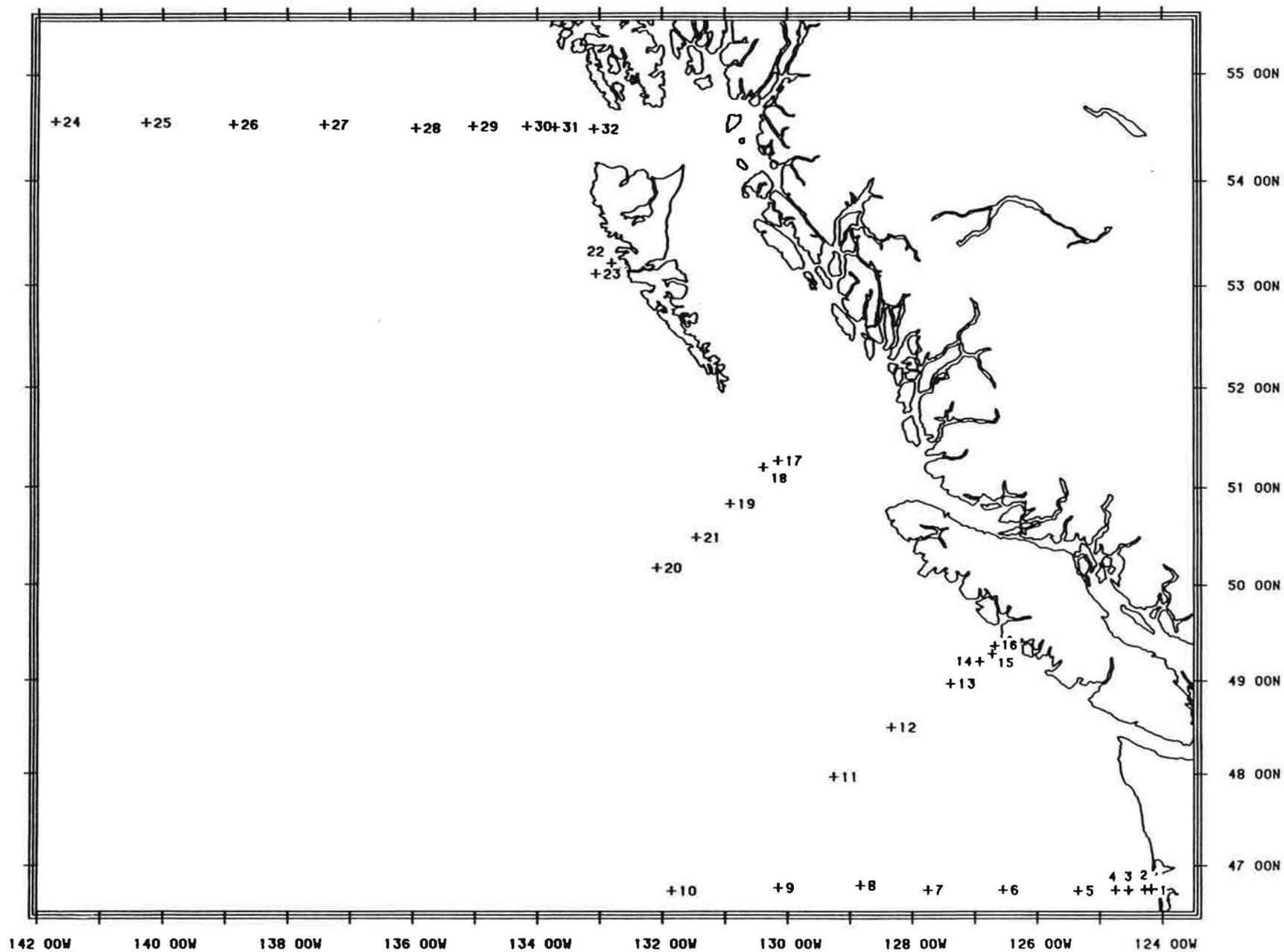


Figure 26.--Station locations of cruise K71-5, October 14 to November 4, 1971.

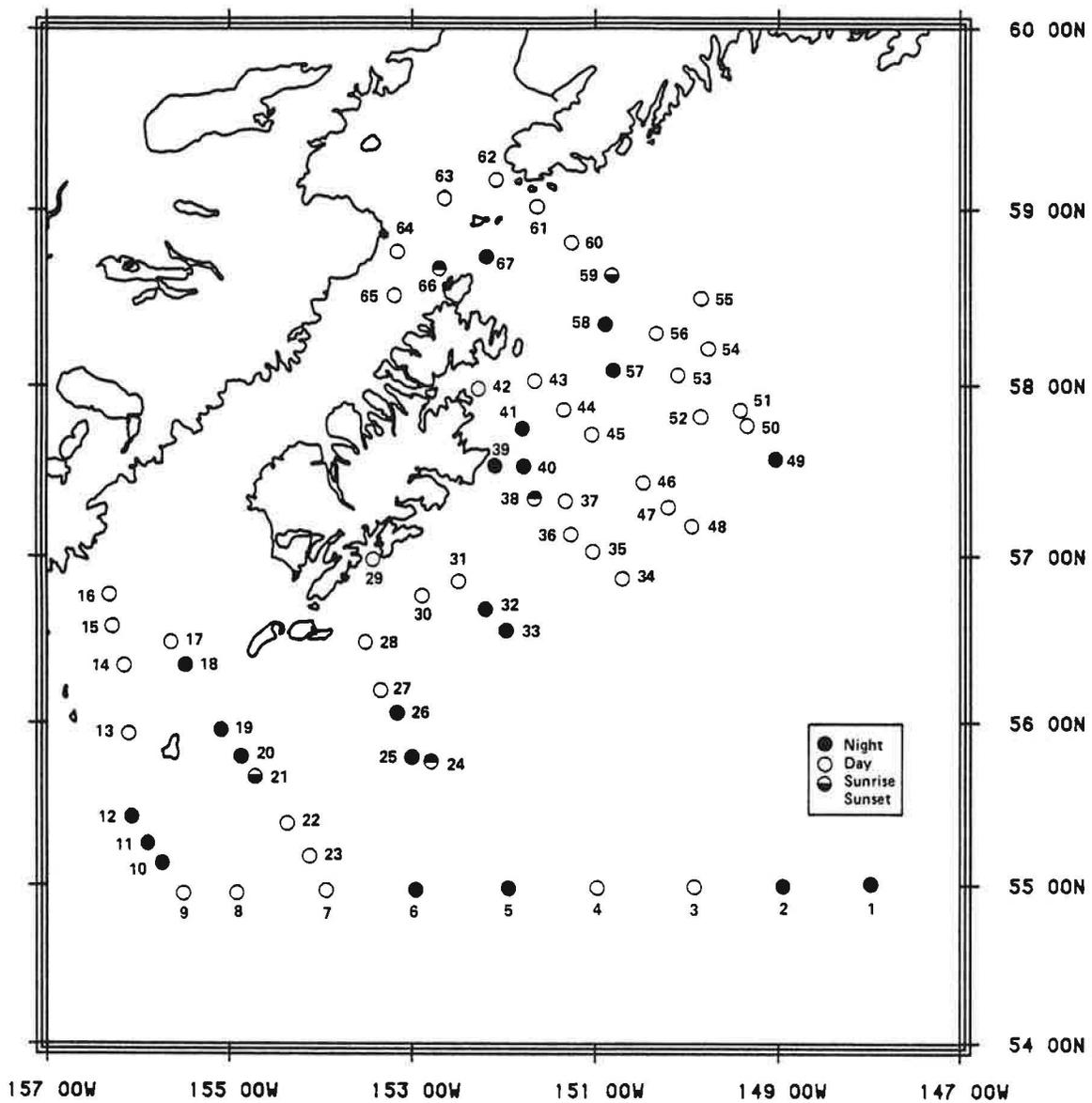


Figure 27.--Station locations of cruise K72-2 (Phase I), April 19 to May 11, 1972.

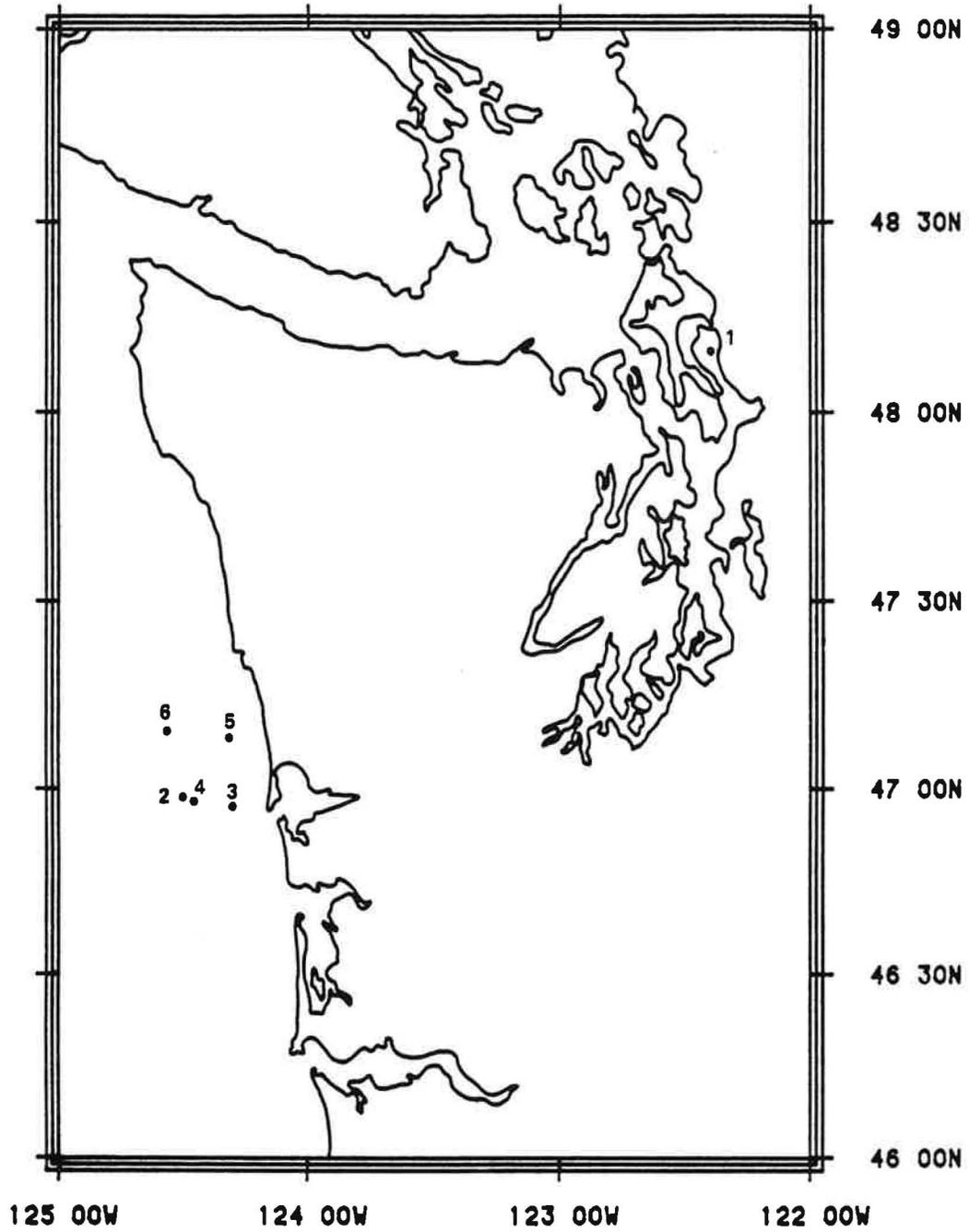


Figure 28.--Station locations of cruise K72-2 (Phases II, III), May 23-27, and May 31-June 16, 1972.

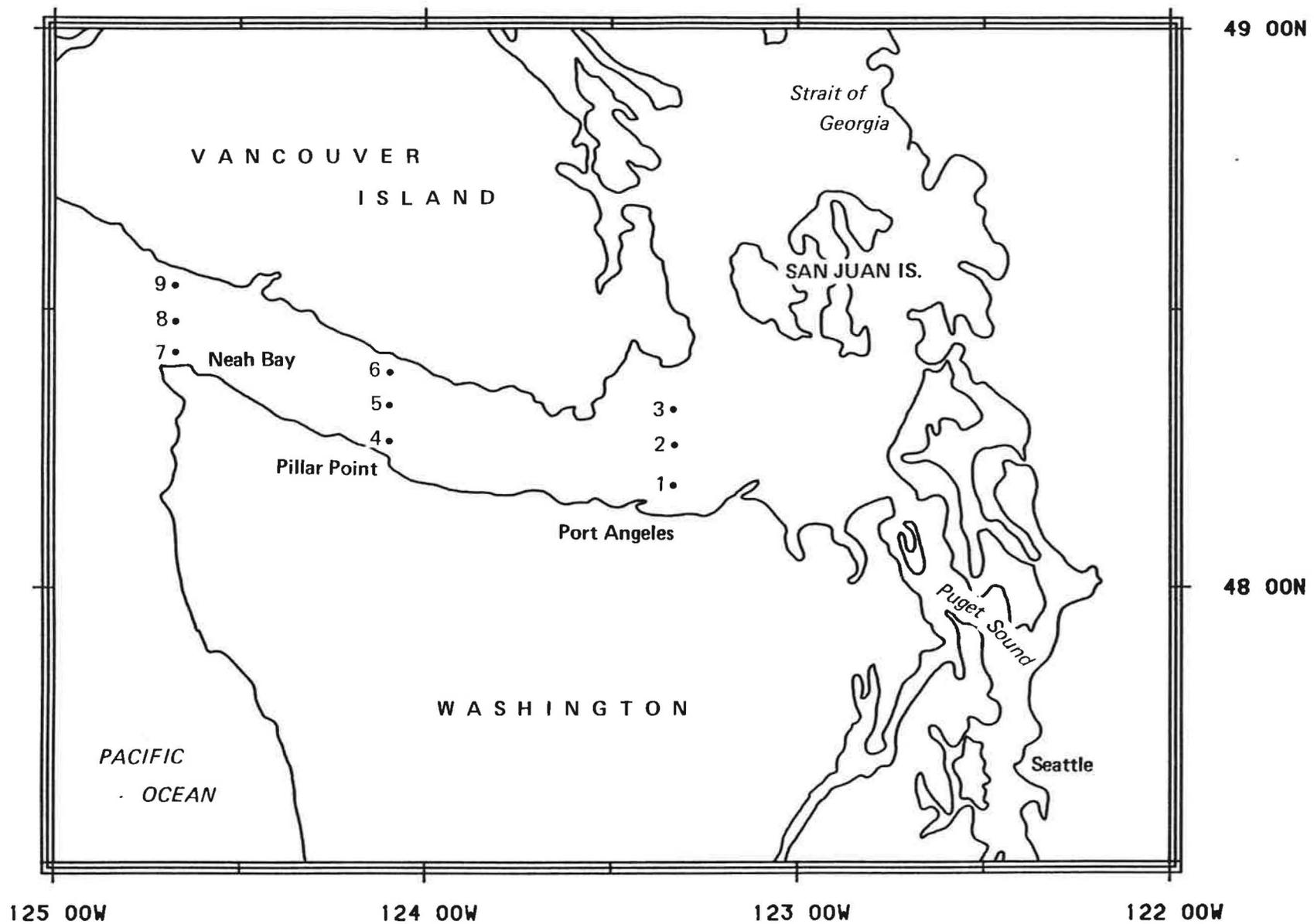


Figure 29.--Station locations of cruises SF7601 to SF7706, February 23, 1976 to October 5, 1977.

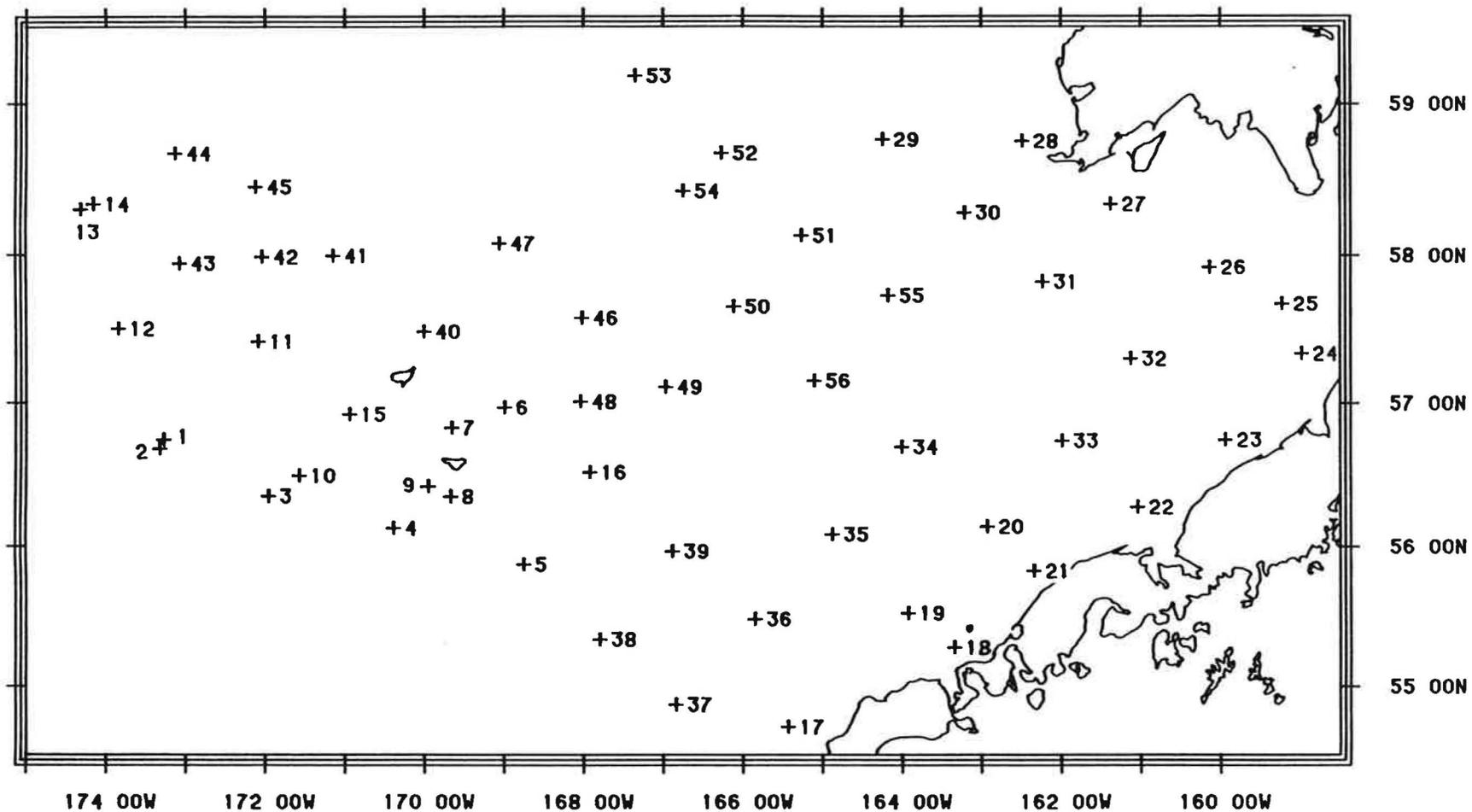


Figure 30.--Station locations for cruise MF76A, April 25-May 31, 1976.

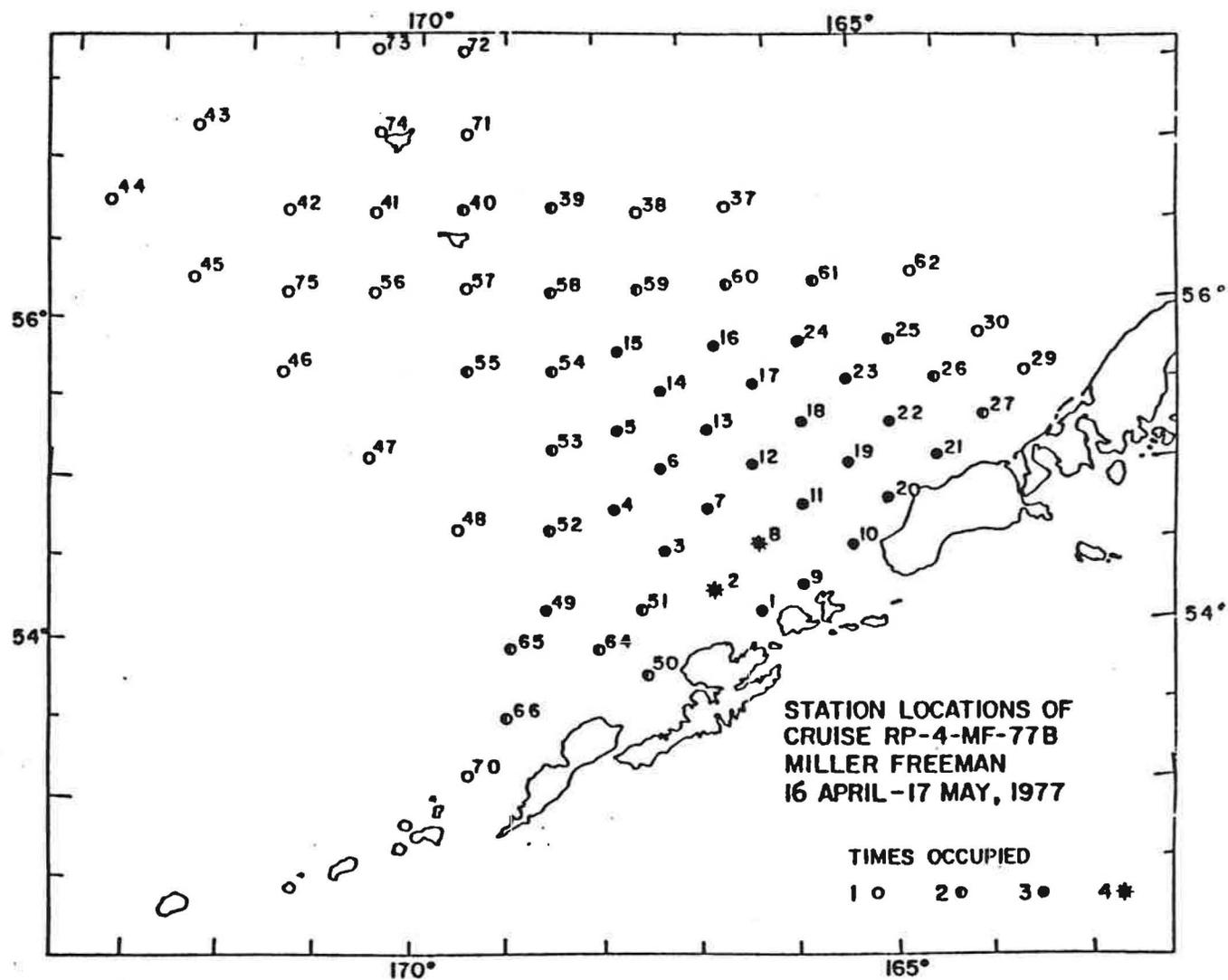


Figure 31.--Station locations for cruises MF77B5 and 6, April 16-May 17, 1977.

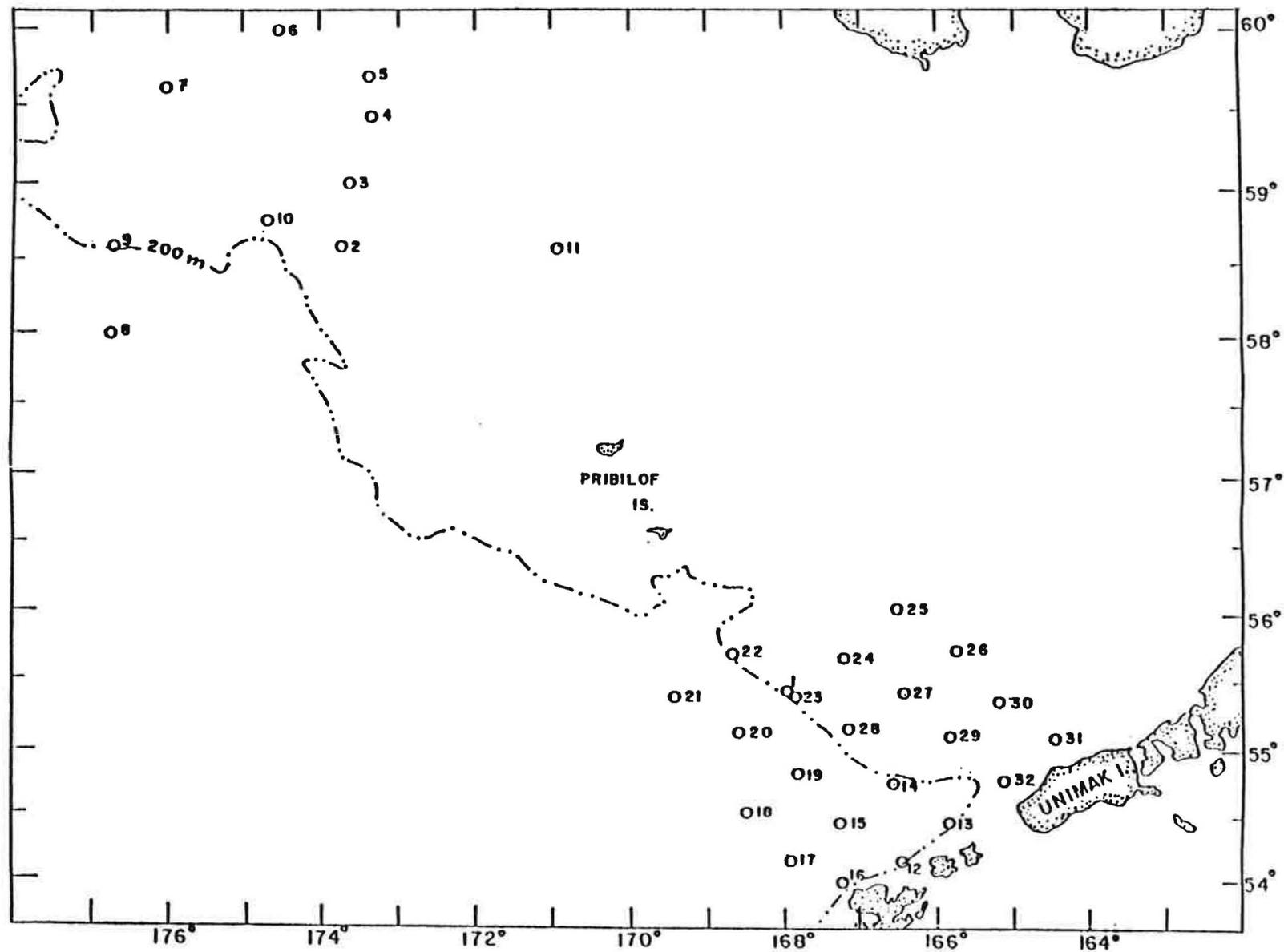


Figure 32.--Station locations for cruise MF78-01, February 11-March 16, 1978.

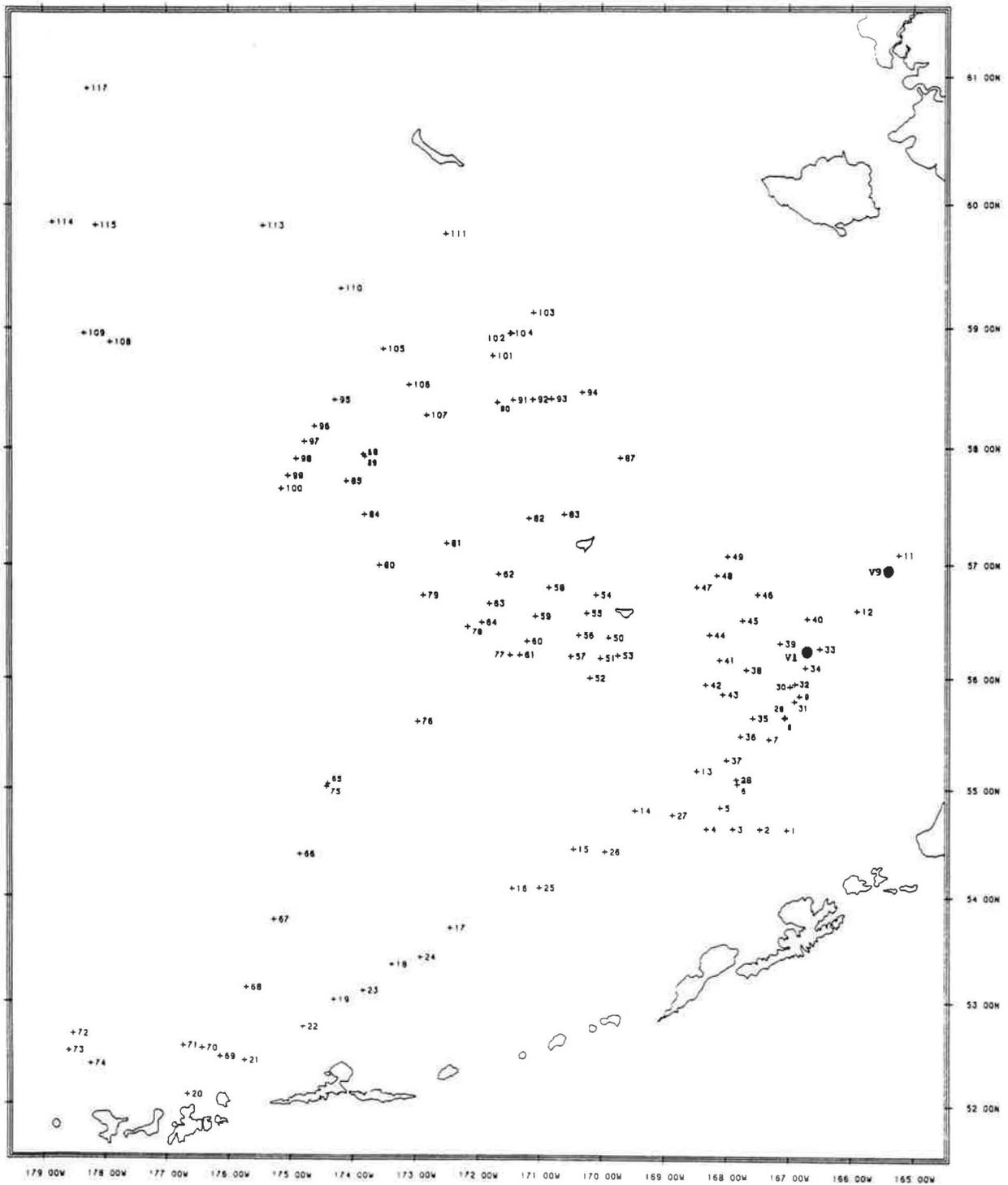


Figure 33.--Station locations for cruise MF79-03, June 1-July 23, 1979. Dots indicate locations of diel stations (V1-V8 and V9-V16).

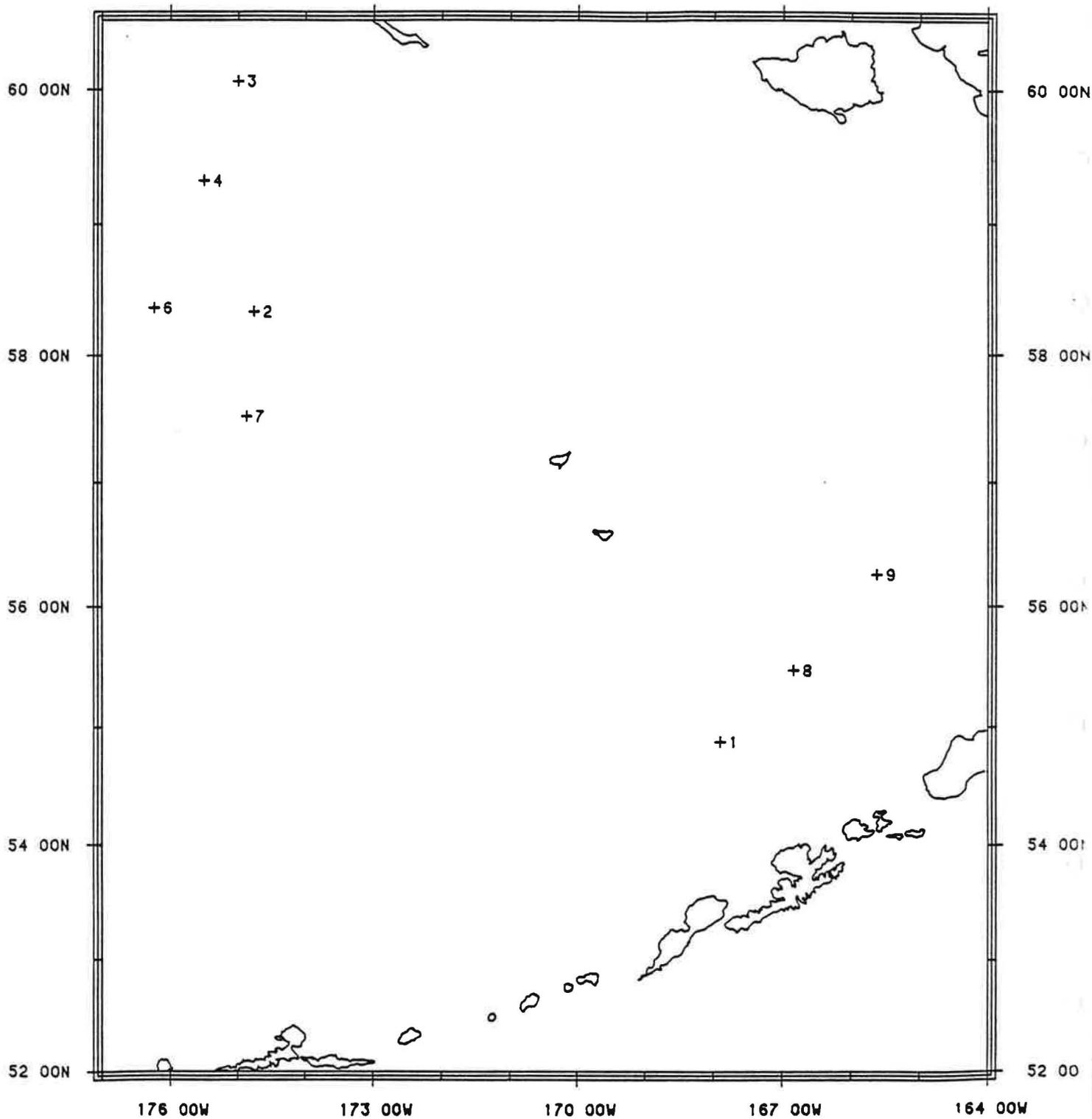


Figure 34.--Station locations of cruise 1MF-80, January 26-February 12, 1980.

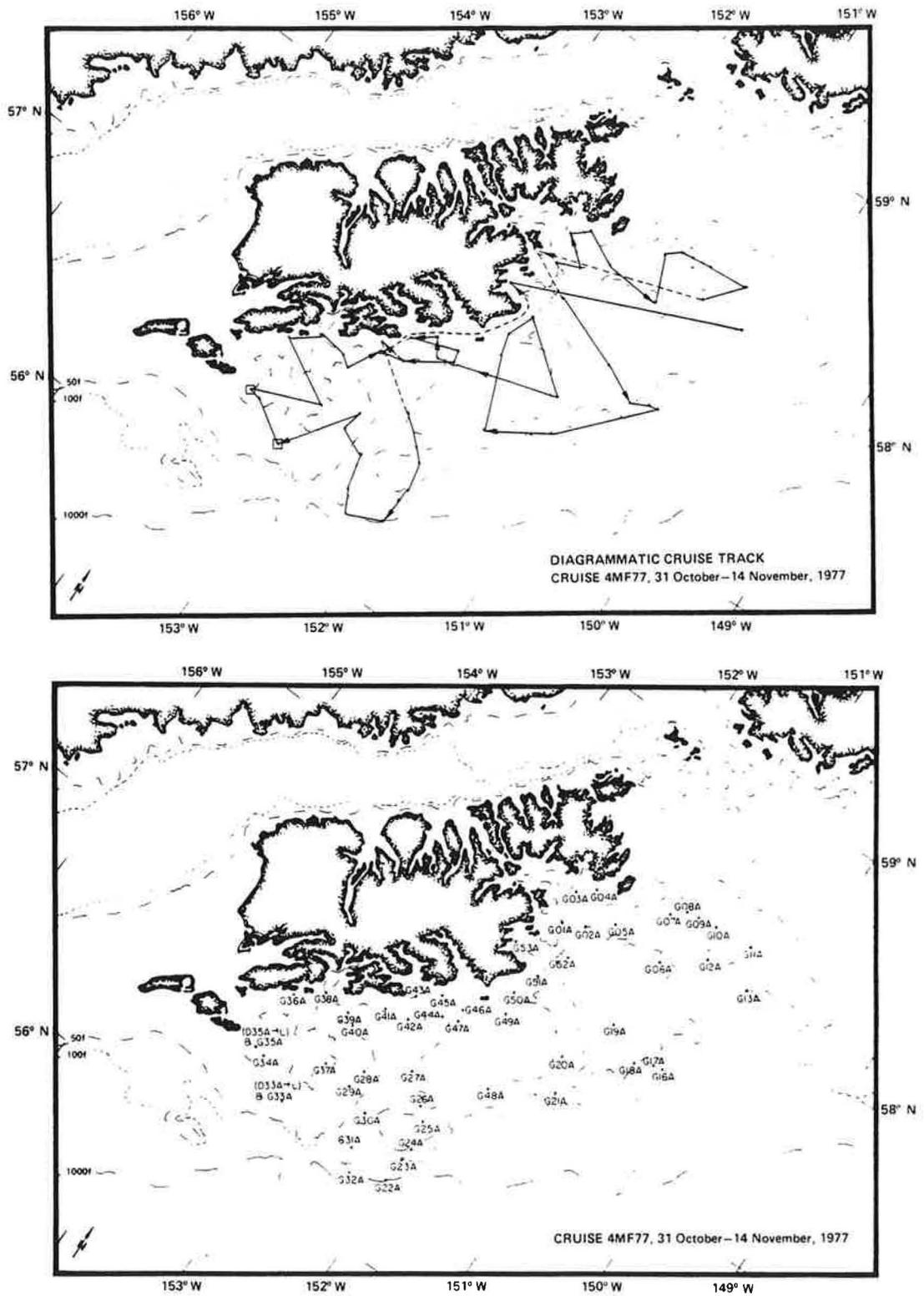


Figure 35.--Cruise track and station locations for cruise 4MF-77, October 31- November 14, 1977.



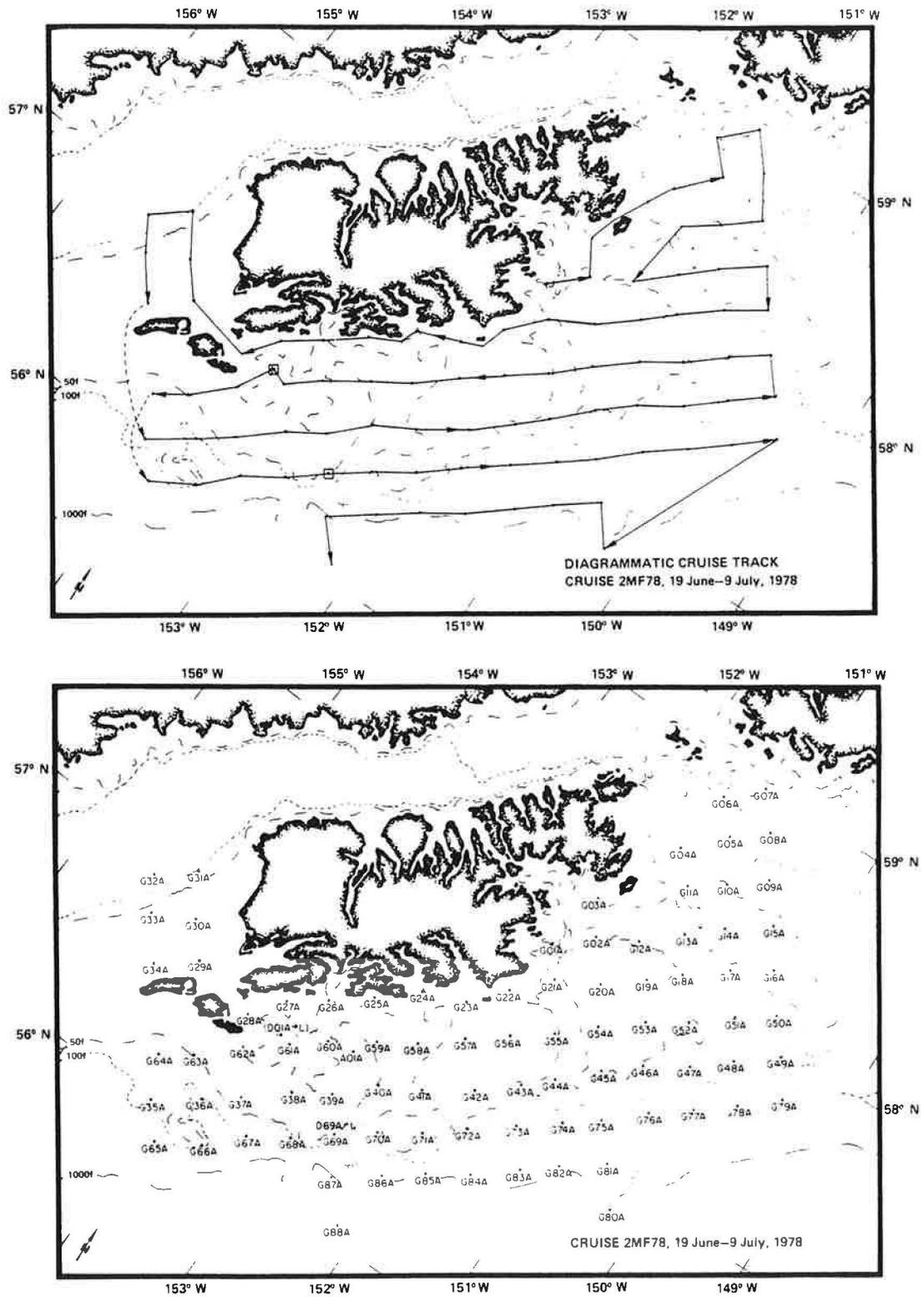


Figure 37.--Cruise track and station locations for cruise 2MF-78, June 19–July 9, 1978.

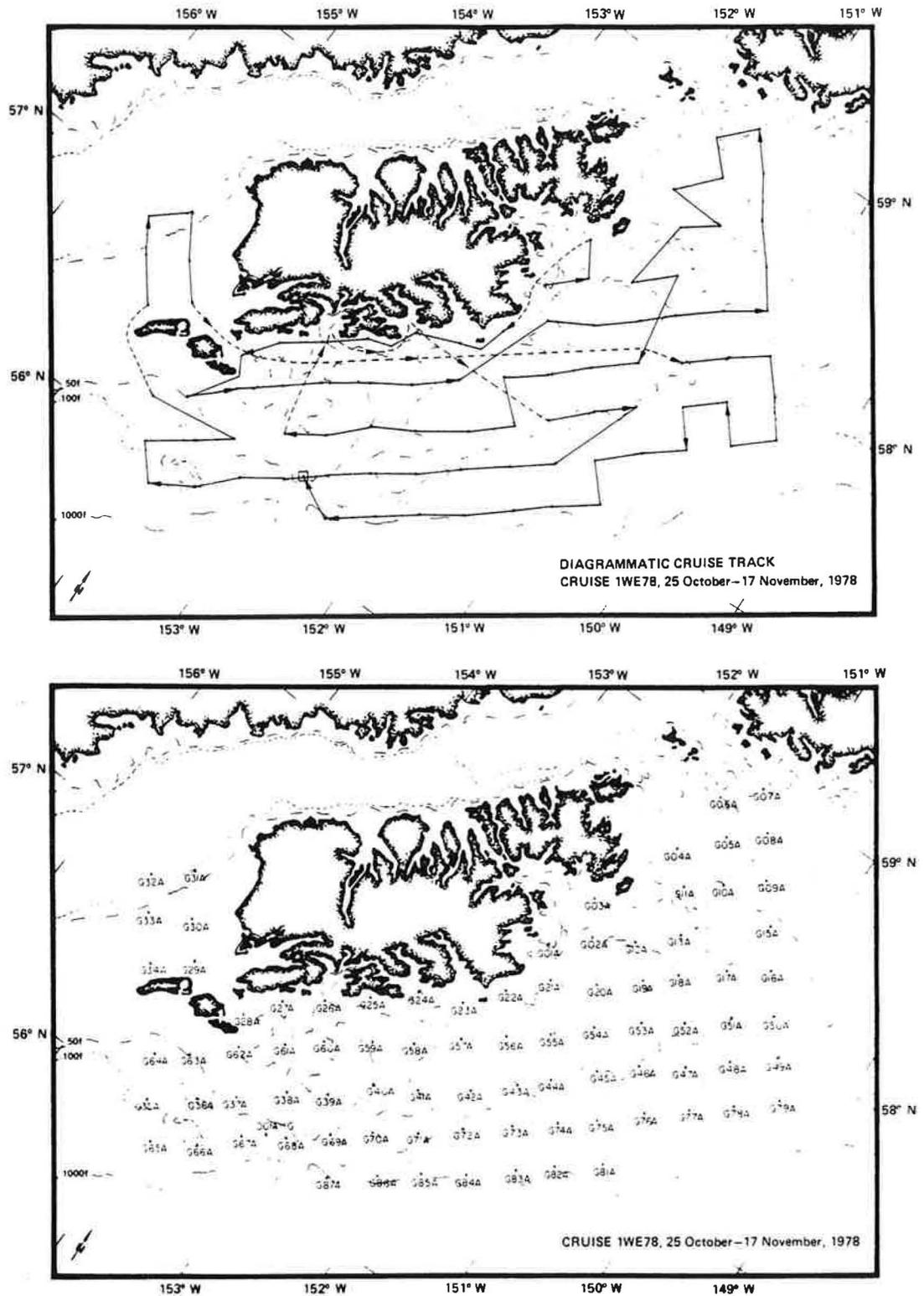


Figure 38.--Cruise track and station locations for cruise 1WE-78, October 25-  
November 17, 1978.

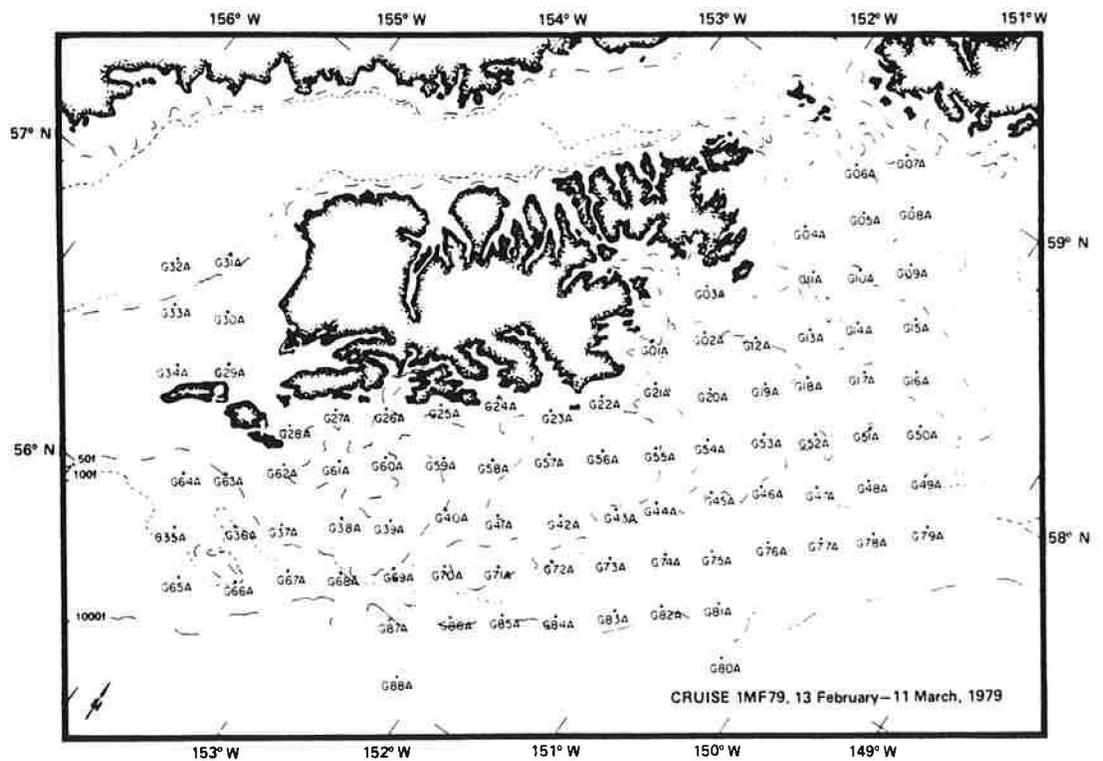
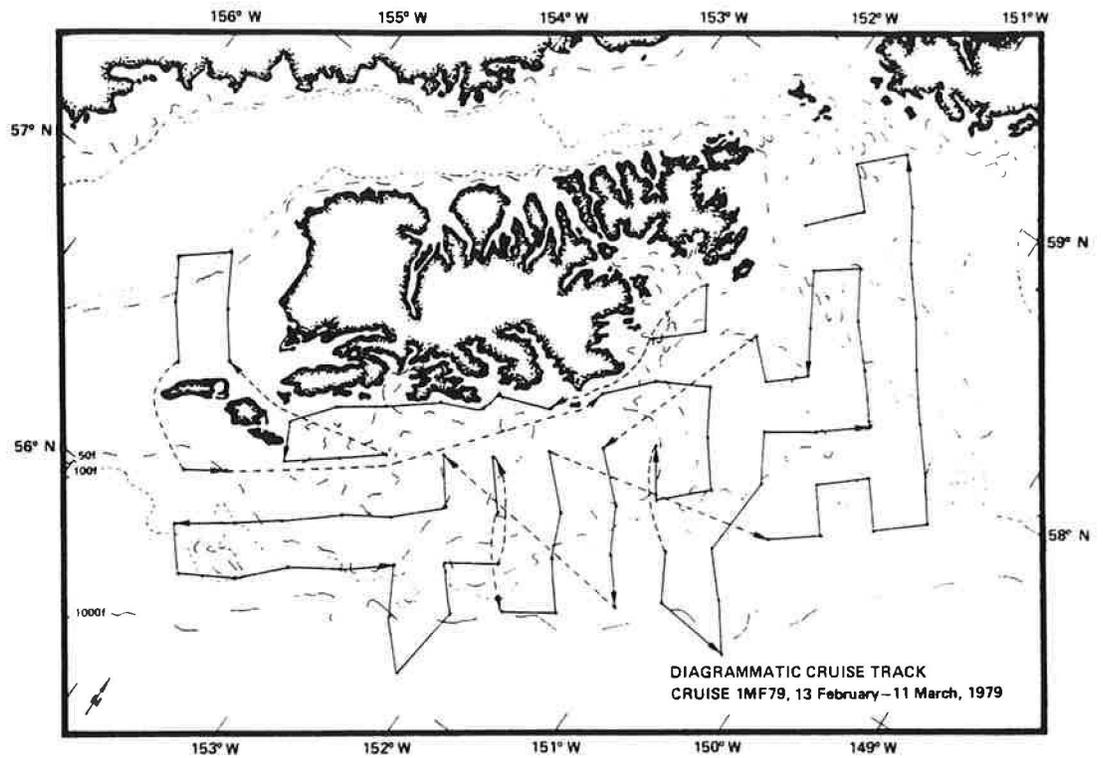


Figure 39.--Cruise track and station locations for cruise 1MF-79, February 13-March 11, 1979.

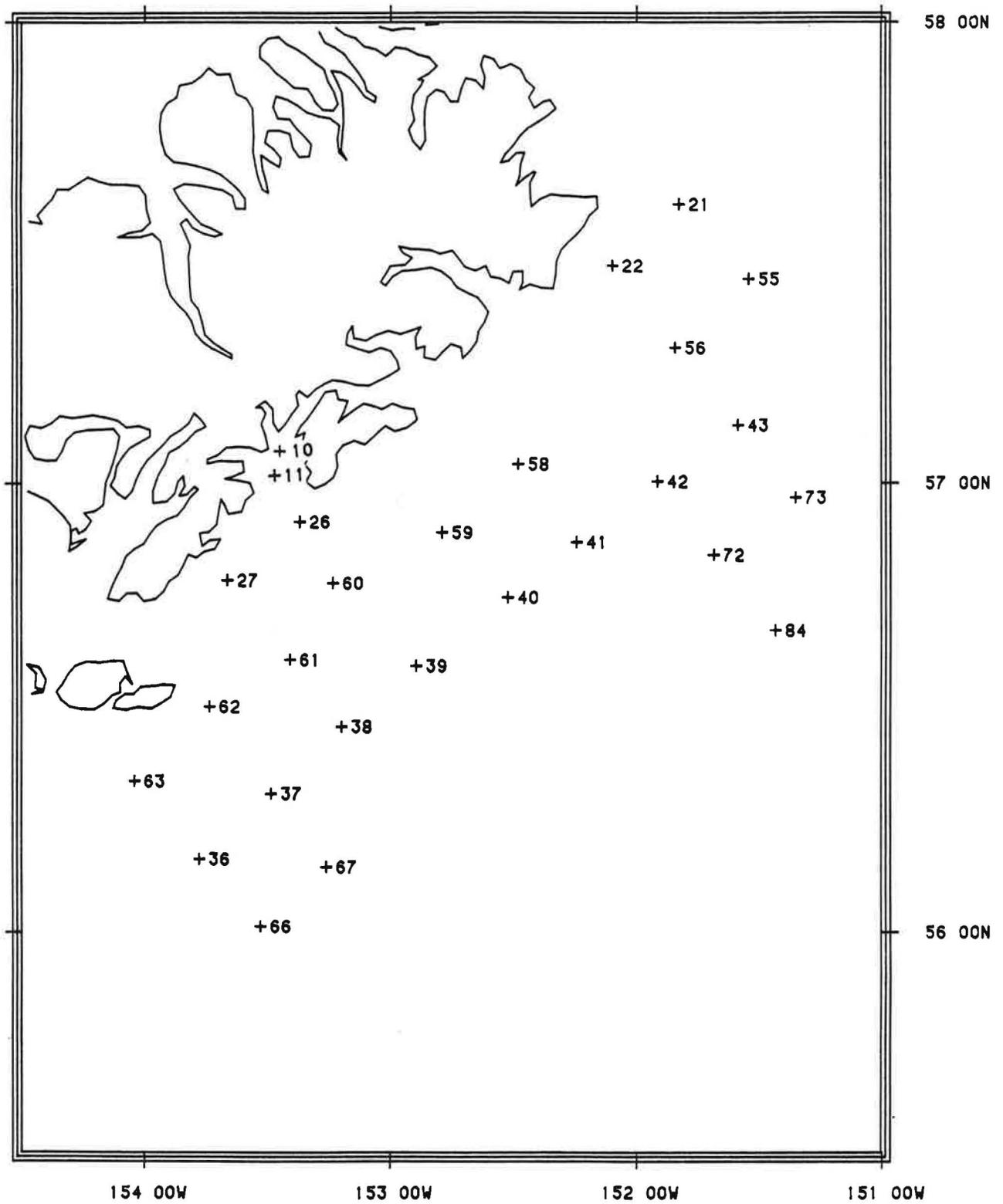


Figure 40.--Station locations for cruise 3MF-78, September 8-21, 1978.

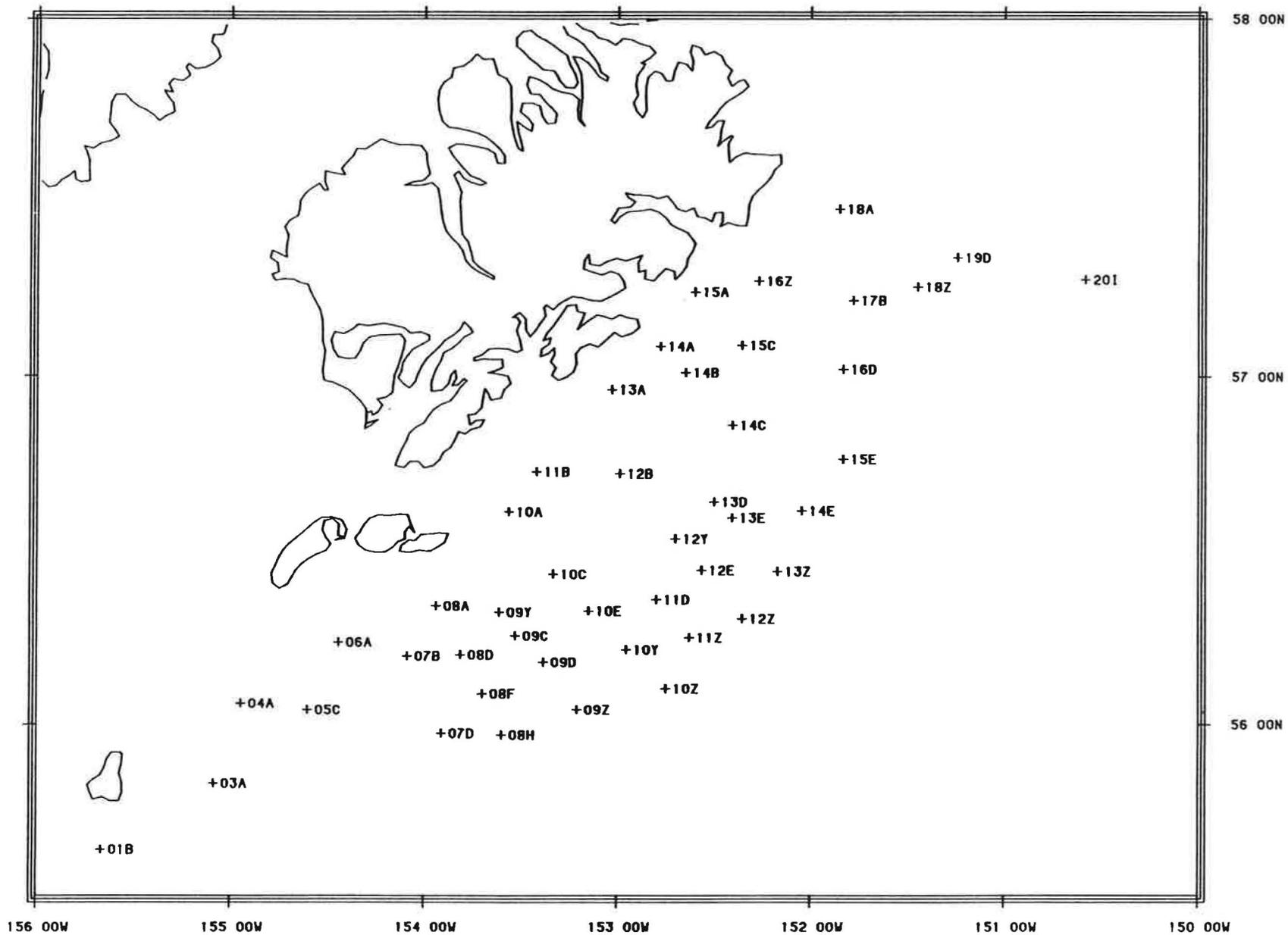


Figure 41.--Neuston station locations for cruise 4MF-78, September 24-October 7, 1978.

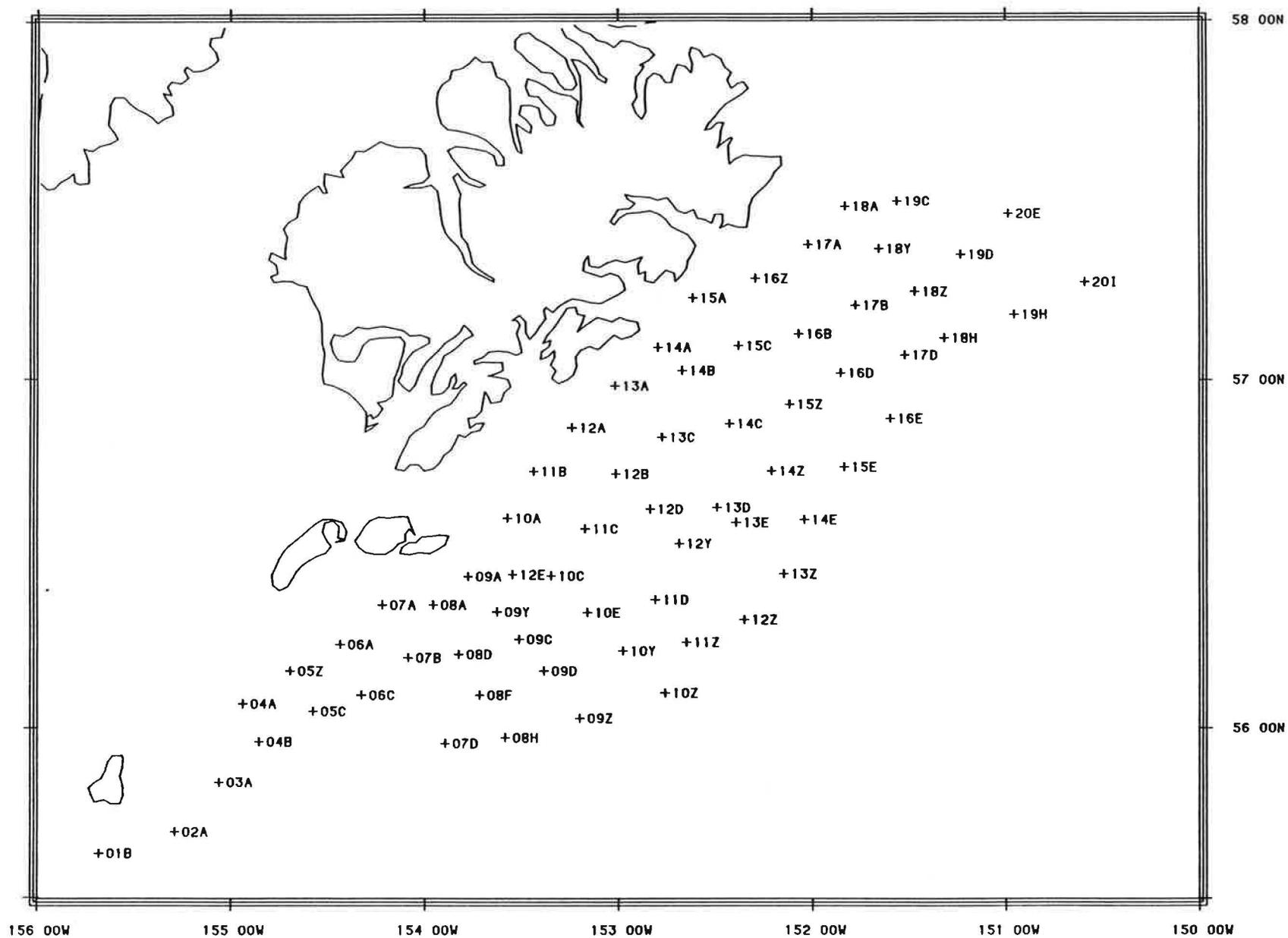


Figure 42.--Bongo station locations for cruise 4MF-78, September 24-October 7, 1978.

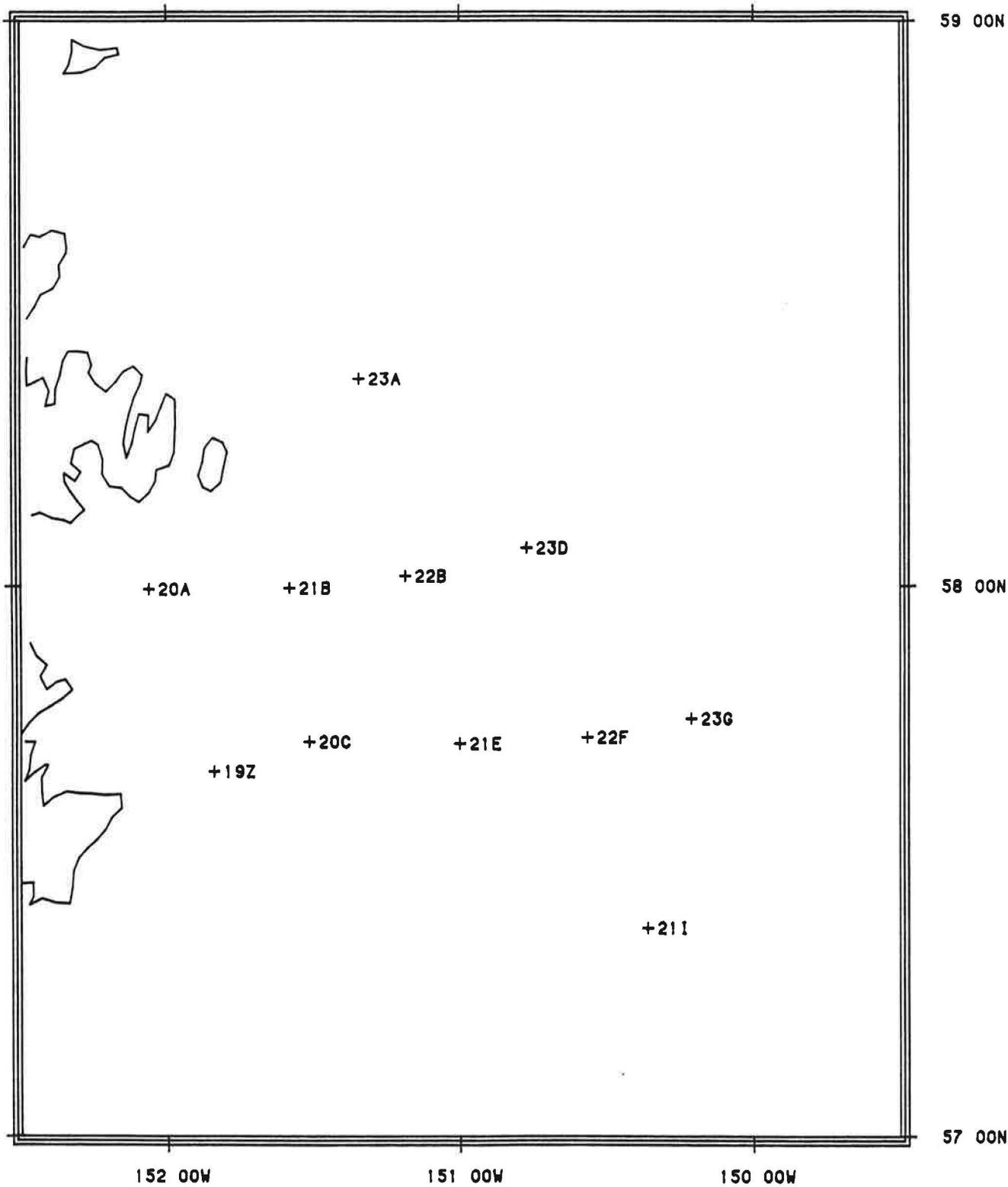


Figure 43.--Neuston station locations for cruise 5MF-78, October 15-  
November 1, 1978.

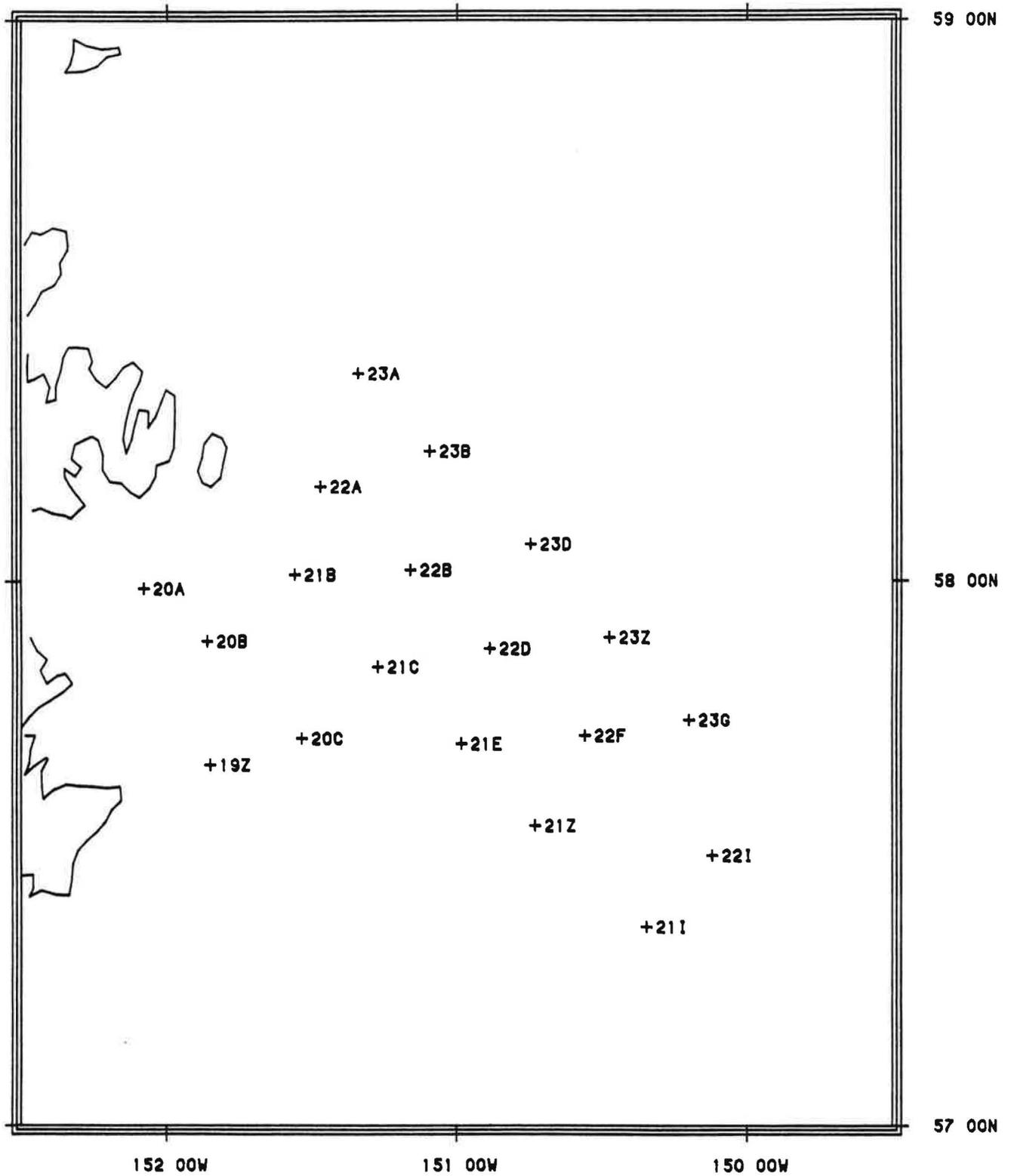


Figure 44.--Bongo station locations for cruise 5MF-78, October 15-  
November 1, 1978.

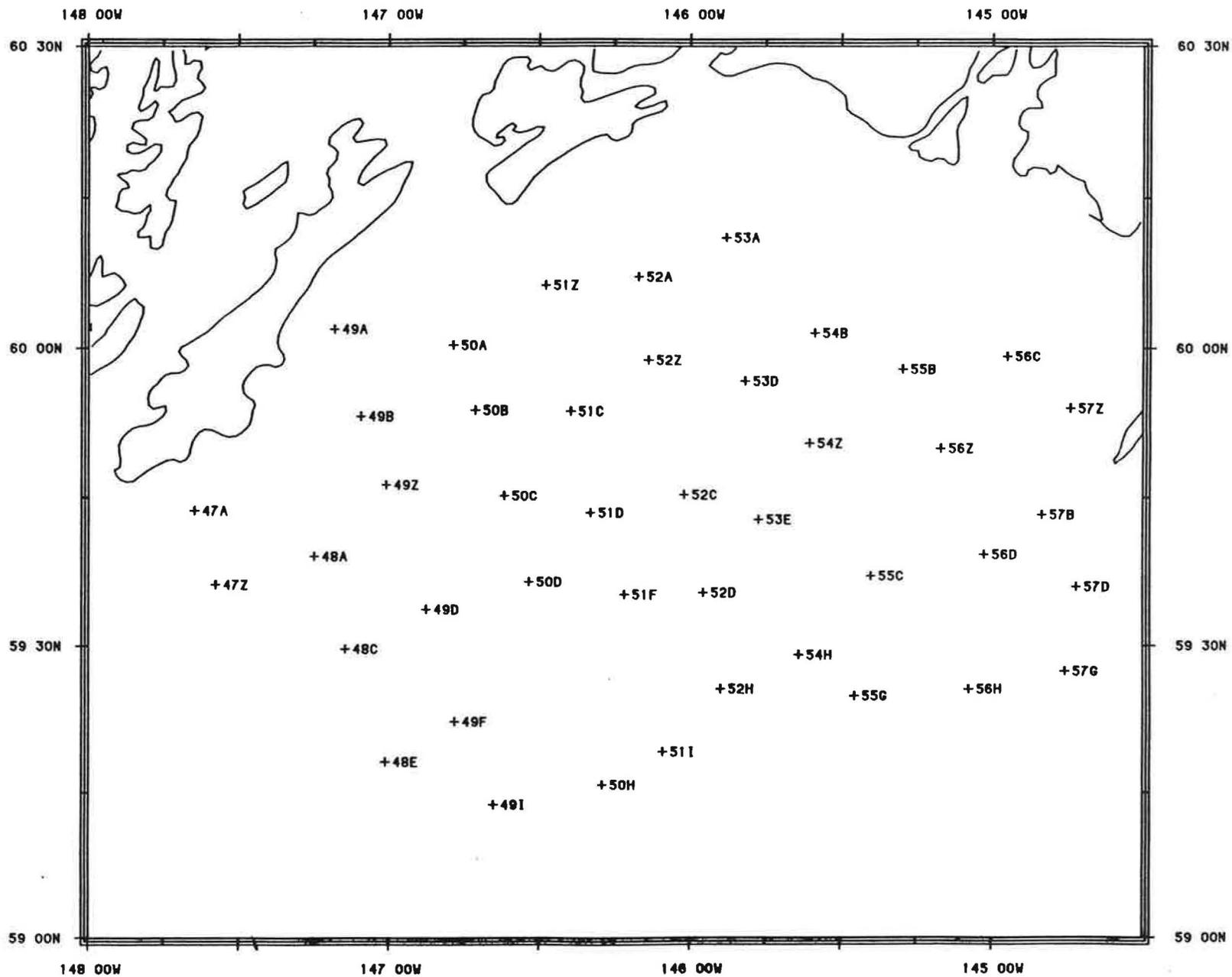


Figure 45.--Station locations for cruise 6MF-78, November 5-16, 1978.

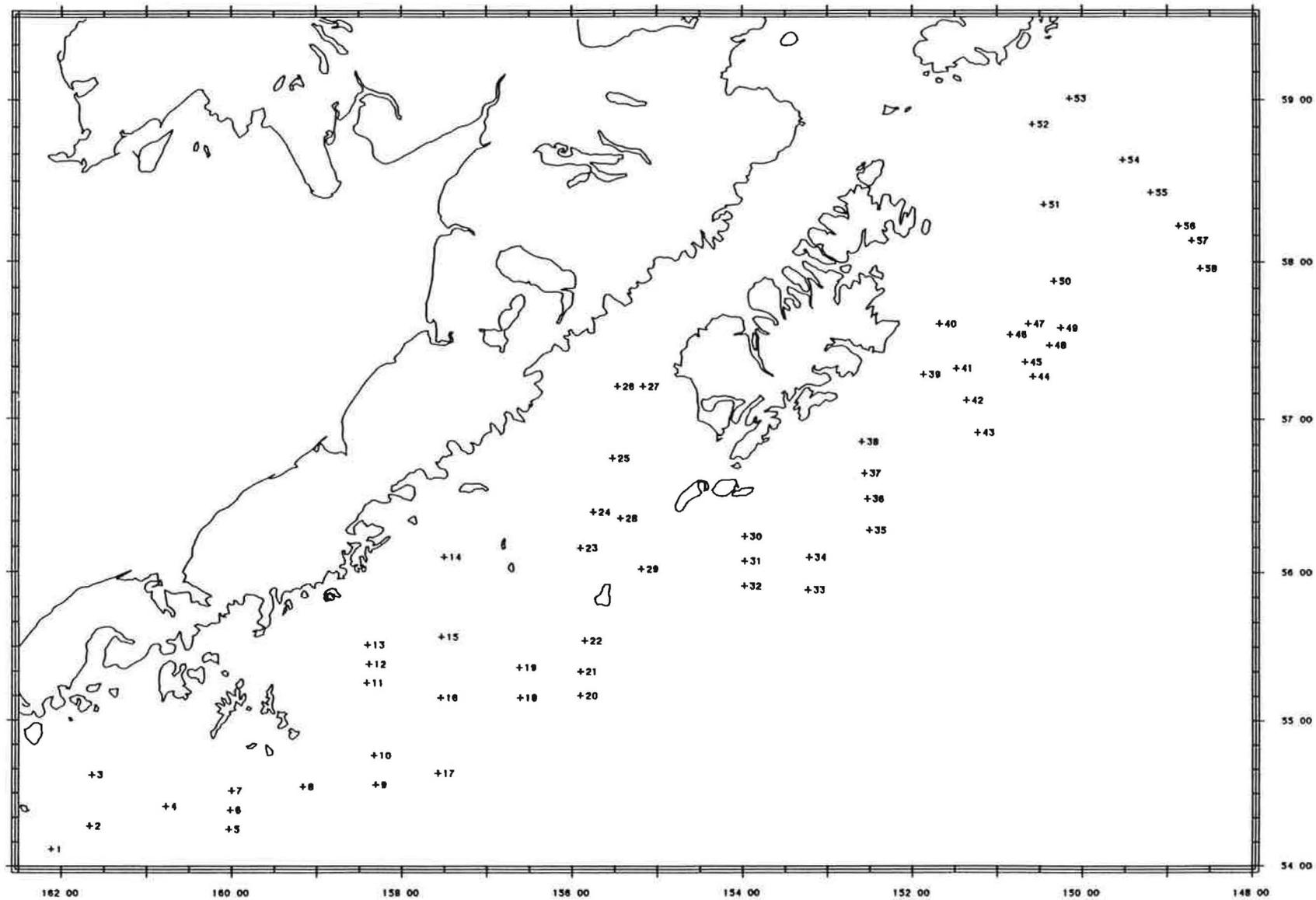


Figure 46.--Station locations for cruise 5TI-79, May 16-24.

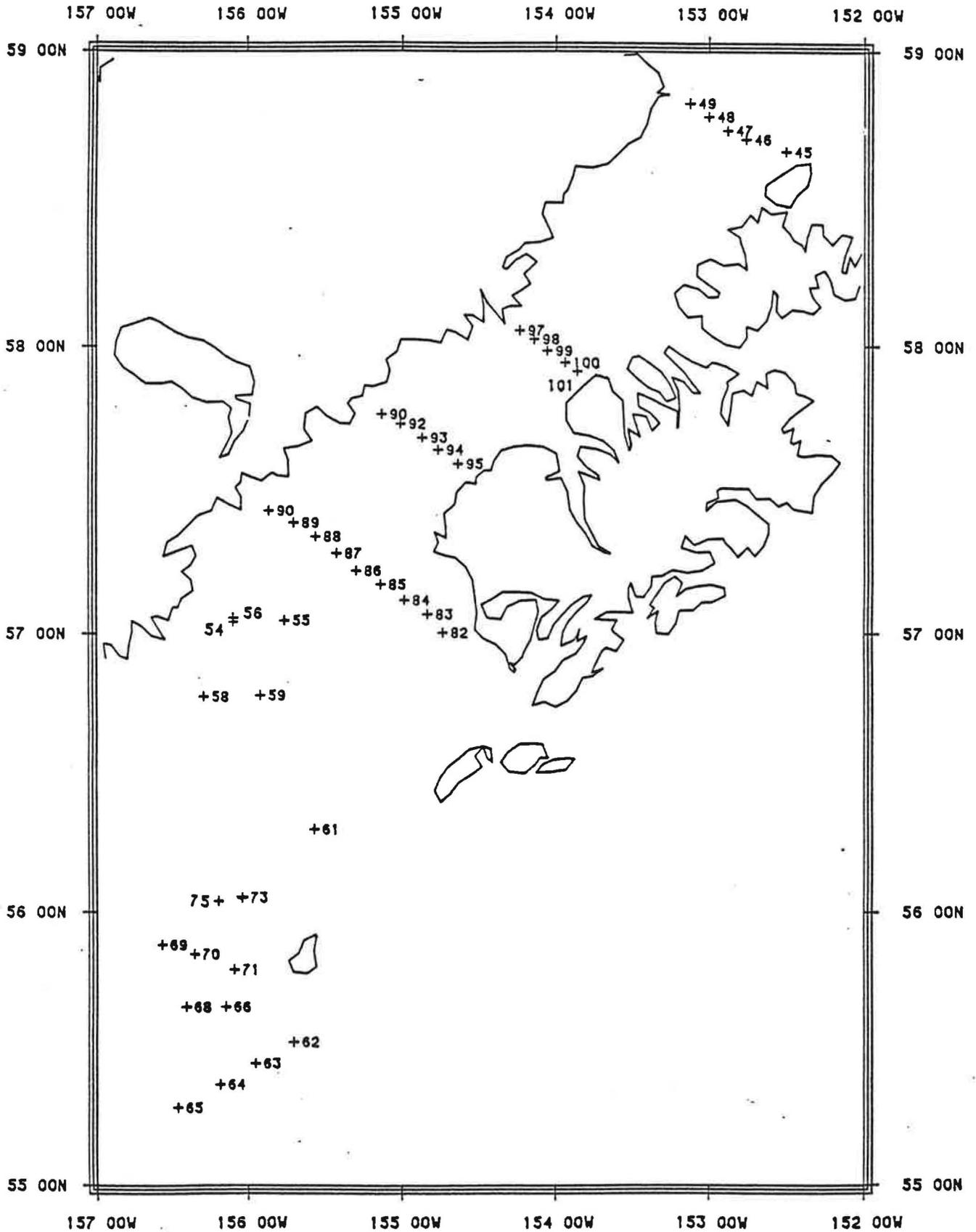


Figure 47.--Station locations for cruise 1P0-79, September 2-October 11, 1979.

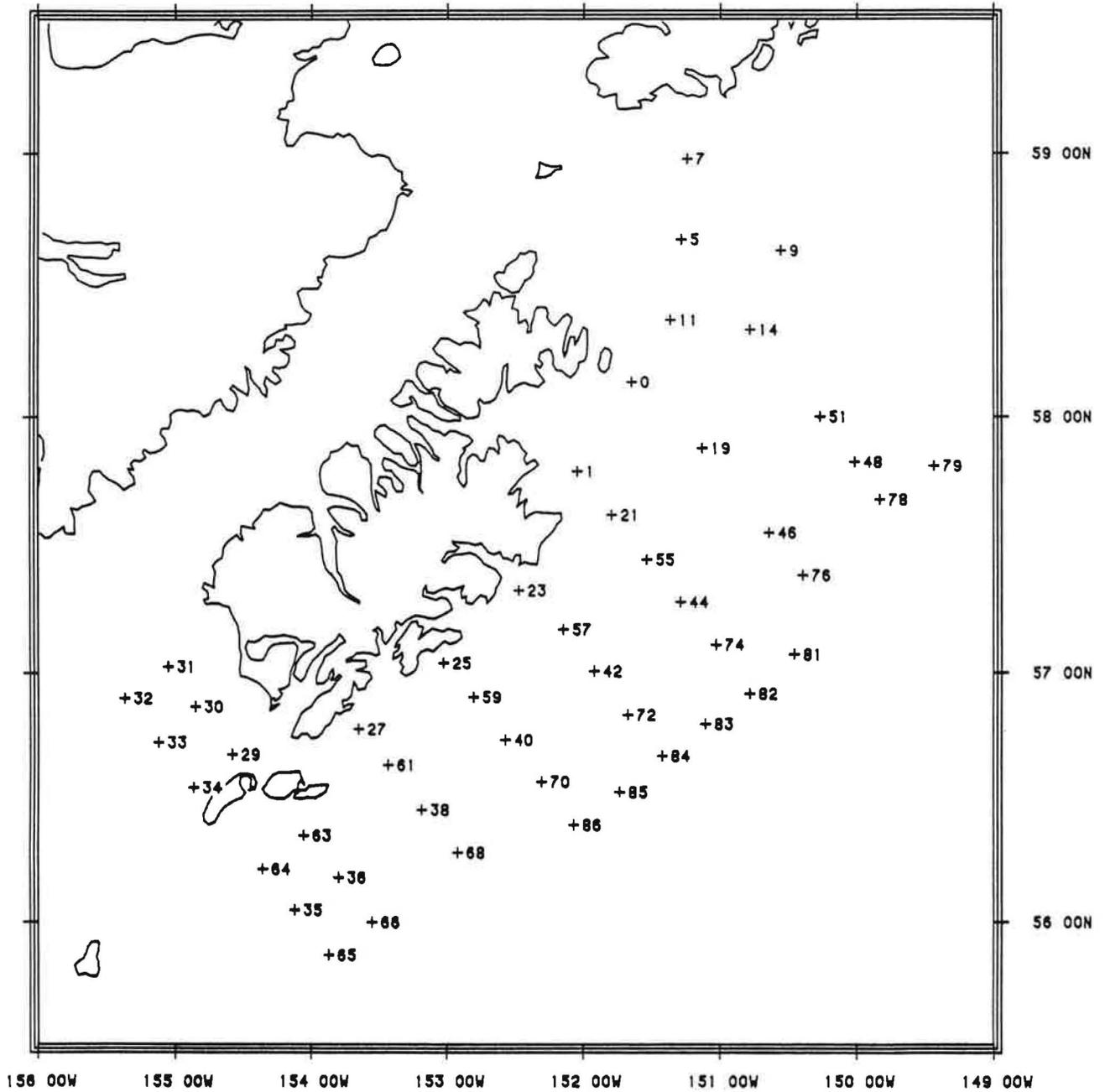


Figure 48.--Cruise track for cruise 1MF-80, April 2-11, 1980.

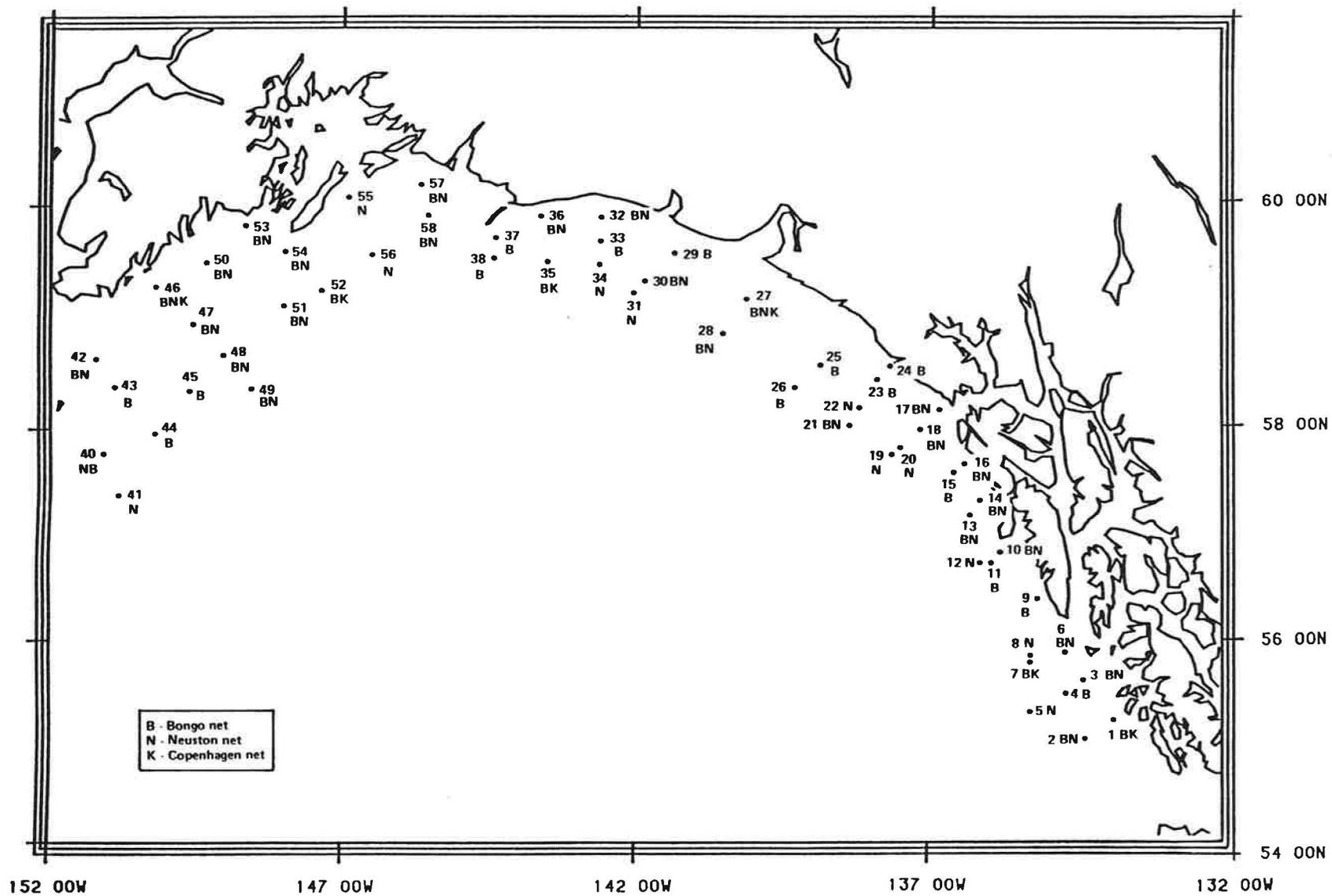


Figure 49.--Station locations in the Gulf of Alaska during cruise SEI77-9, July 5-27, 1977.

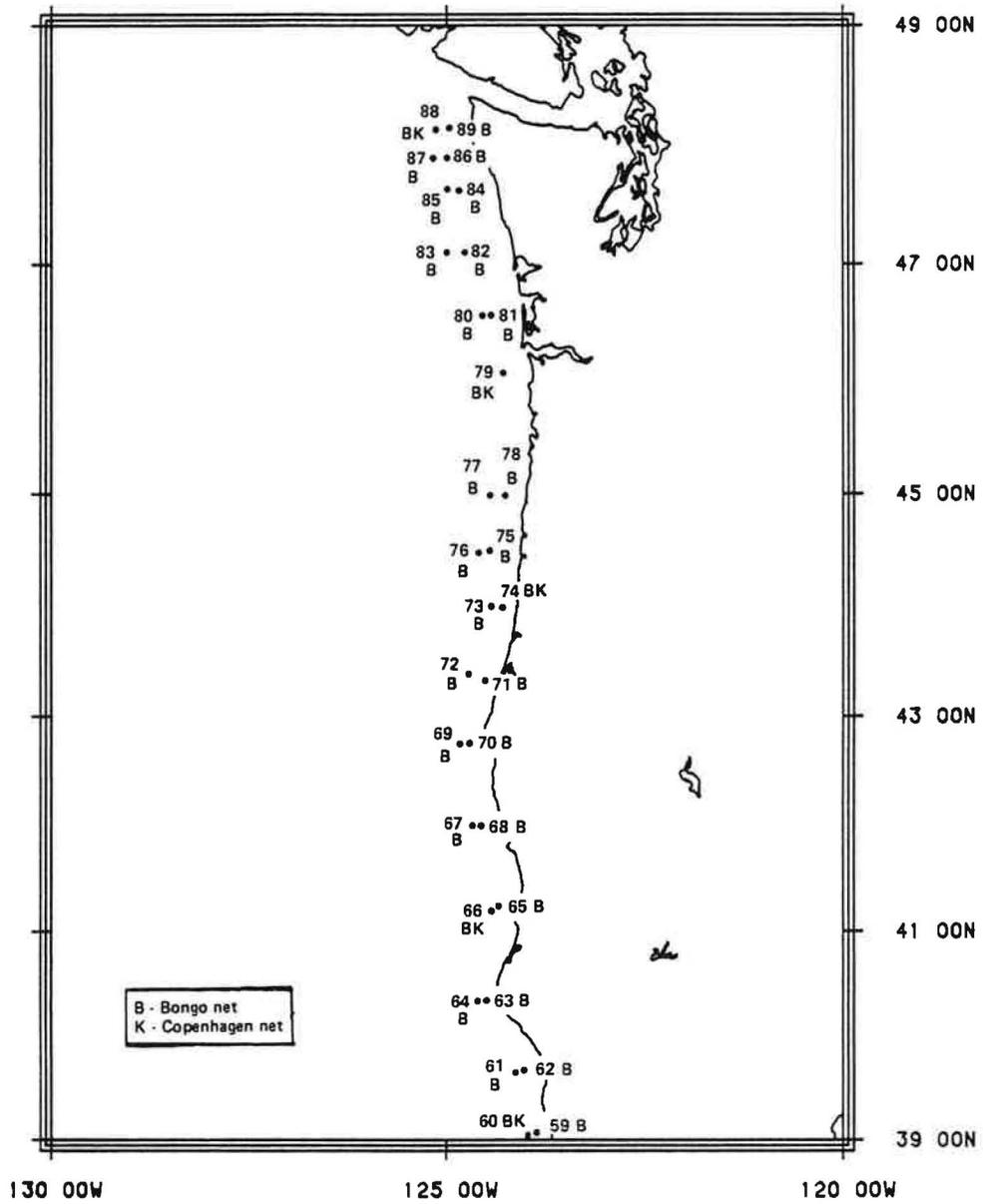


Figure 50.--Station locations from Northern California to Northern Washington for cruise SEI77-9, August 16-September 6, 1977.

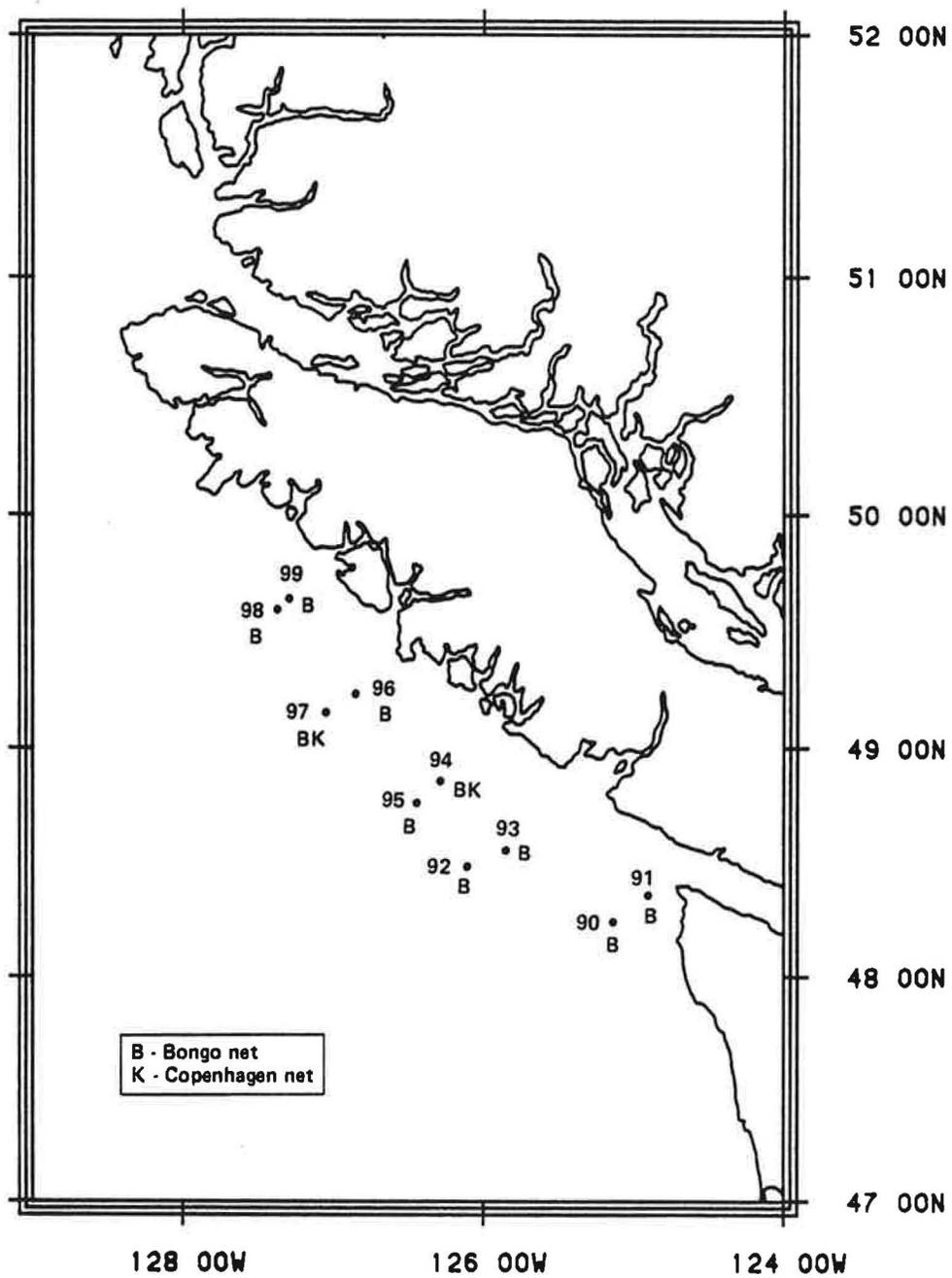


Figure 51.--Station locations off Vancouver Island during cruise SEI77-9, August 16-September 6, 1977.

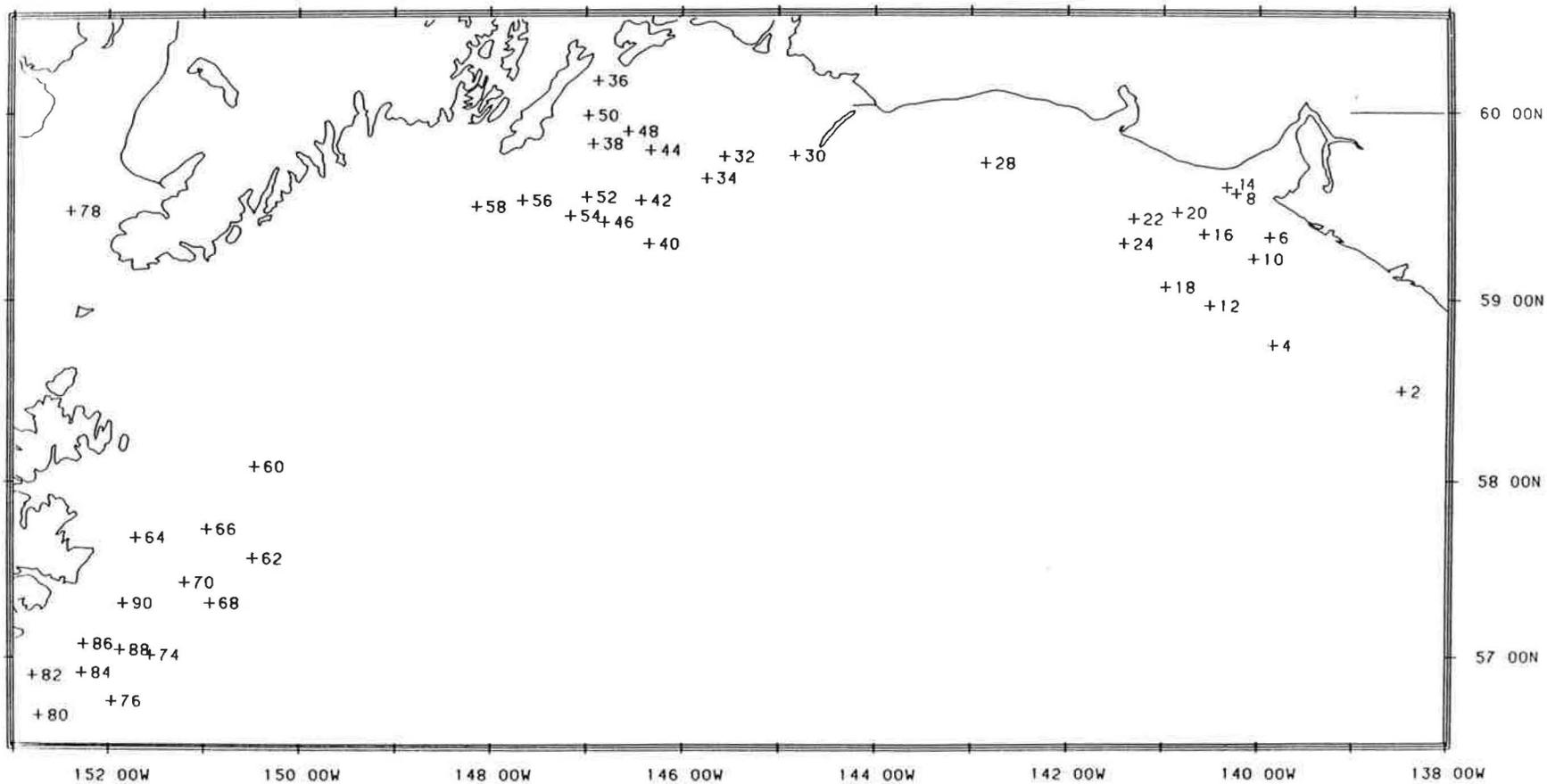


Figure 52.--Station locations for cruise 10D-80, July 1-August 12, 1980.

**Timing of NWAFC-TINRO ichthyoplankton surveys  
off Washington, Oregon and California**

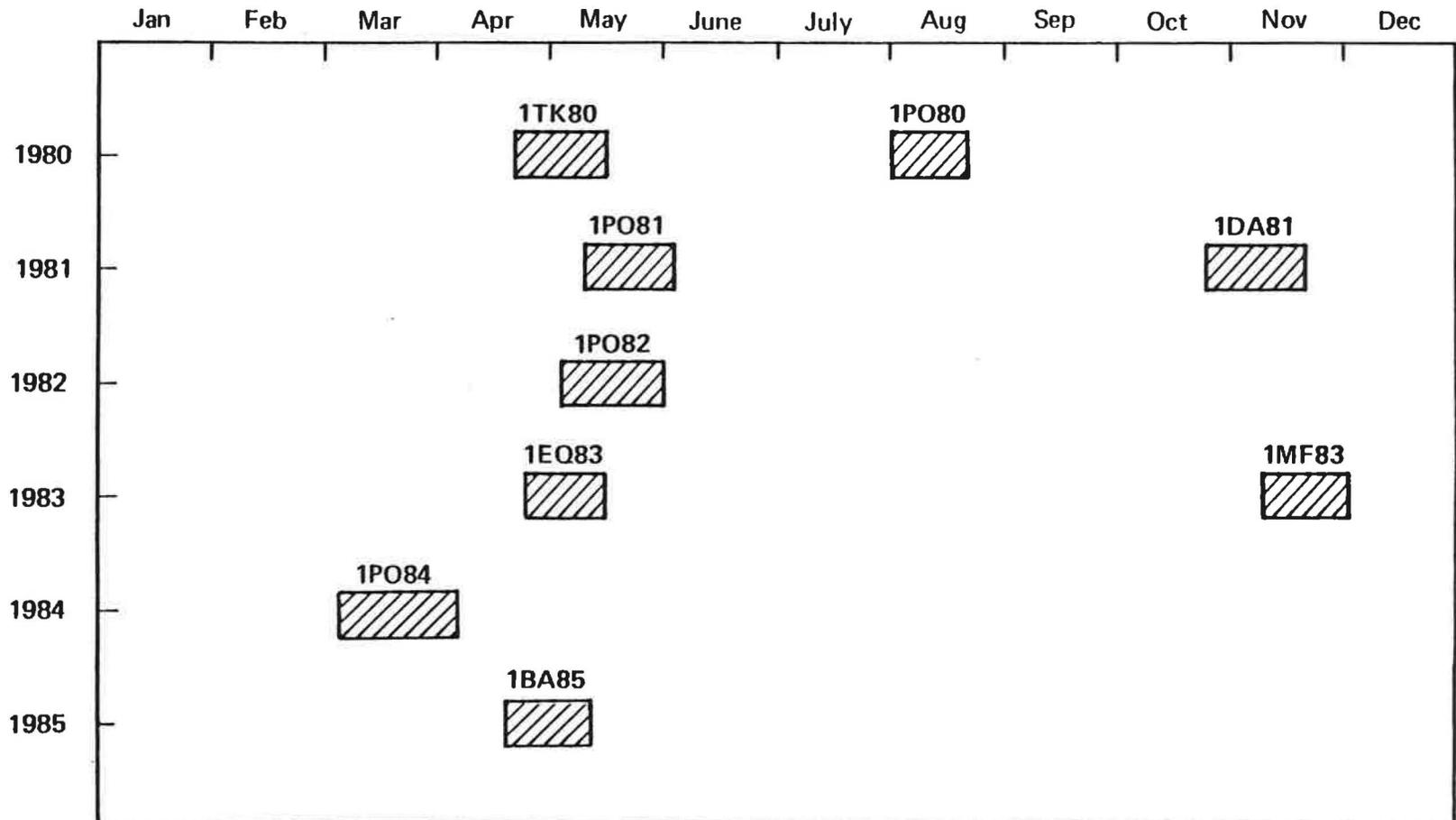


Figure 53.--Timing of NWAFC-TINRO ichthyoplankton surveys off Washington, Oregon, and California.

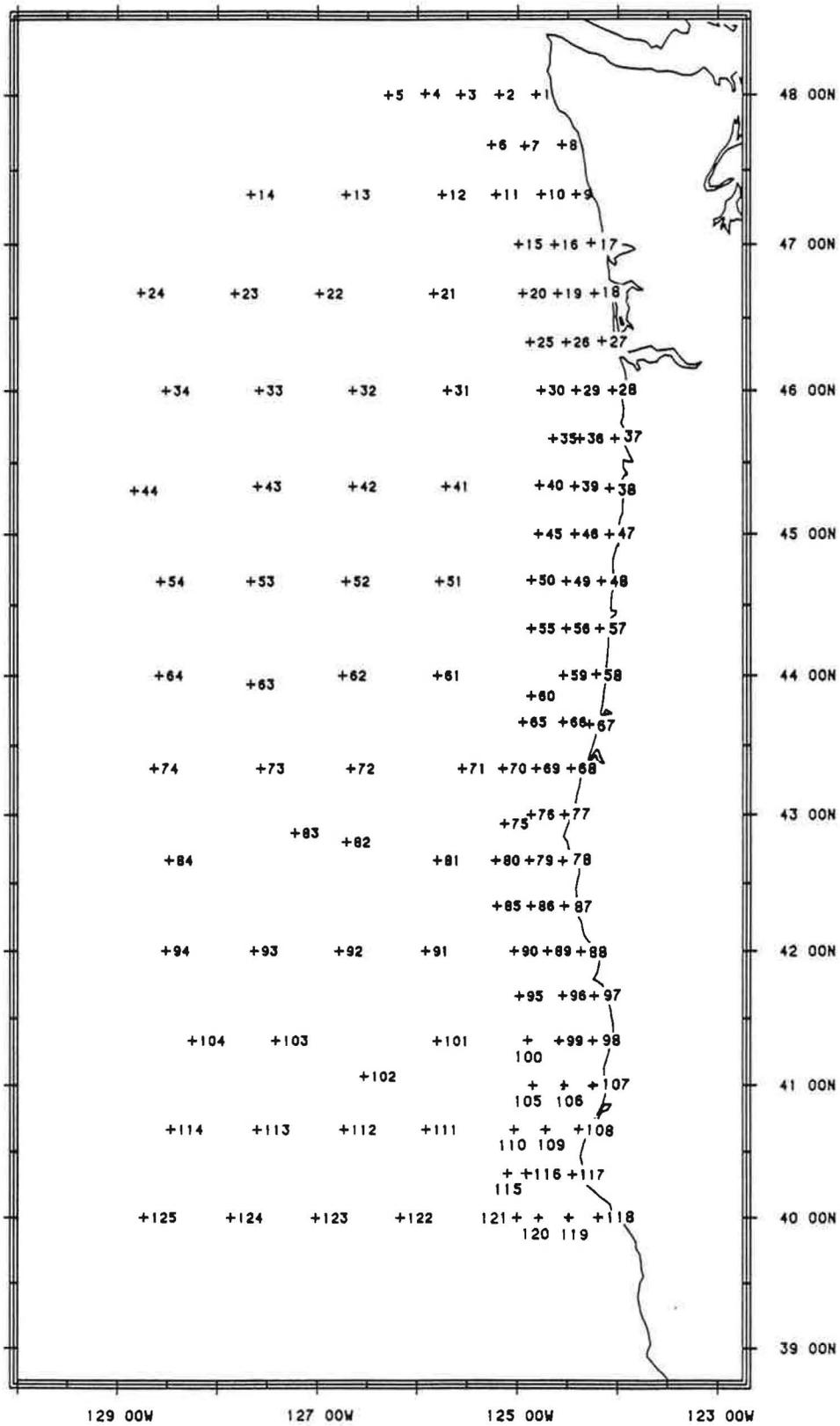


Figure 54.--Station locations for cruise 1TK-80, April 20-May 15, 1980.

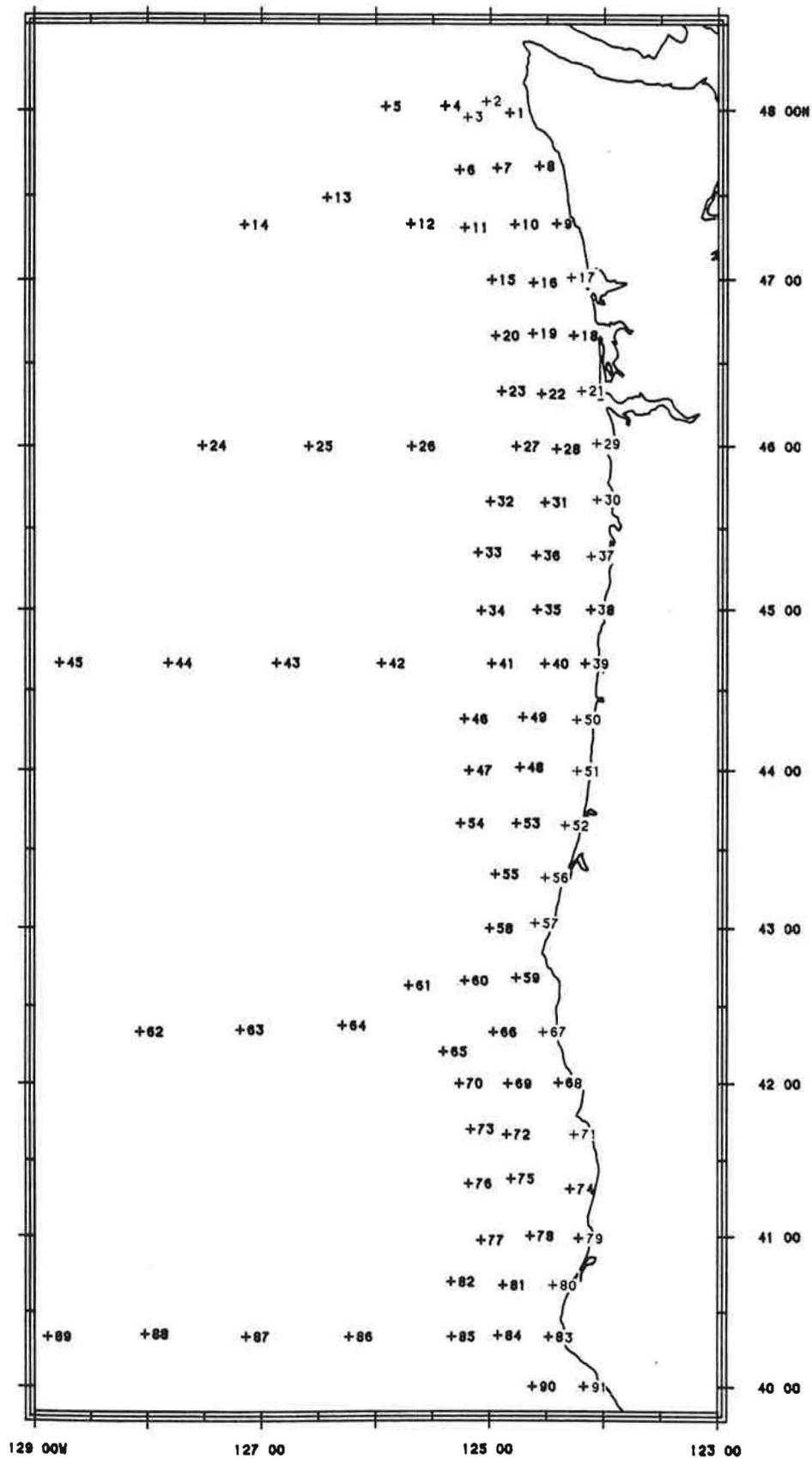


Figure 55.--Station locations and cruise track for cruise 1PO-80, August 1-20, 1980.

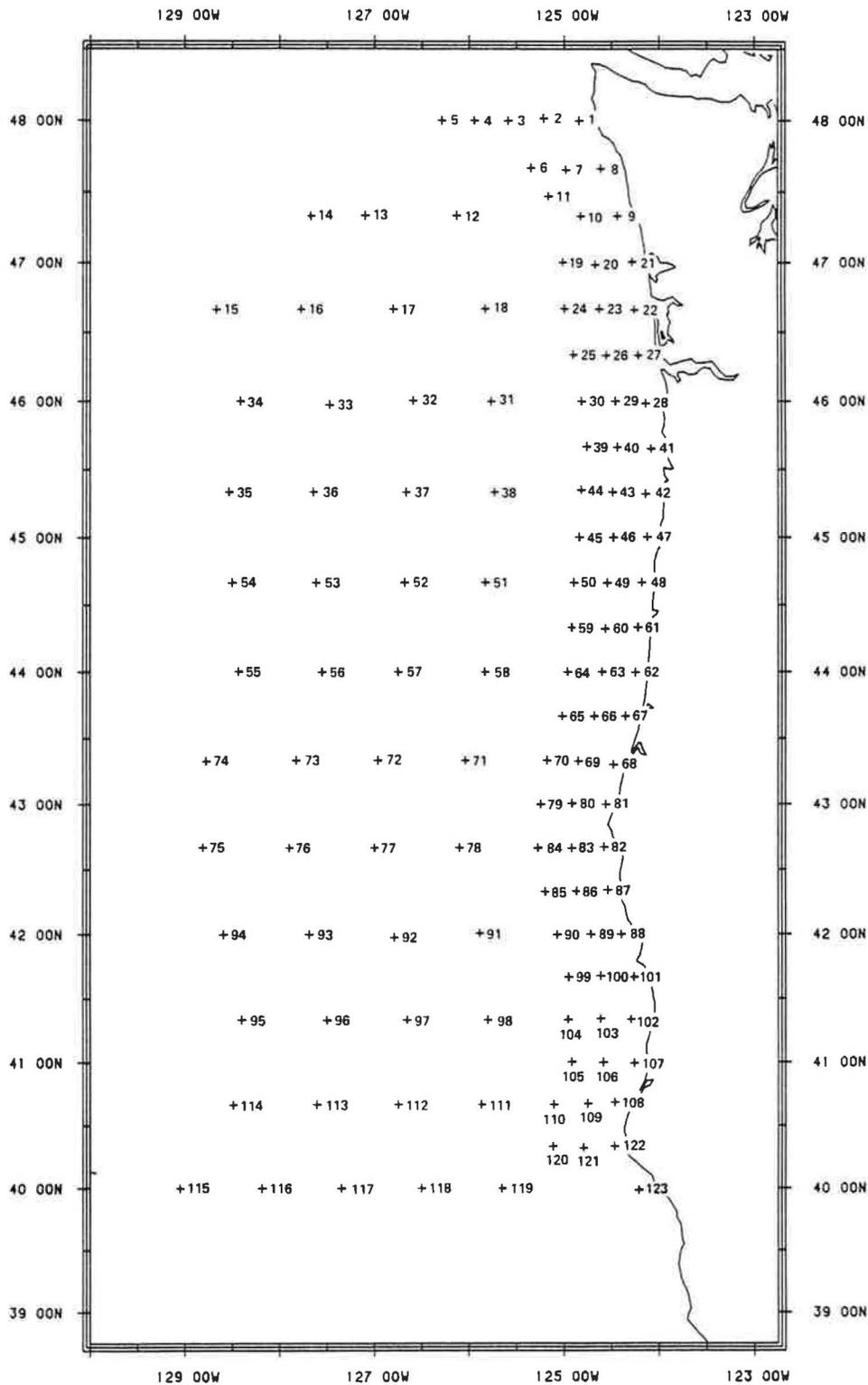


Figure 56.--Station locations for cruise 1PO-81, May 9-June 2, 1981.

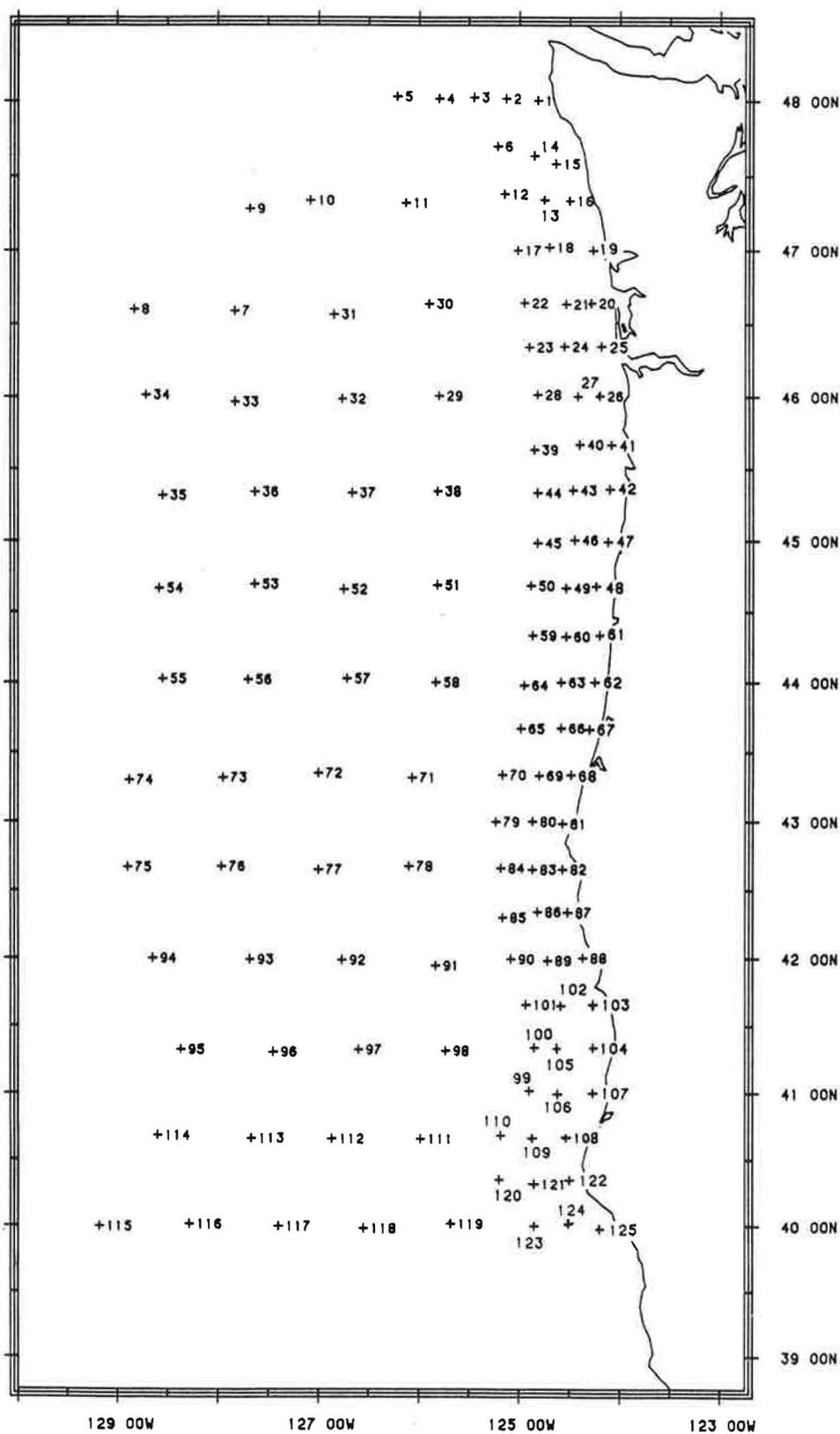


Figure 57.--Station locations for cruise 1DA-81, October 24-November 19, 1981.

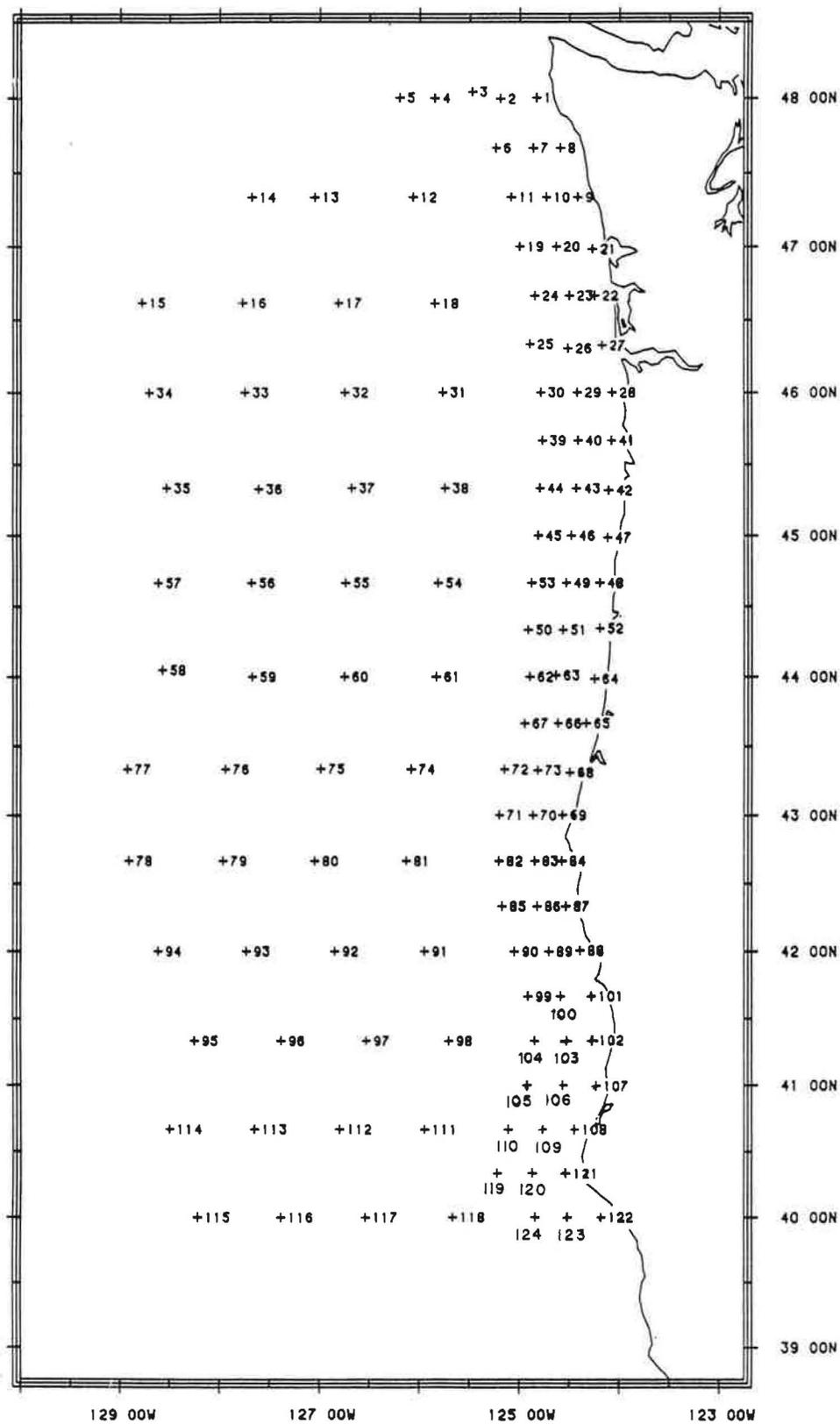


Figure 58.--Neuston station locations for cruise 1PO-82, May 3-June 1, 1982.

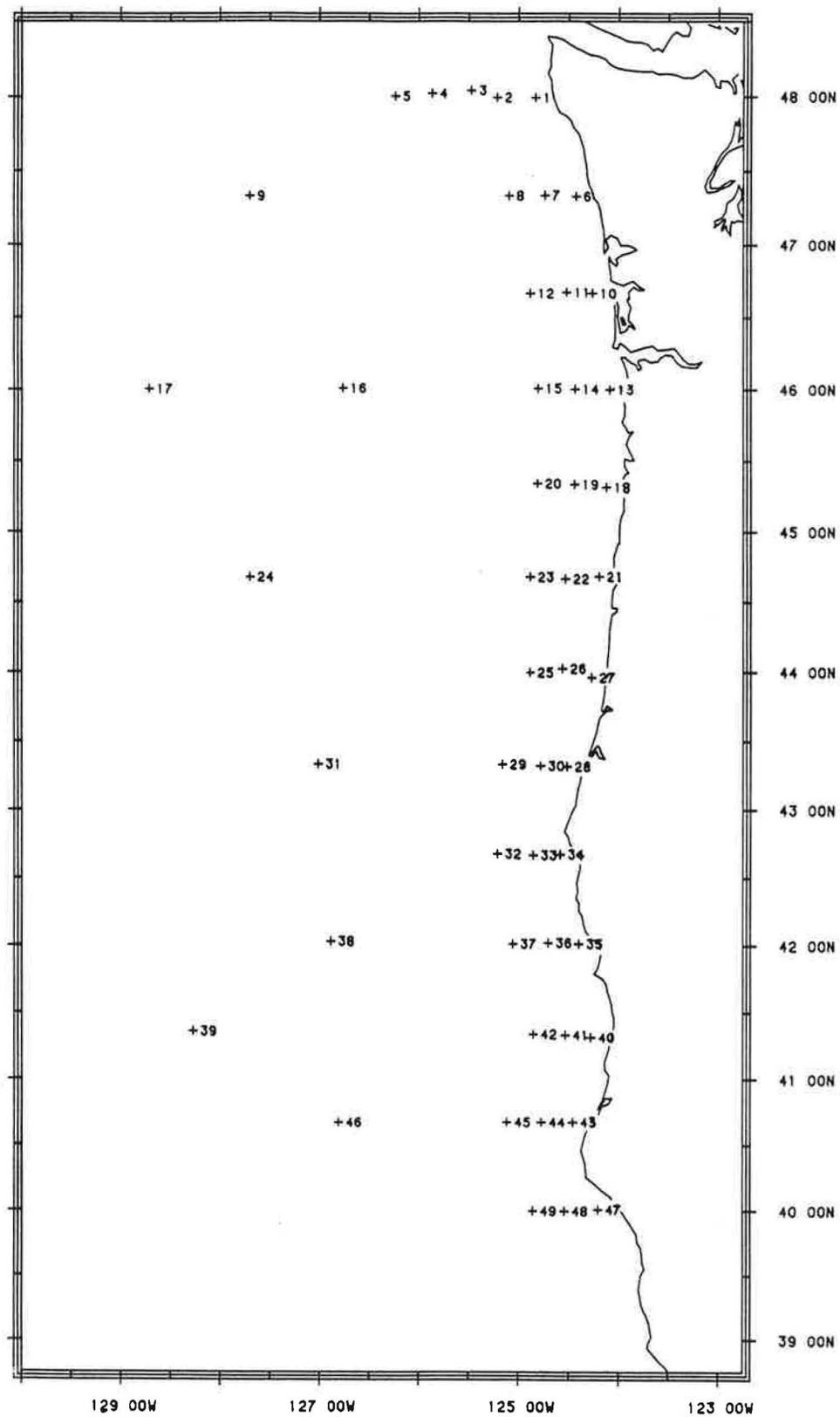


Figure 59.--Bongo locations for cruise 1PO-82, May 3-June 1, 1982.

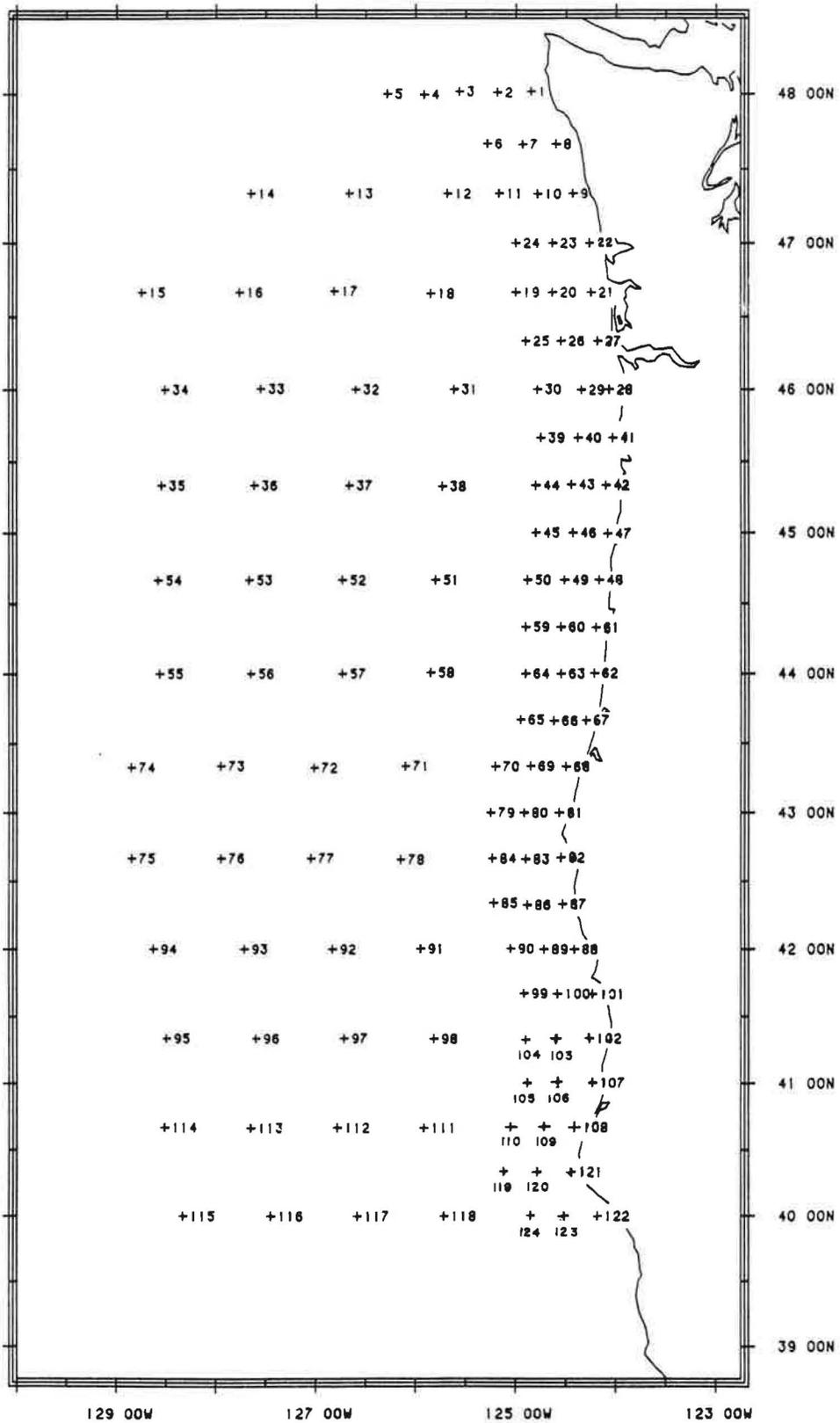


Figure 60.--Station locations for cruise 1EQ-83, April 23-May 15, 1983.

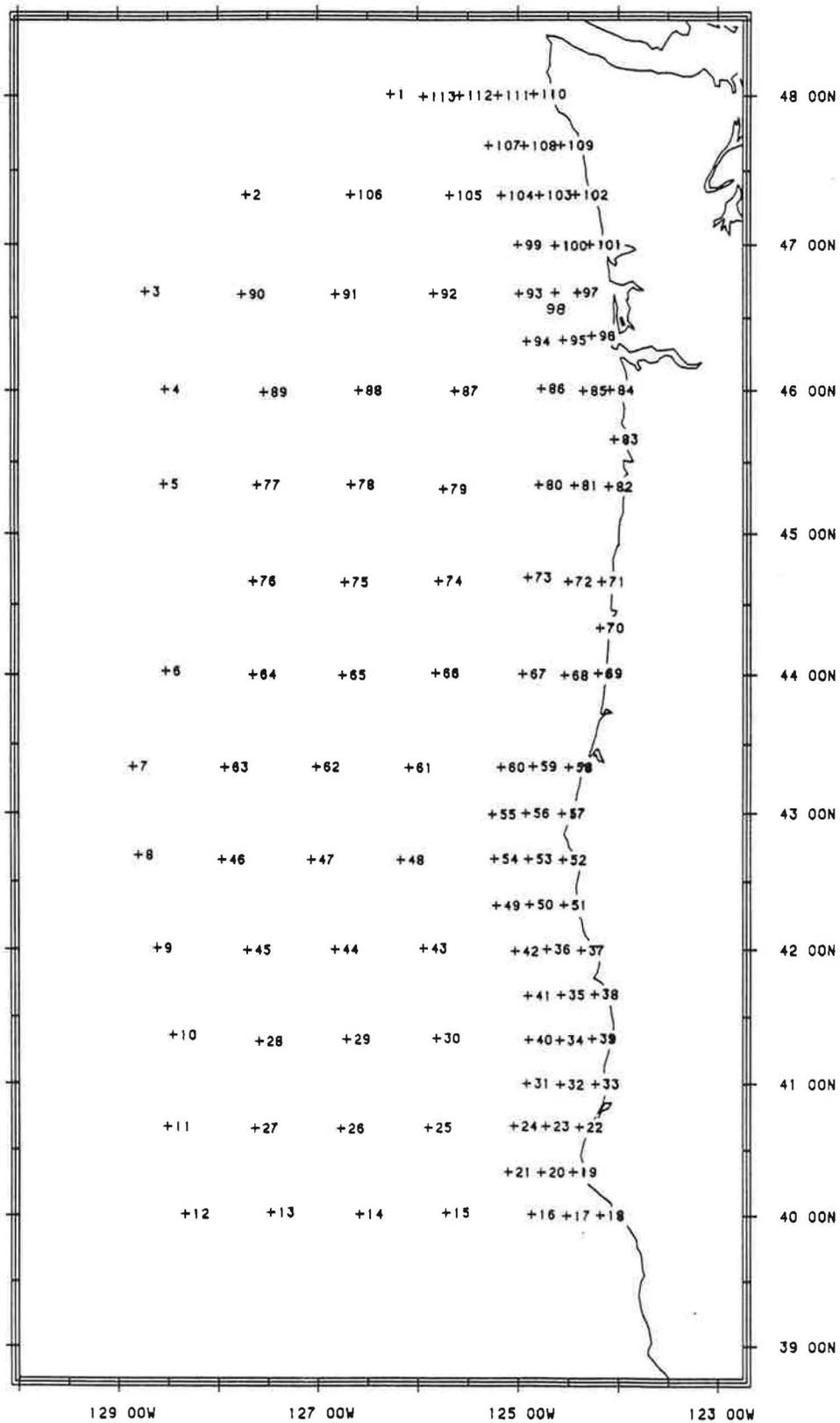


Figure 61.--Station locations for cruise 1MF-83, November 11-December 2, 1983.

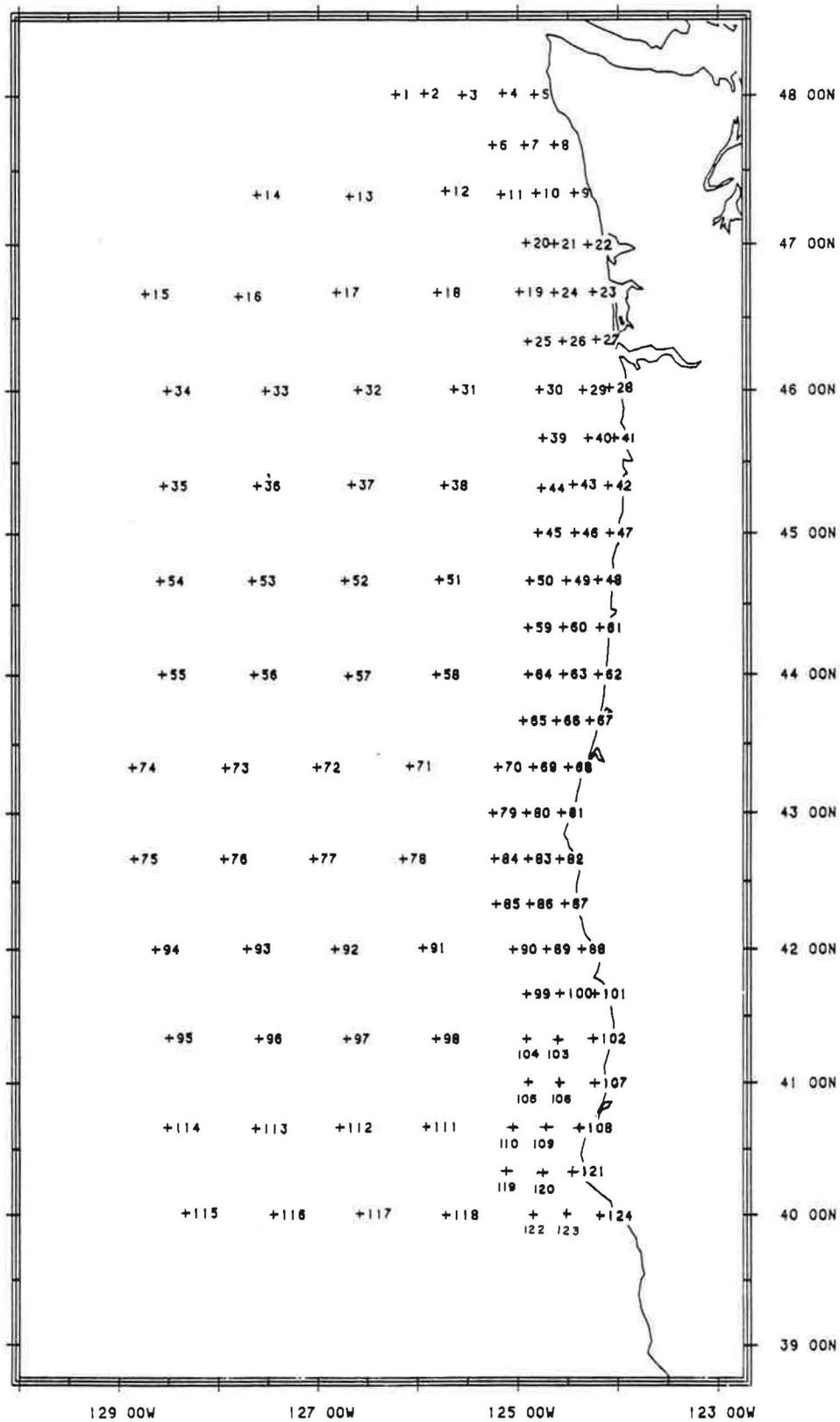


Figure 62.--Station locations for cruise IPO-84, March 11-April 4, 1984.

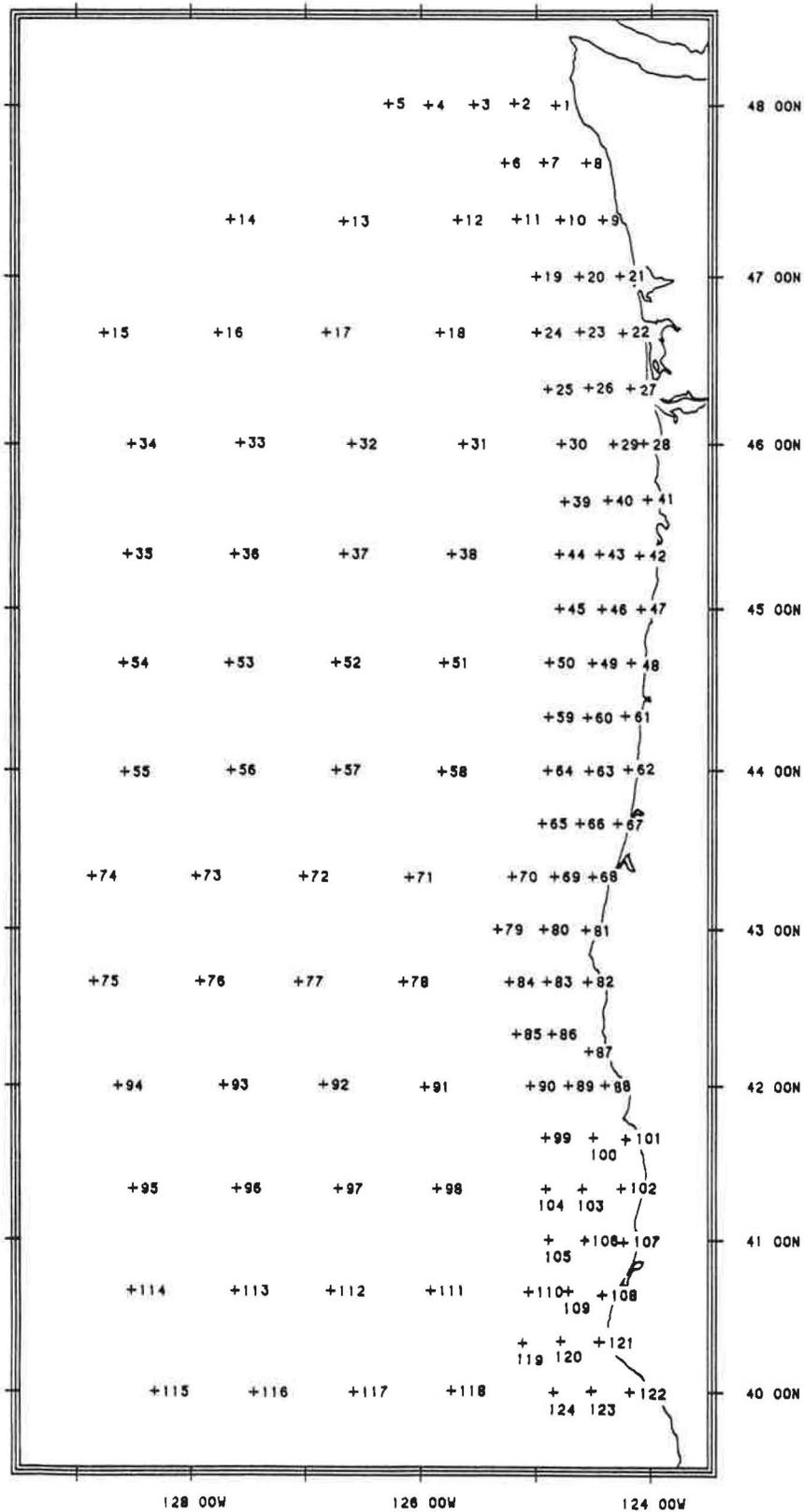


Figure 63.--Station locations for cruise 1BA-85, April 19-May 11, 1985.

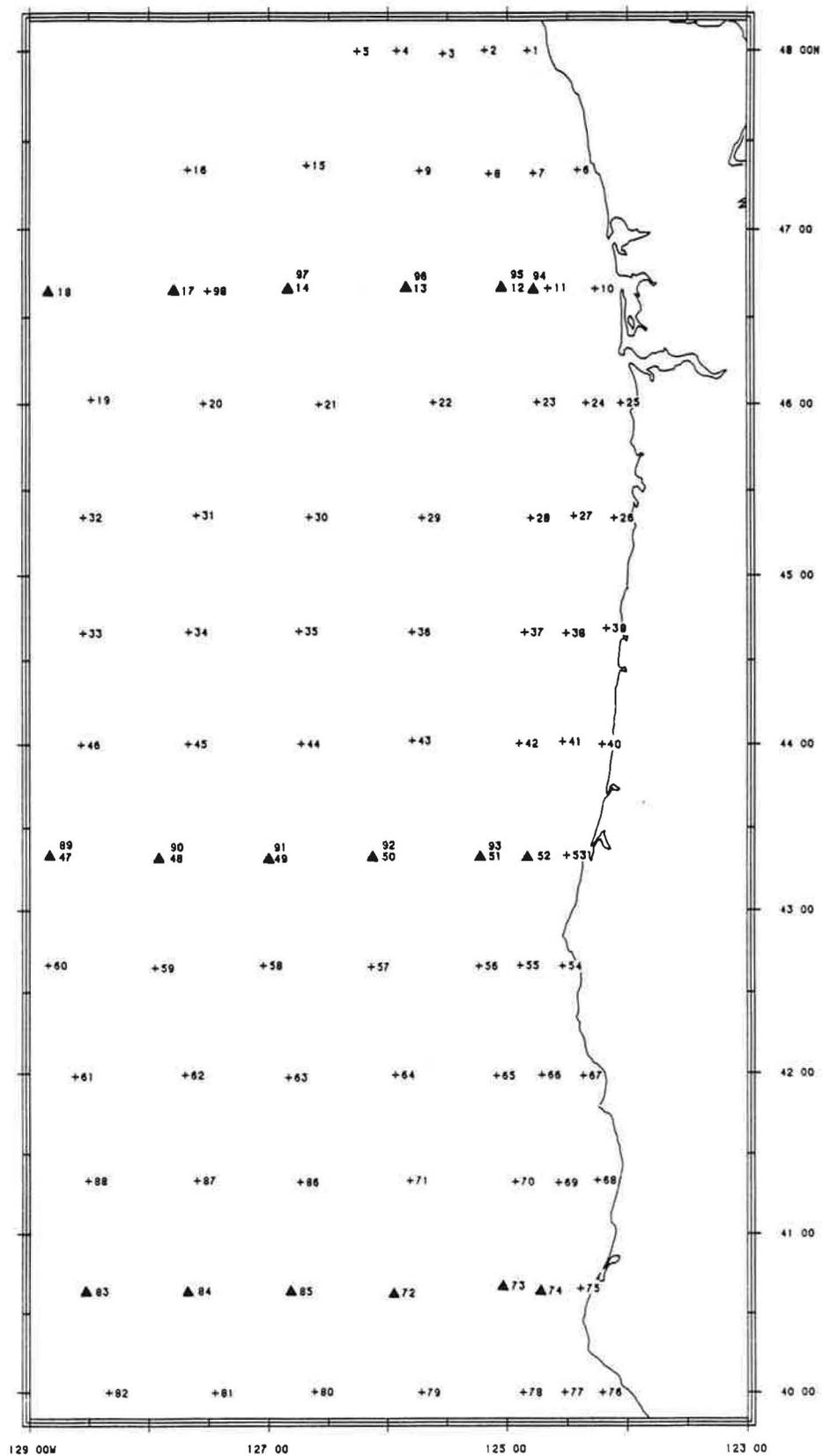


Figure 64.--Station locations for cruise 1MF-87, January 7-31, 1987 (▲ denotes stations where special deep Tucker trawls were performed).

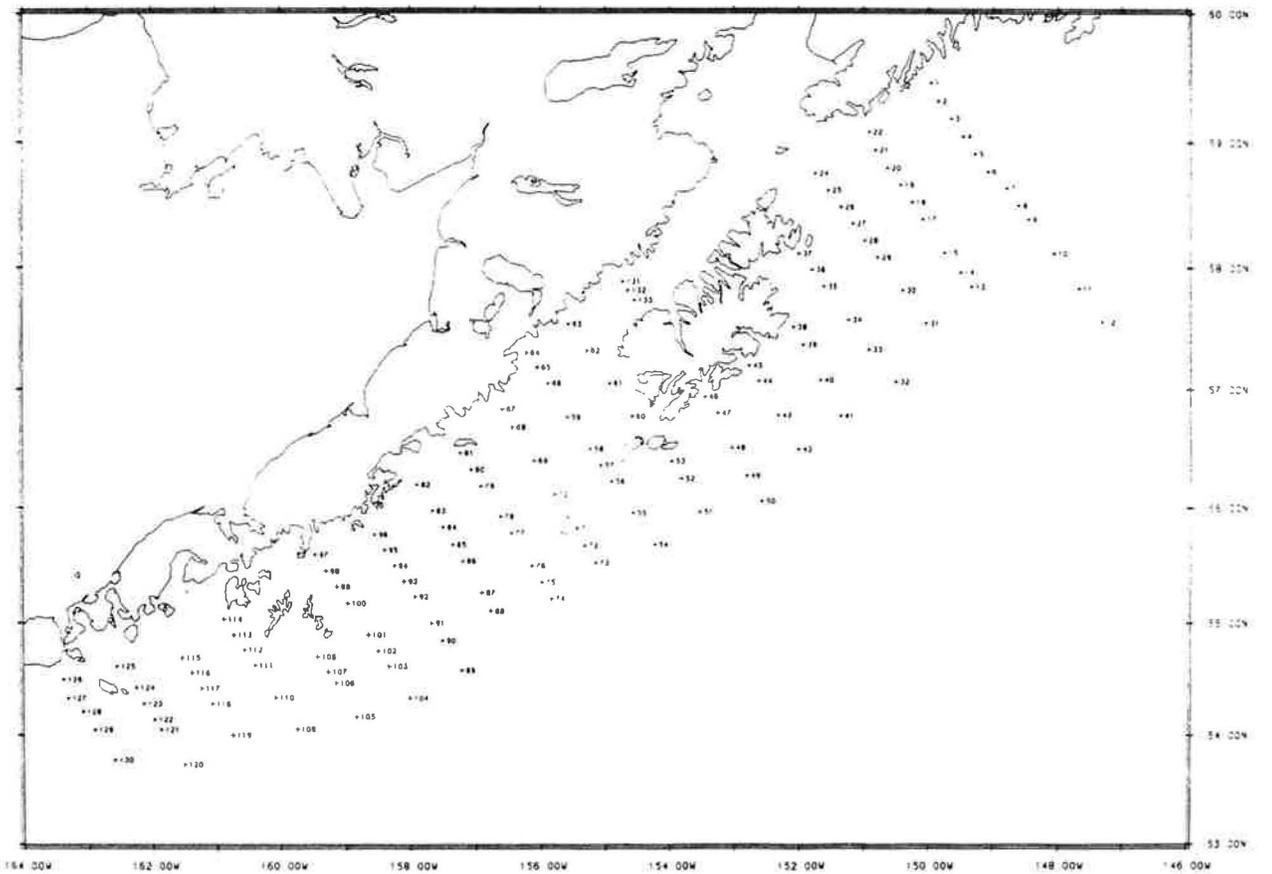
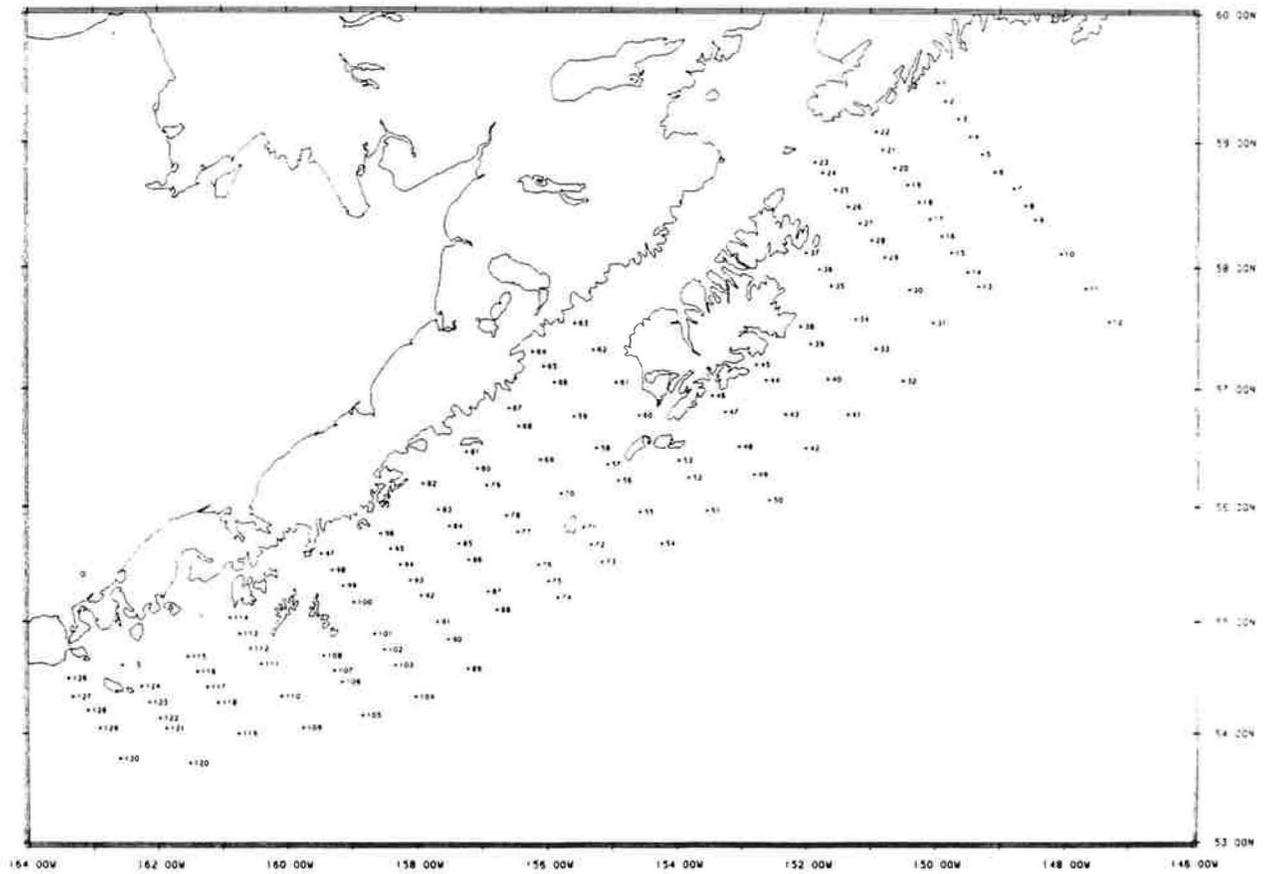


Figure 65.--Locations of neuston stations (above) and bongo stations (below) for cruise 1SH81, March 3 to March 30, 1981.

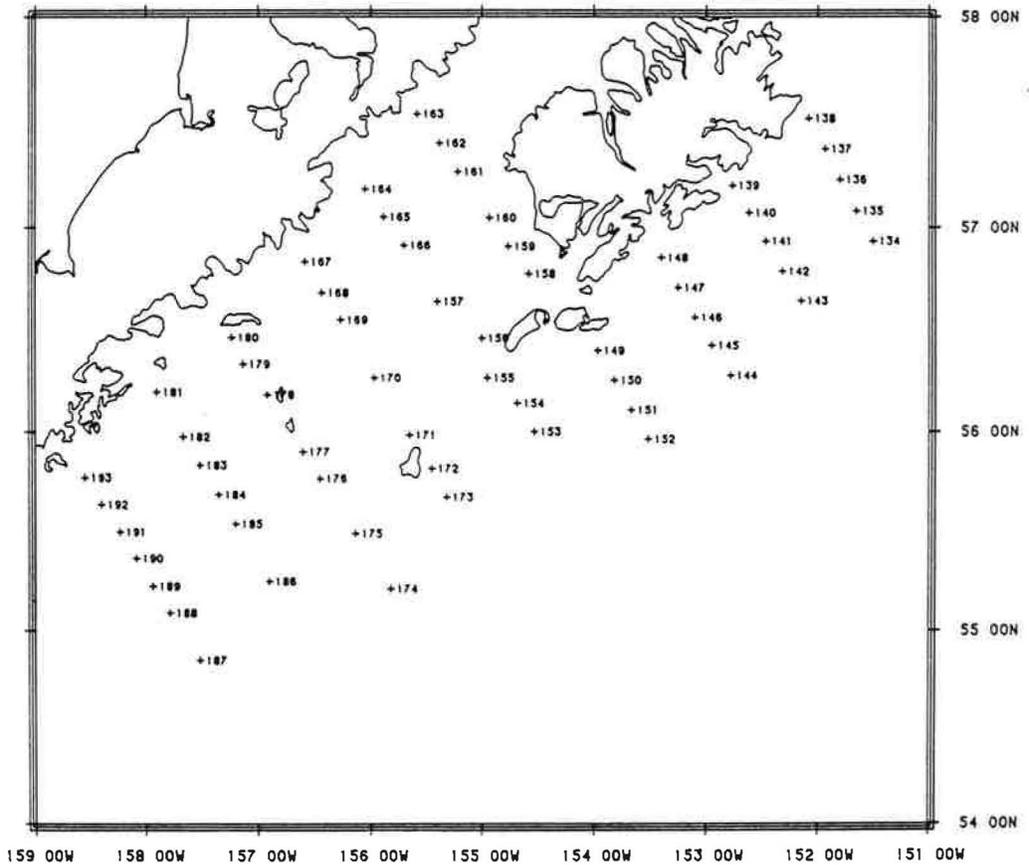
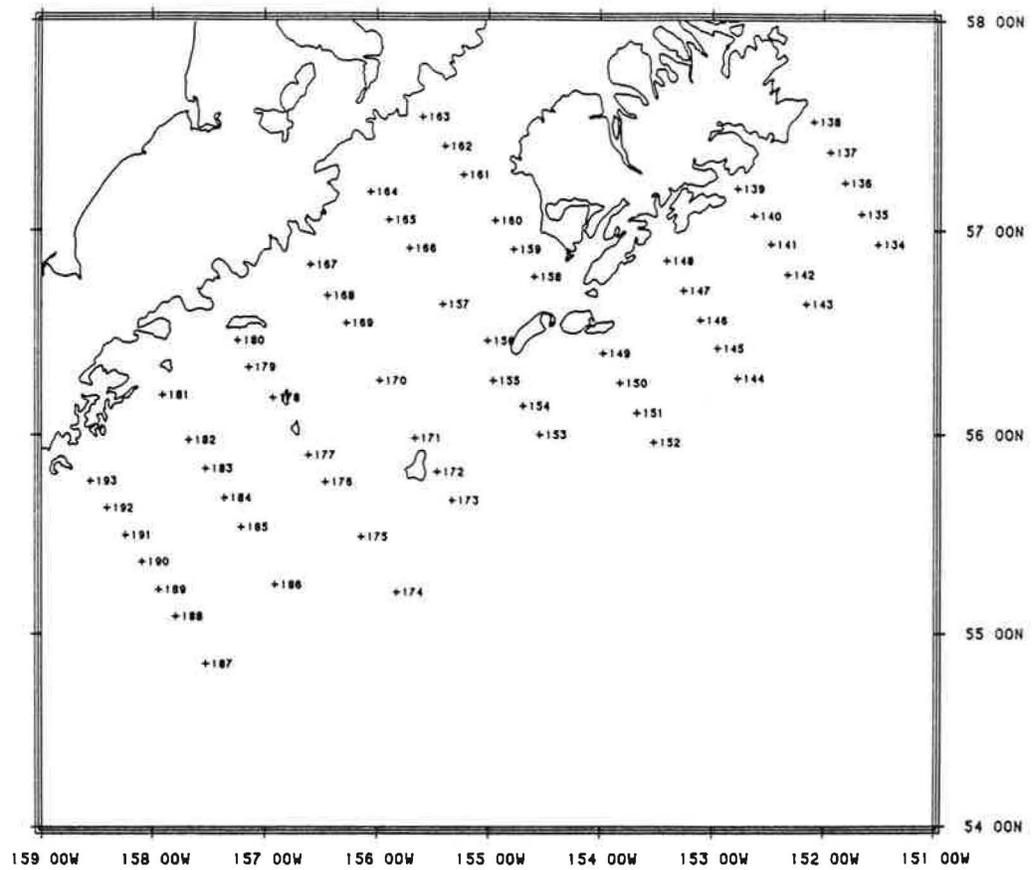


Figure 66.--Locations of neuston stations (above) and bongo stations (below) for cruise 2SH81, April 16 to April 24, 1981.

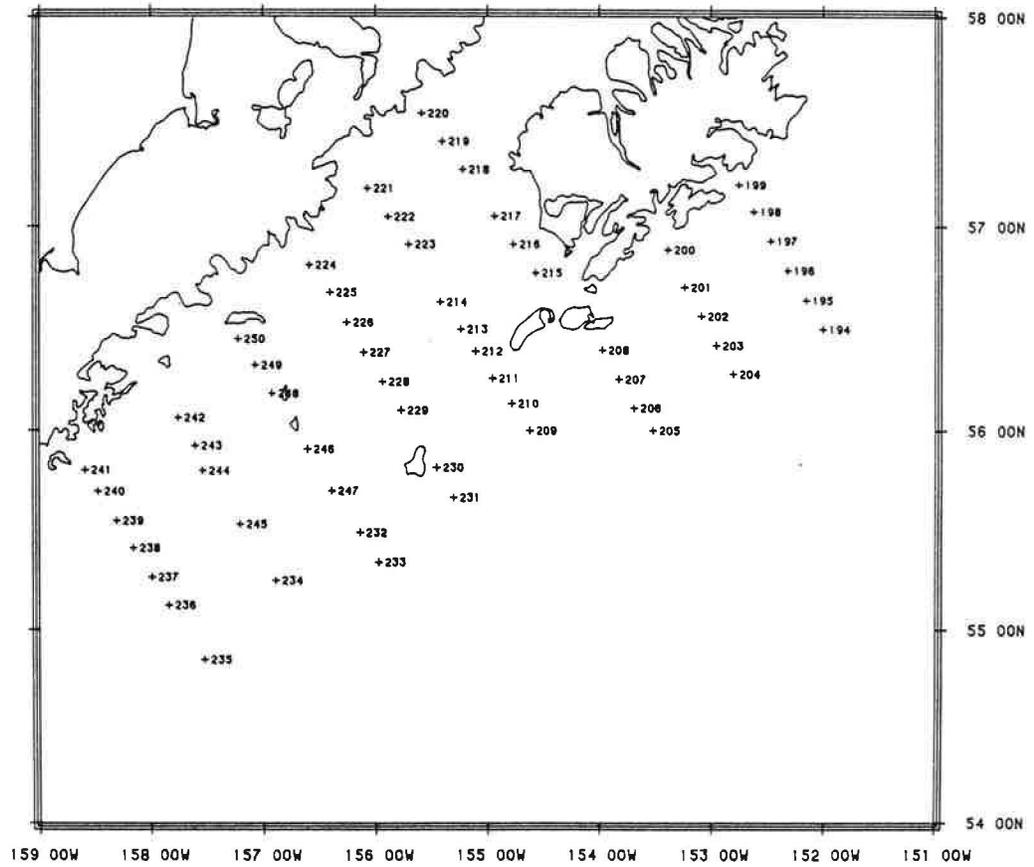


Figure 67.--Locations of bongo stations for cruise 3SH81, May 20 to May 28, 1981.

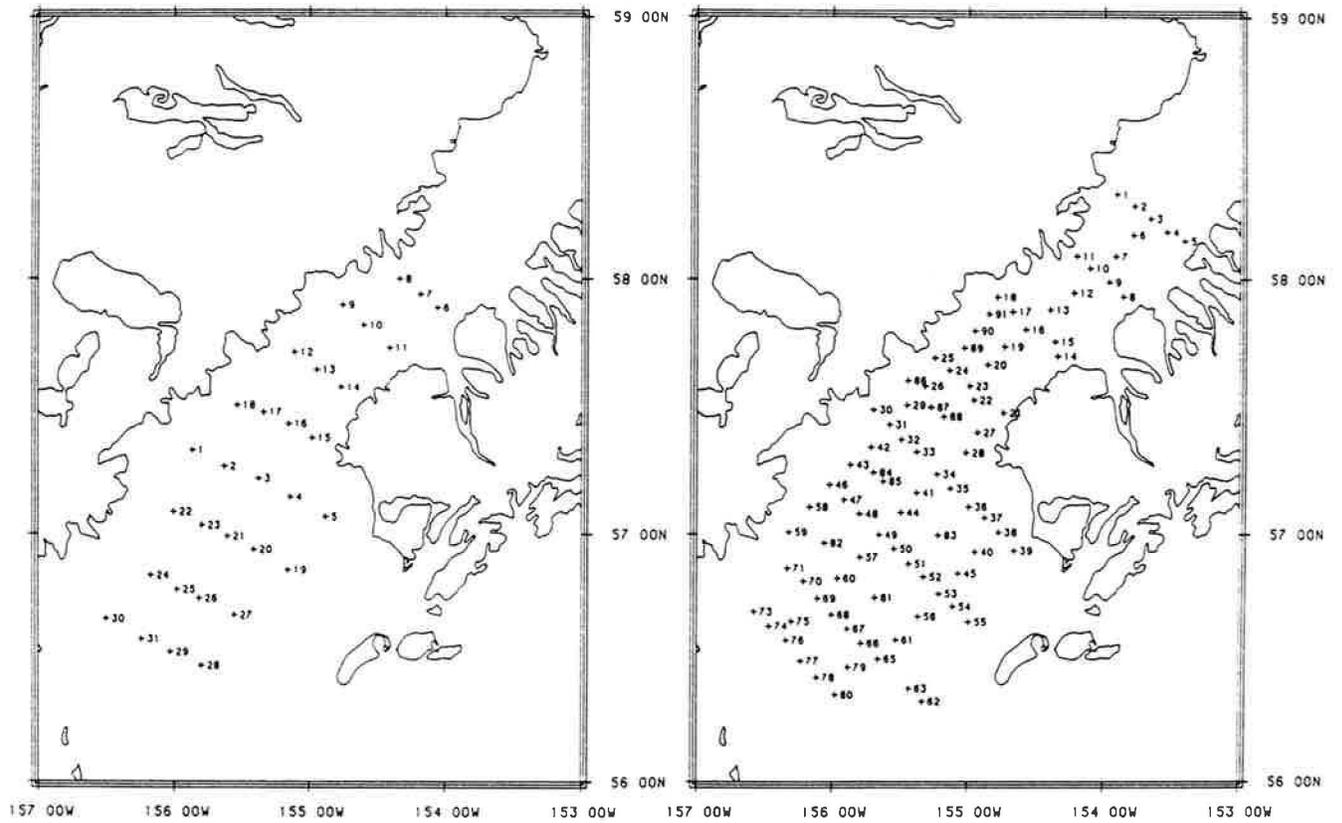


Figure 68.--Locations of bongo stations for cruise 1MF81, March 12 to March 20, 1981 (left) and for cruise 2MF81, March 30 to April 8, 1981 (right).

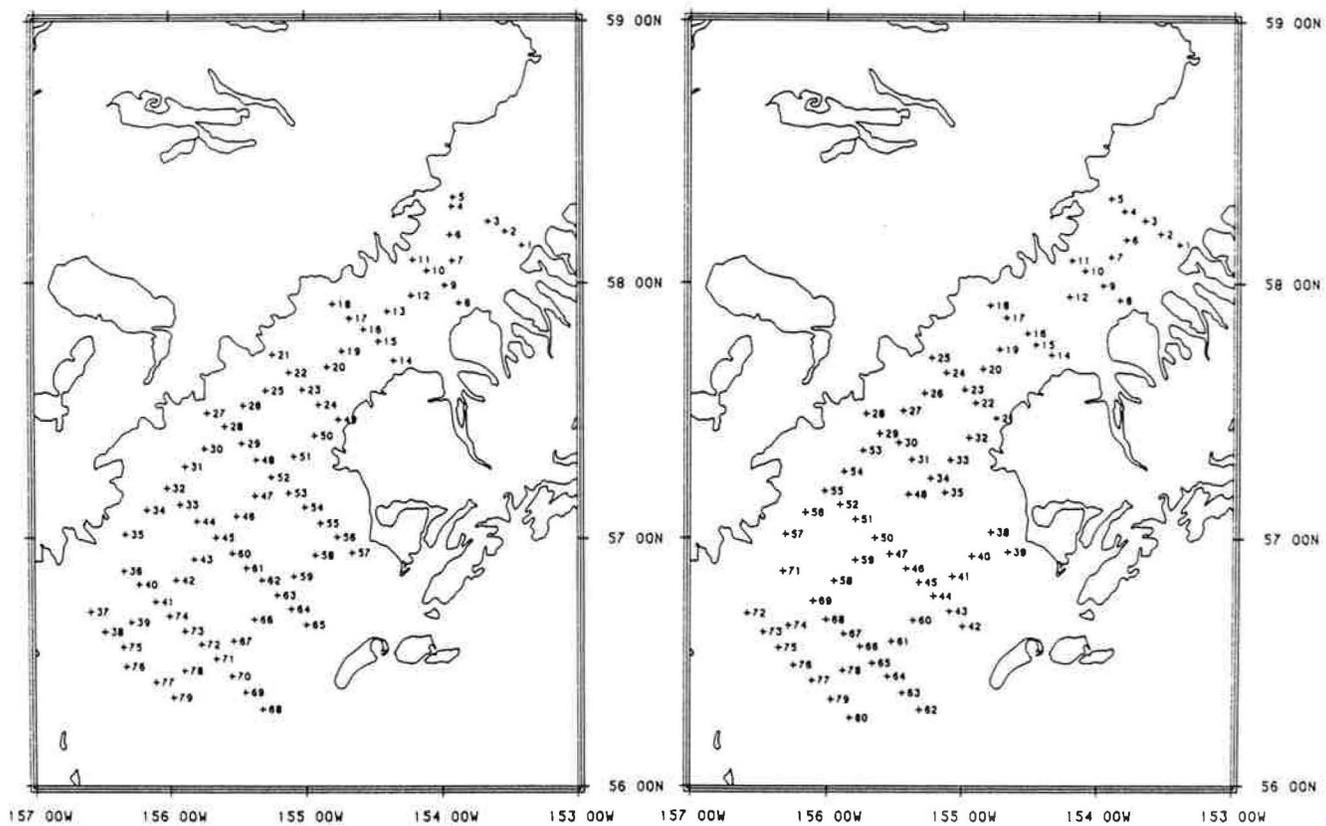


Figure 69.--Locations of bongo stations for cruise 3MF81, April 26-May 2, (left), and for cruise 4MF-81, May 20-24, 1981 (right).

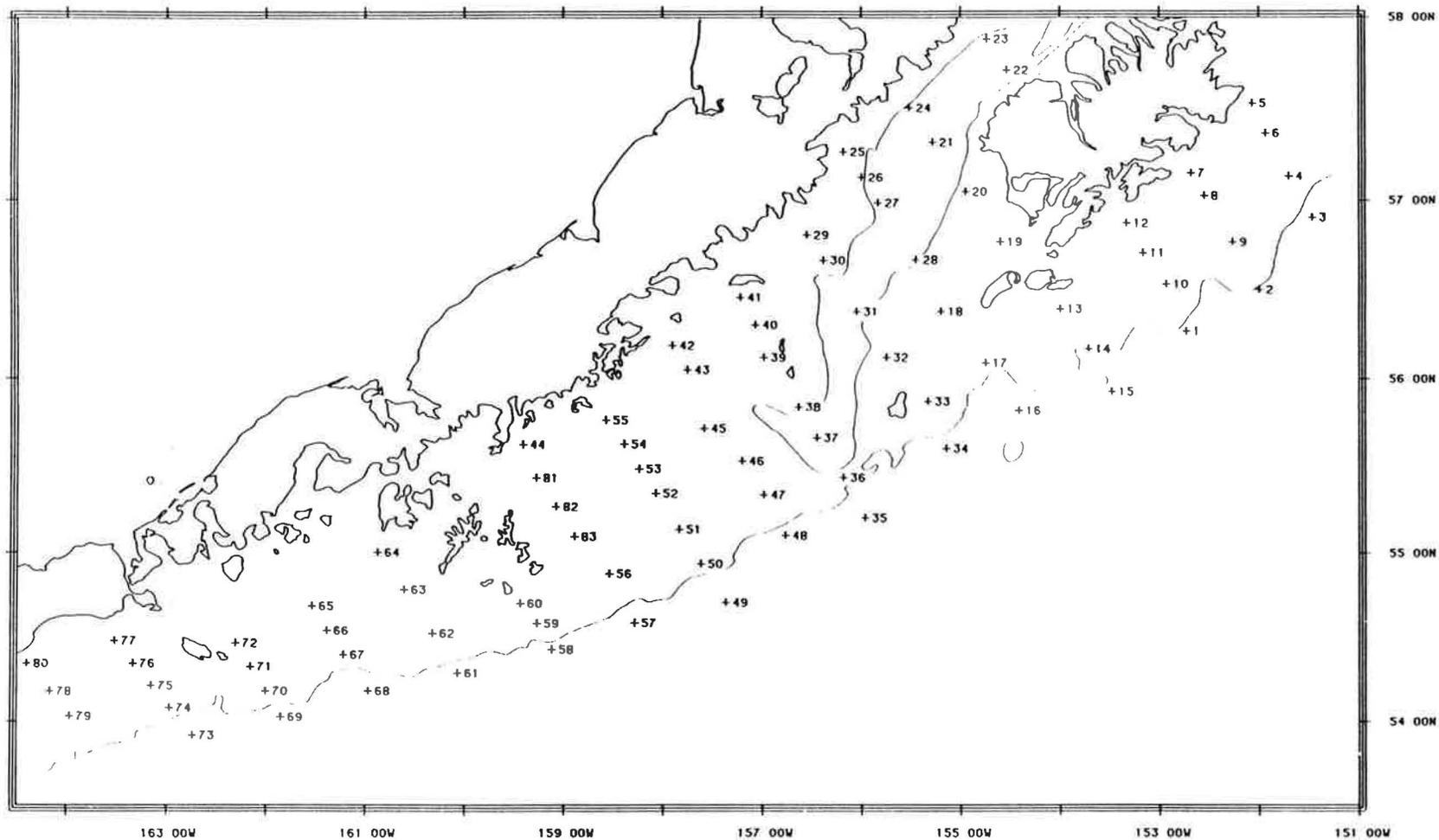


Figure 70.--Station locations for cruise 1DA-82, April 4-23, 1982.

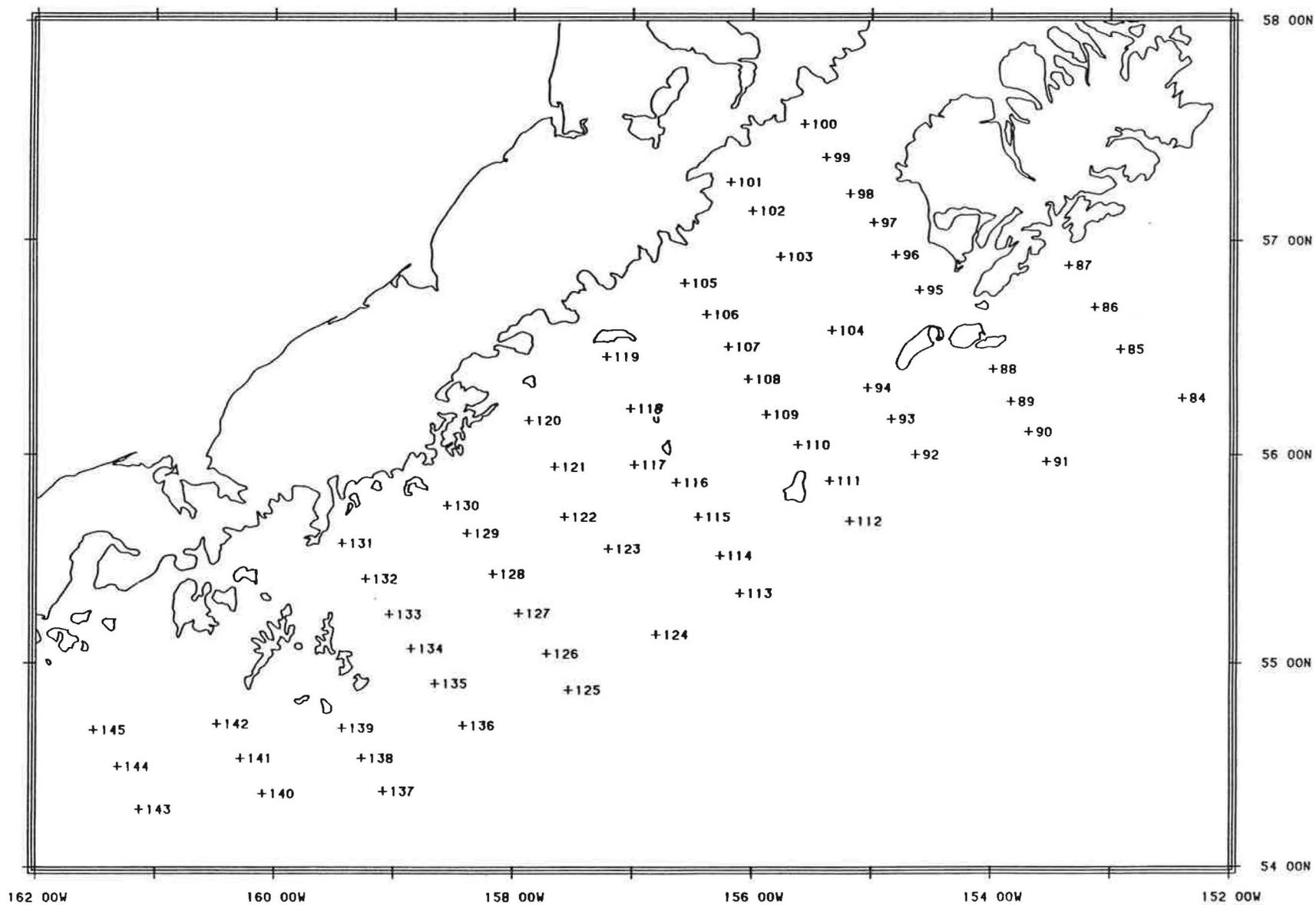


Figure 71.--Station locations for cruise 2DA-82, May 21-31, 1982.

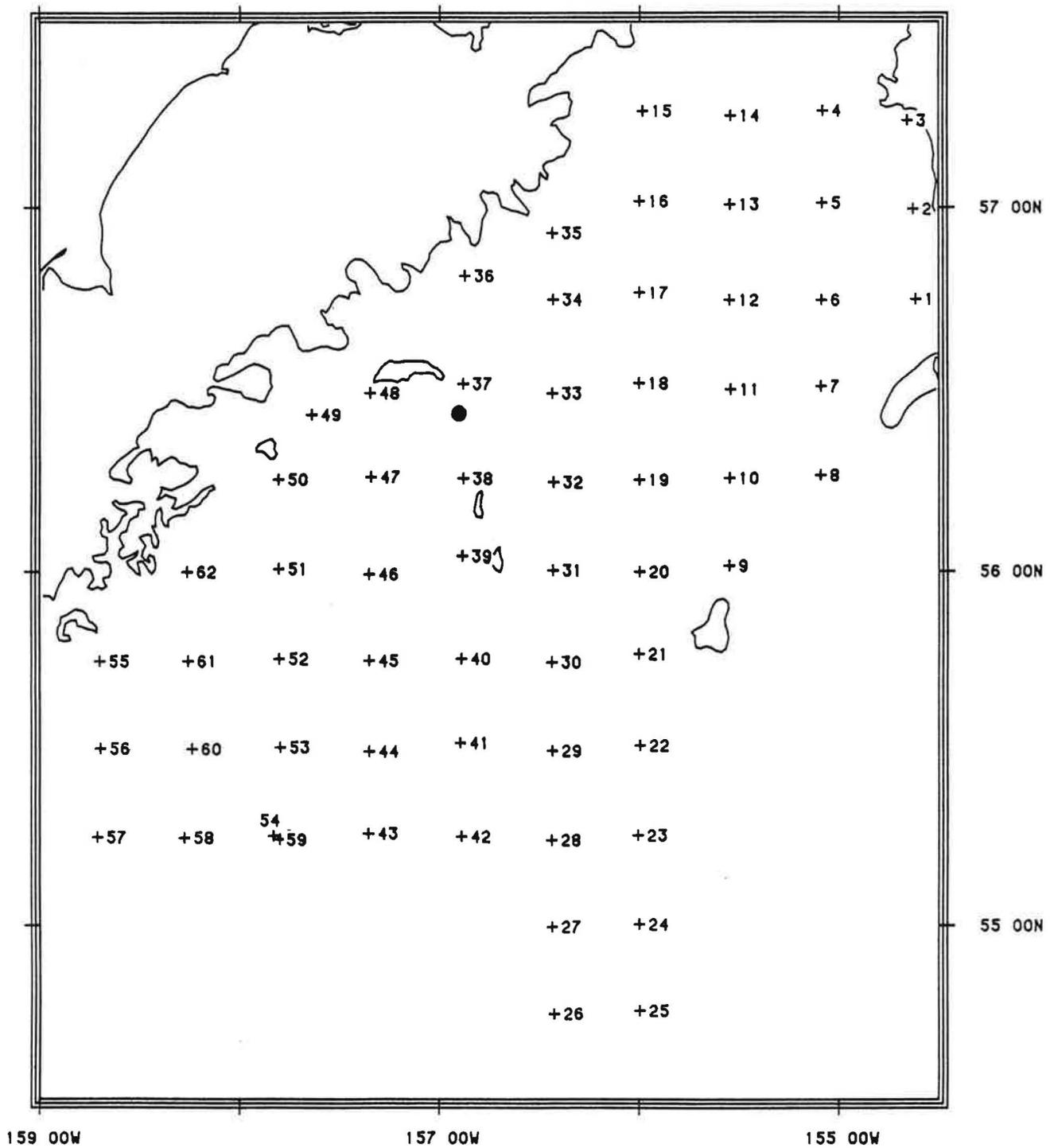


Figure 72.--Station locations for cruise 1CH-83, May 16-28, 1983. Dot indicates location of diel station.

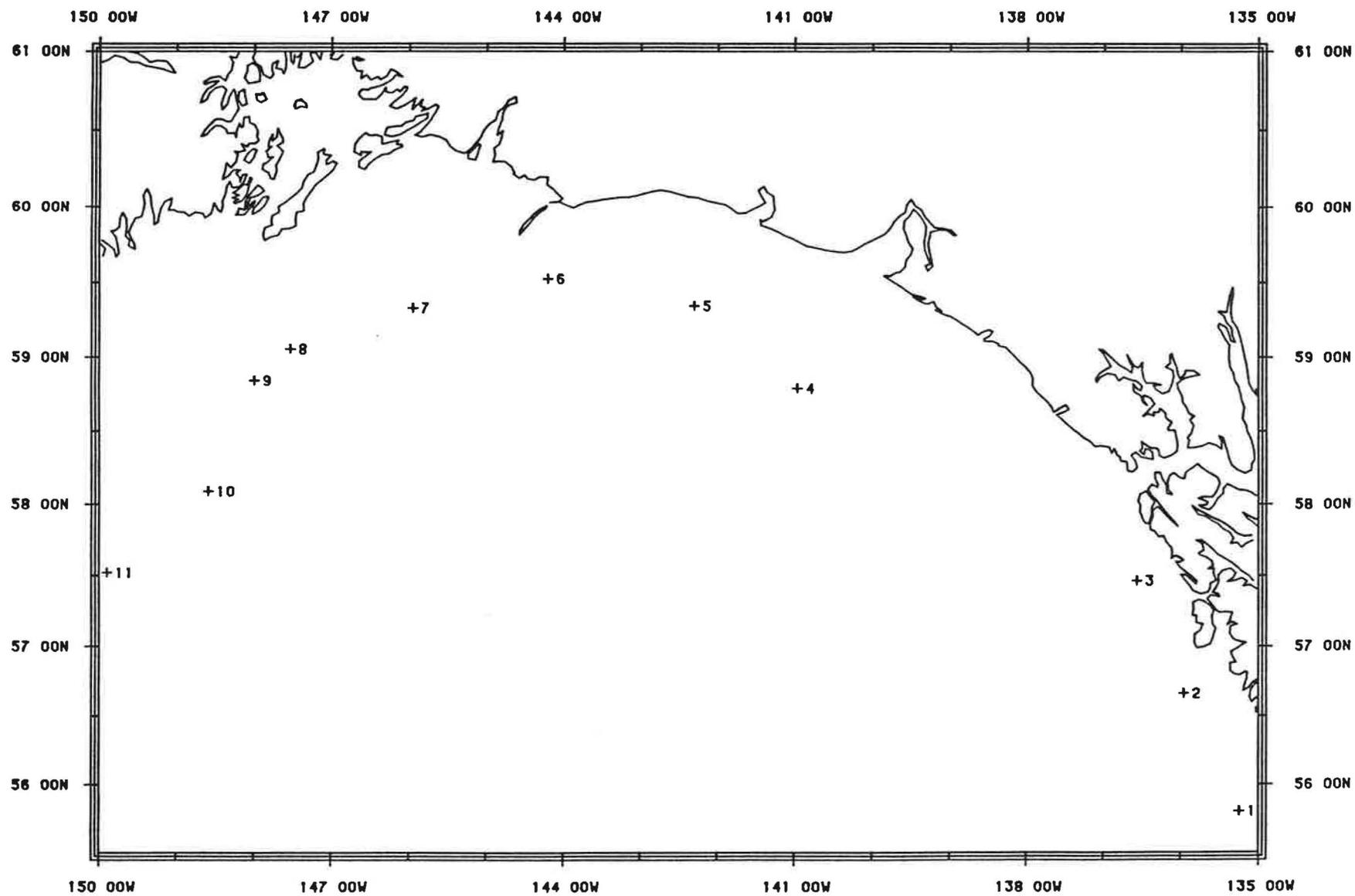


Figure 73.--Locations of neuston stations from Seattle to Kodiak Island for cruise 1CH-83, May 14-19, 1983.

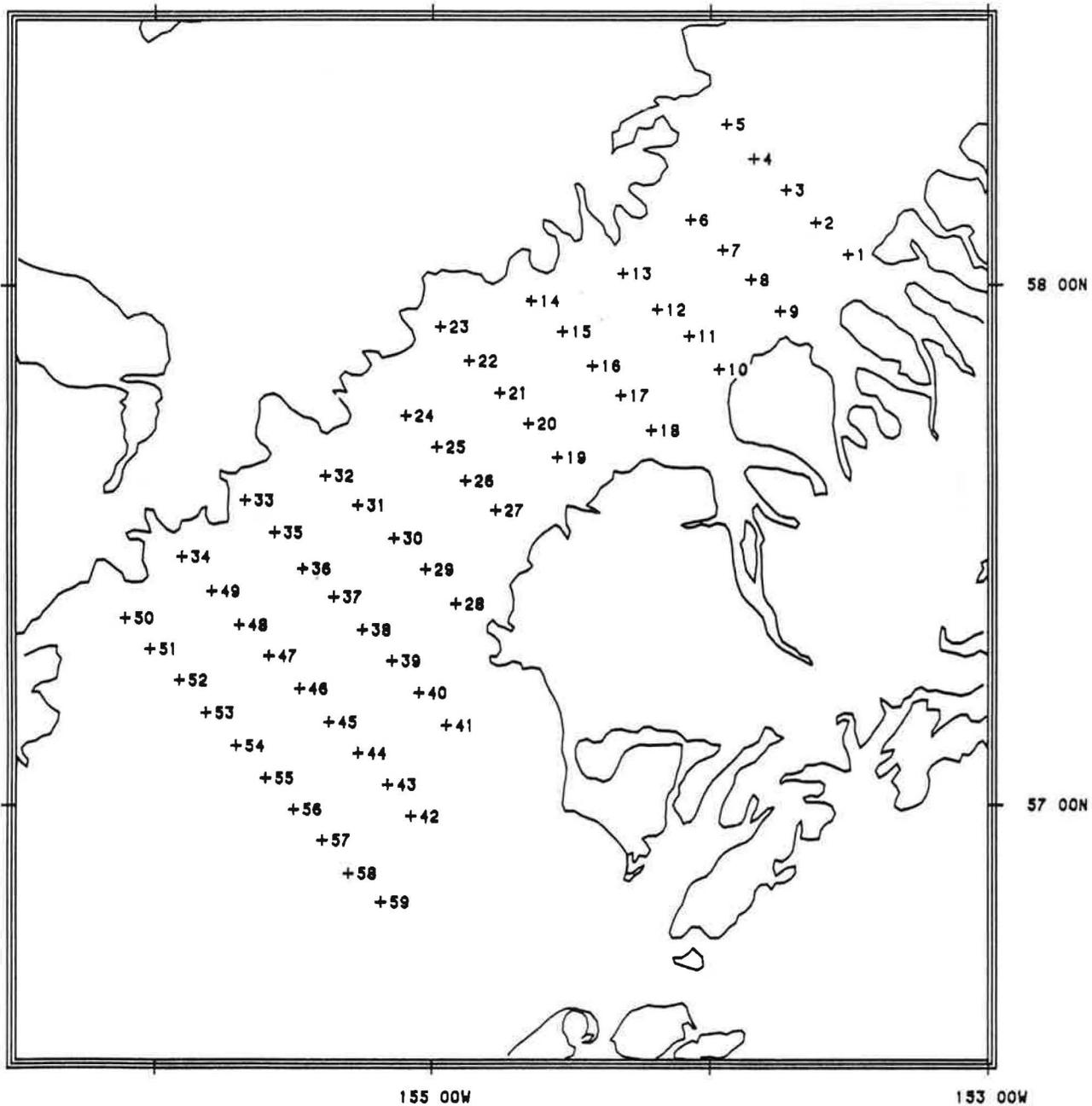


Figure 74.--Station locations for cruise 1CH-84, March 20-23, 1984.

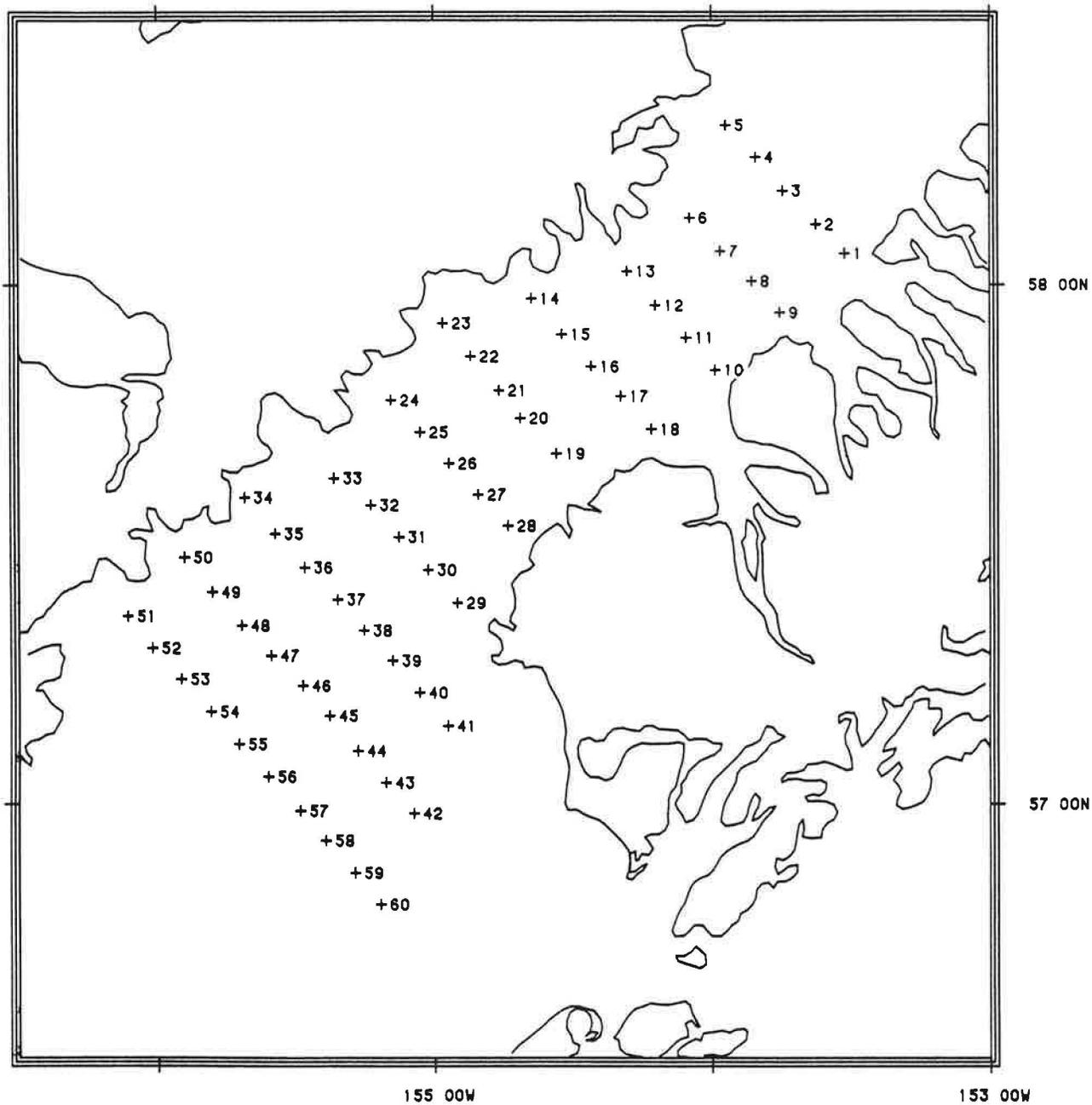


Figure 75.--Station locations for cruise 2CH-84, March 24-26, 1984.

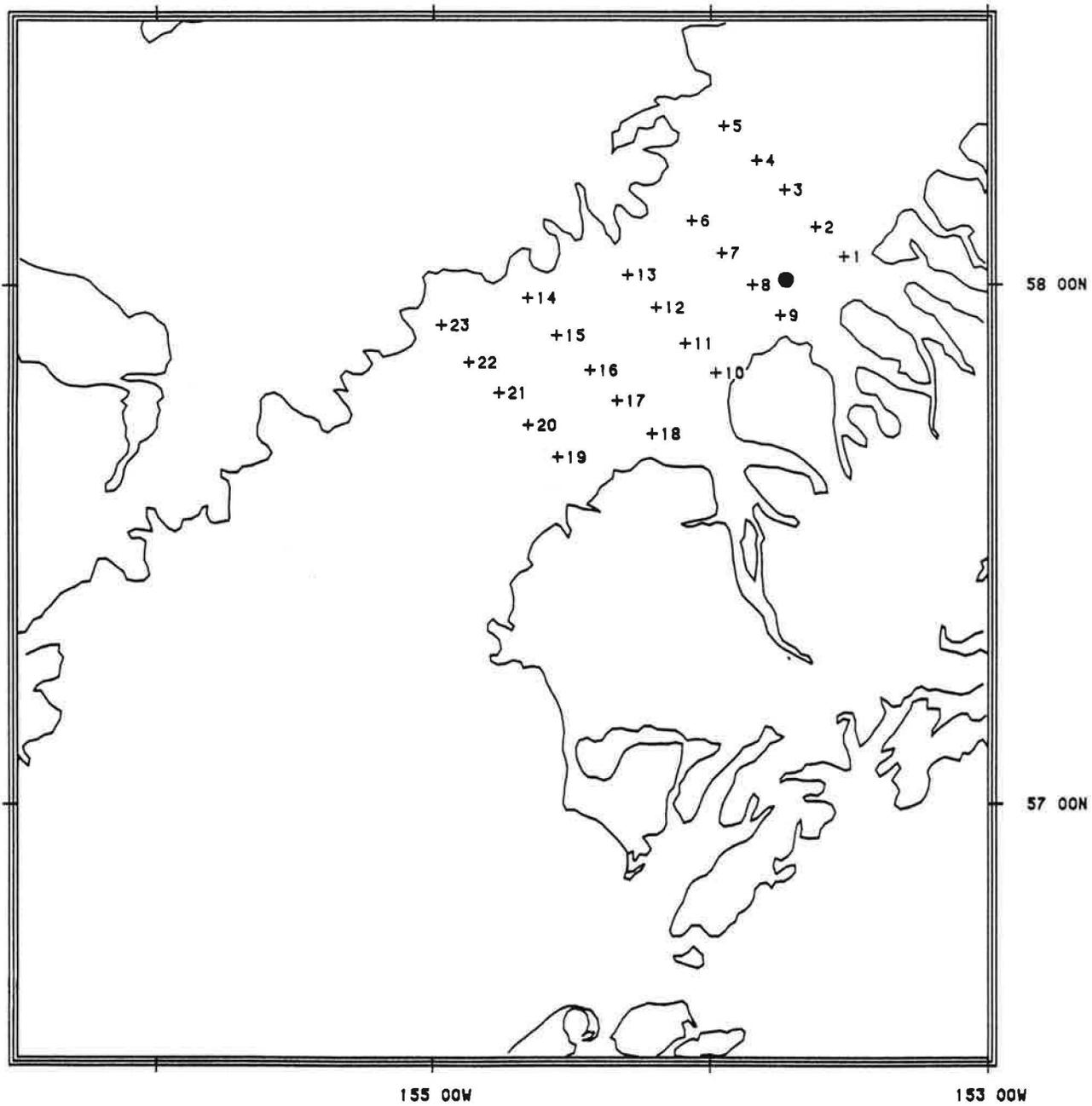


Figure 76.--Station locations for cruise 3CH-84, March 27-28, 1984. Dot indicates location of drogue station.

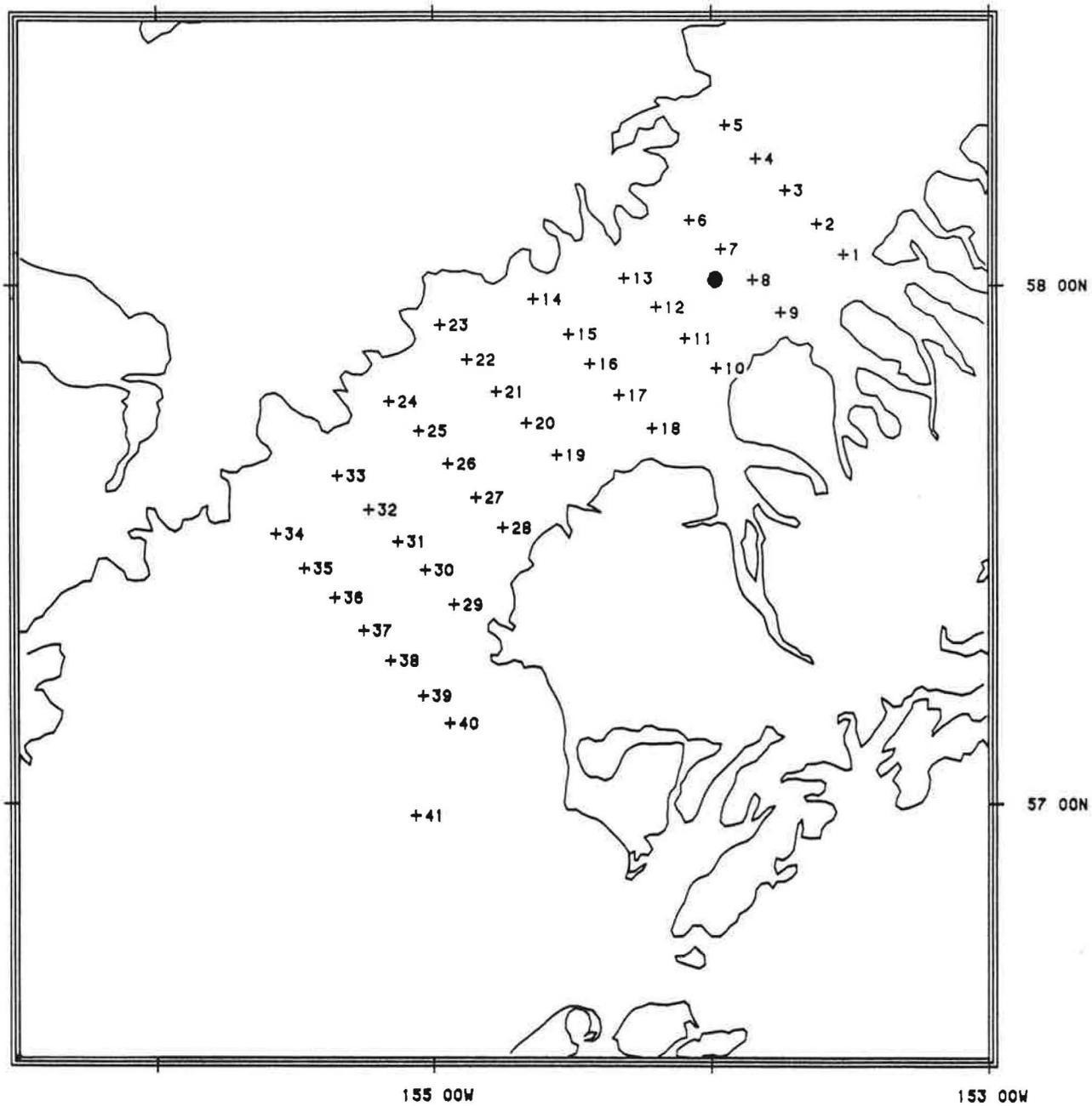


Figure 77.--Station locations for cruise 4CH-84, March 29-31, 1984. Dot indicates location of drogue station.

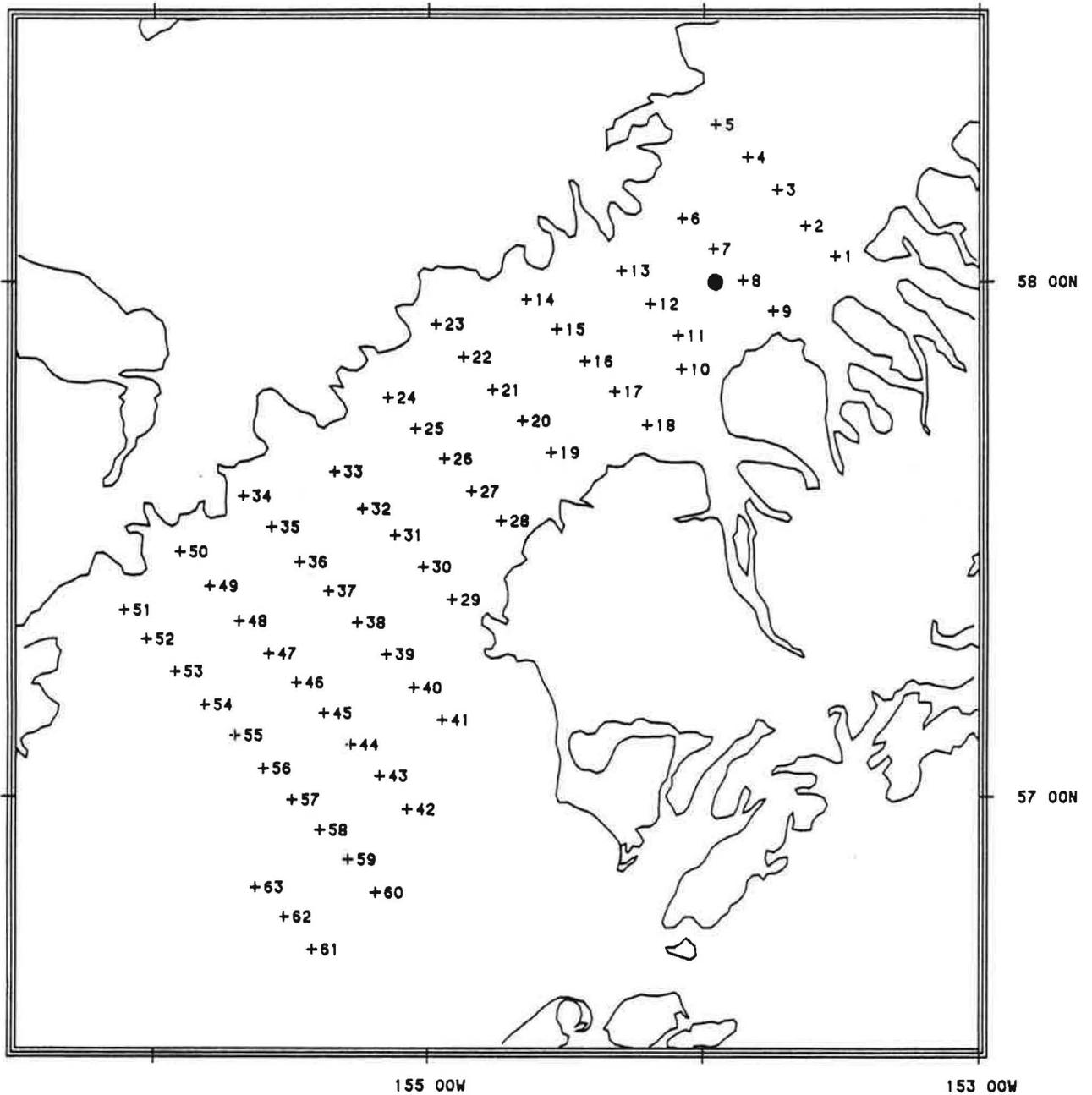


Figure 78.--Station locations for cruise 5CH-84, April 4-8, 1984. Dot indicates location of drogue station.

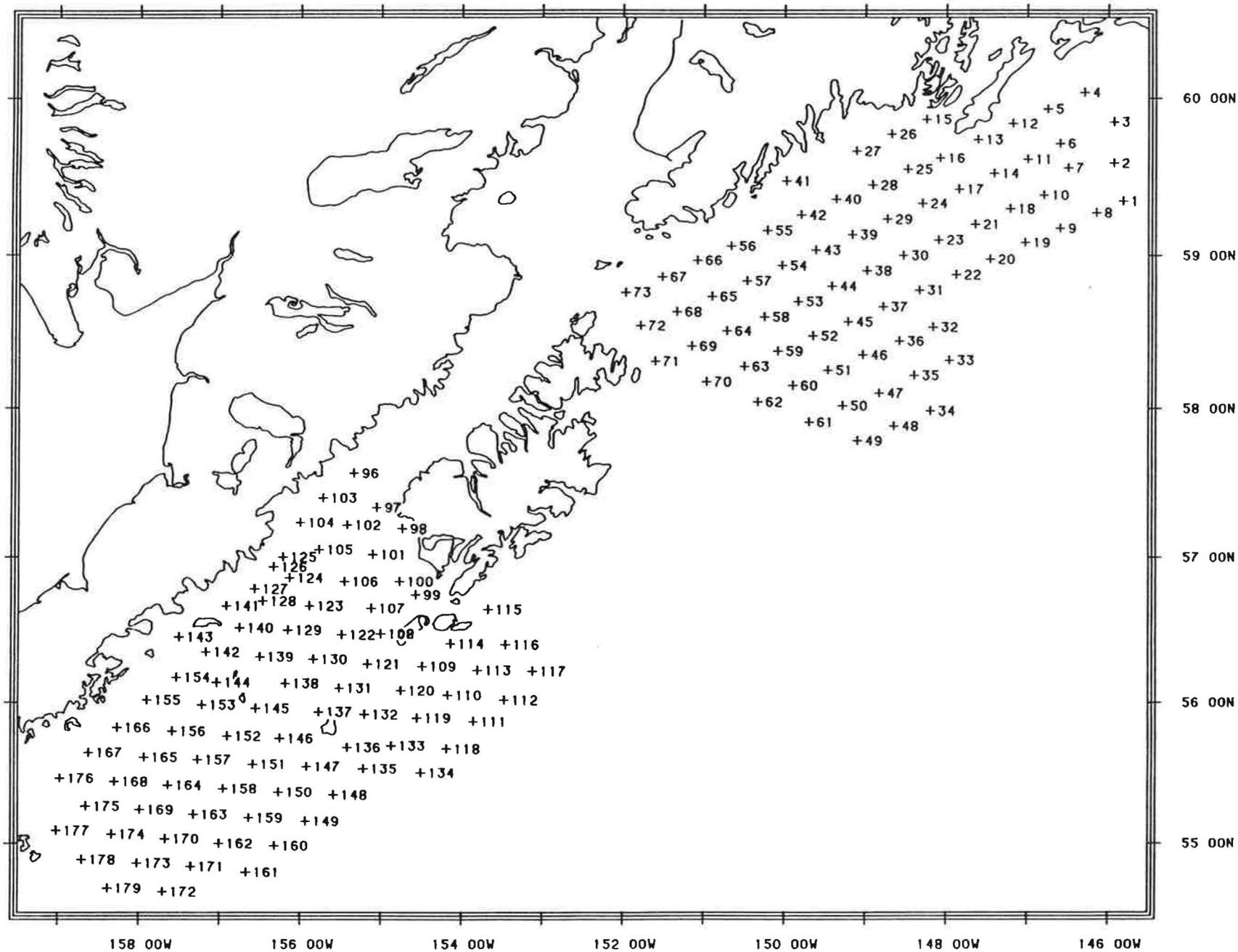


Figure 79.--Station locations for cruise 1SH-84, April 17-May 9, 1984.

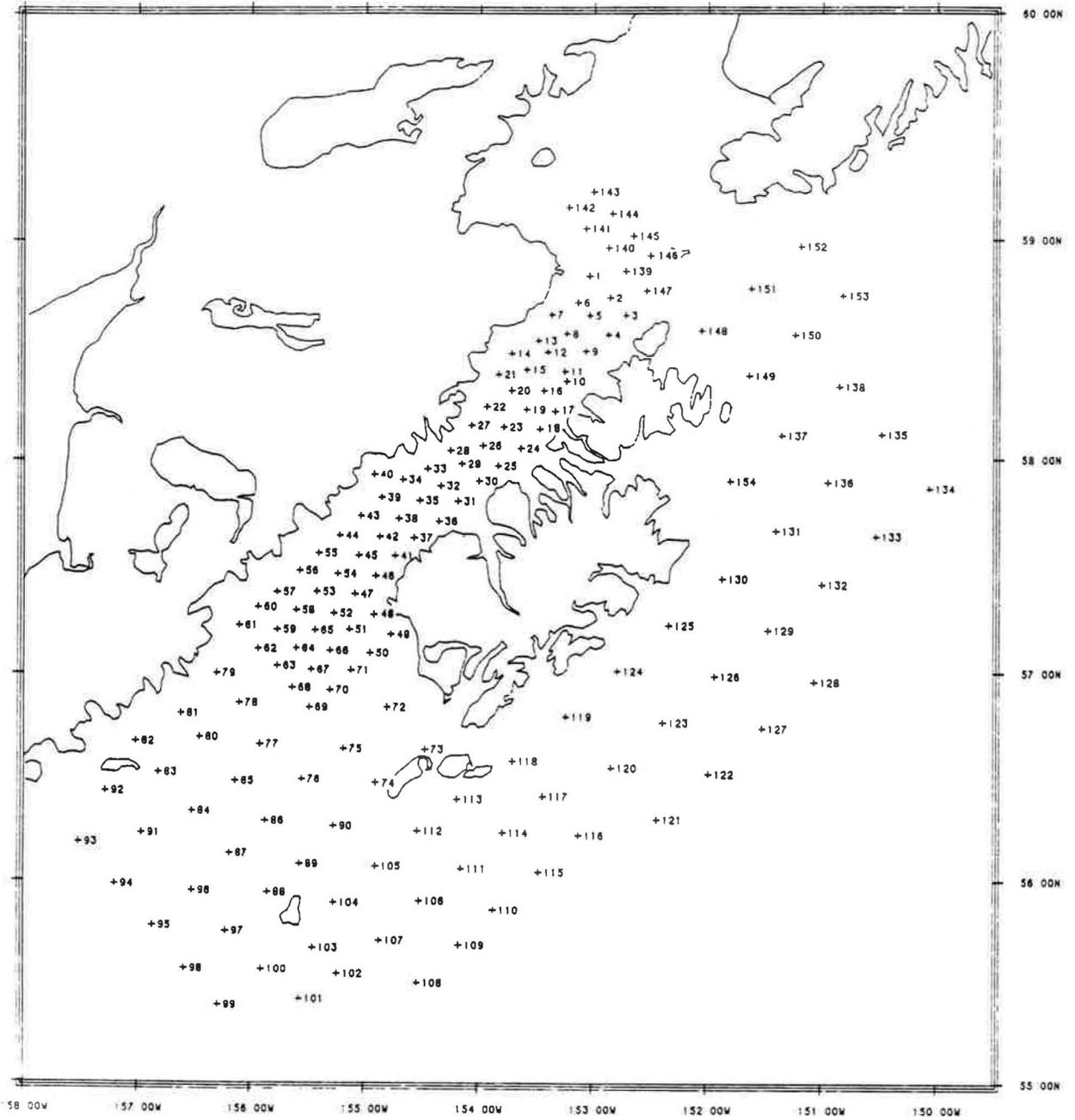


Figure 80.--Station locations for cruise 1PO-85, March 29-April 21, 1985.

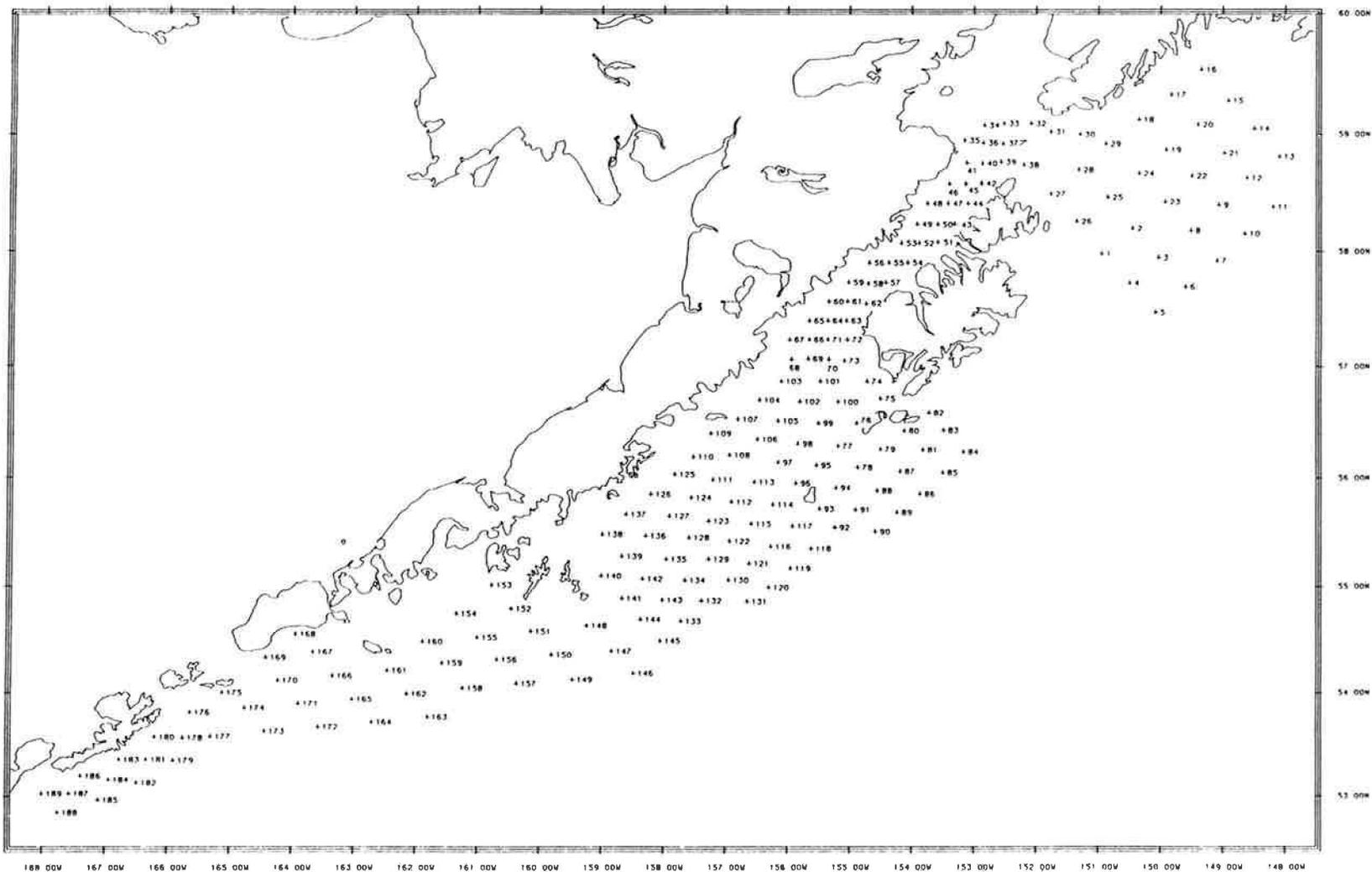


Figure 81.--Station locations for cruise 2PO-85, May 16-June 8, 1985.

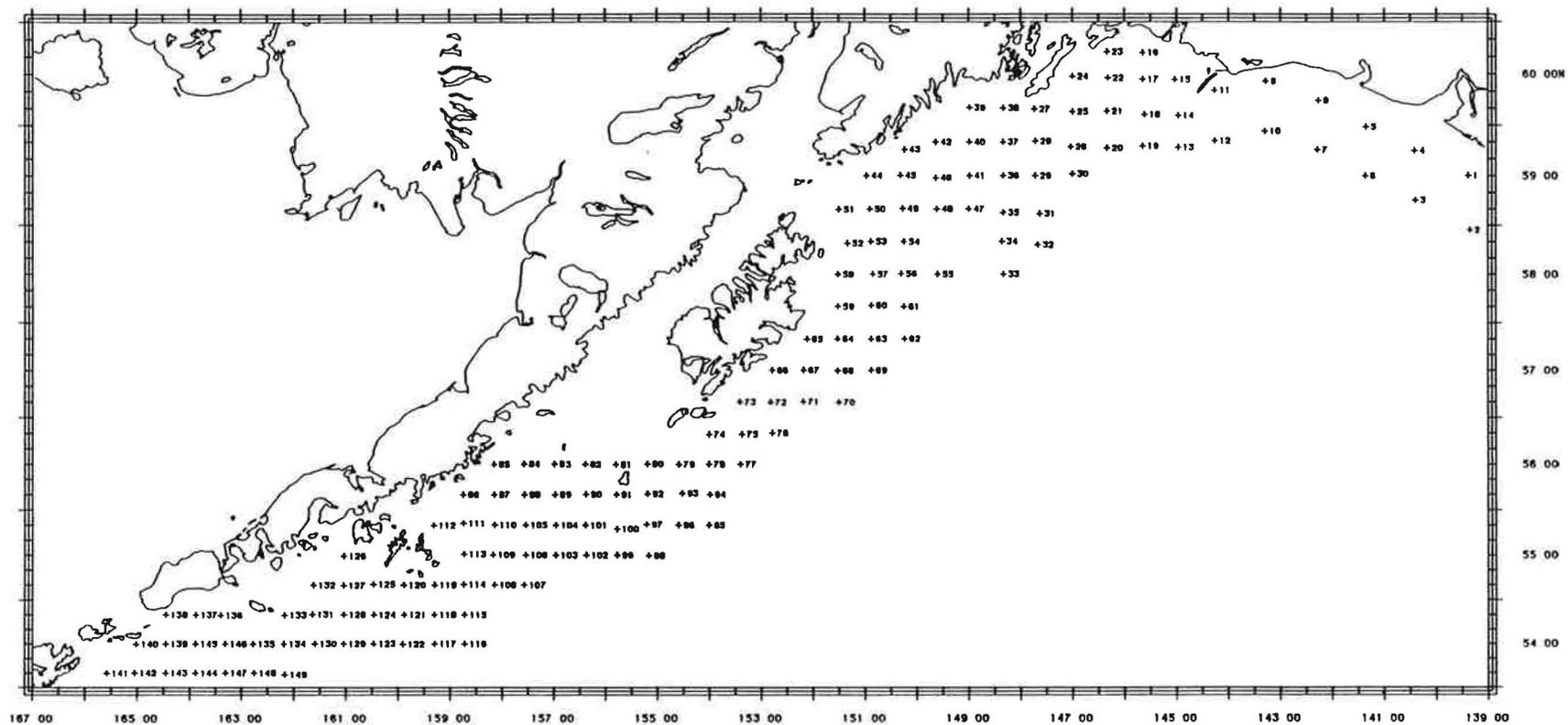


Figure 82.--Station locations for cruise 1GI-86, March 30-April 20, 1986.

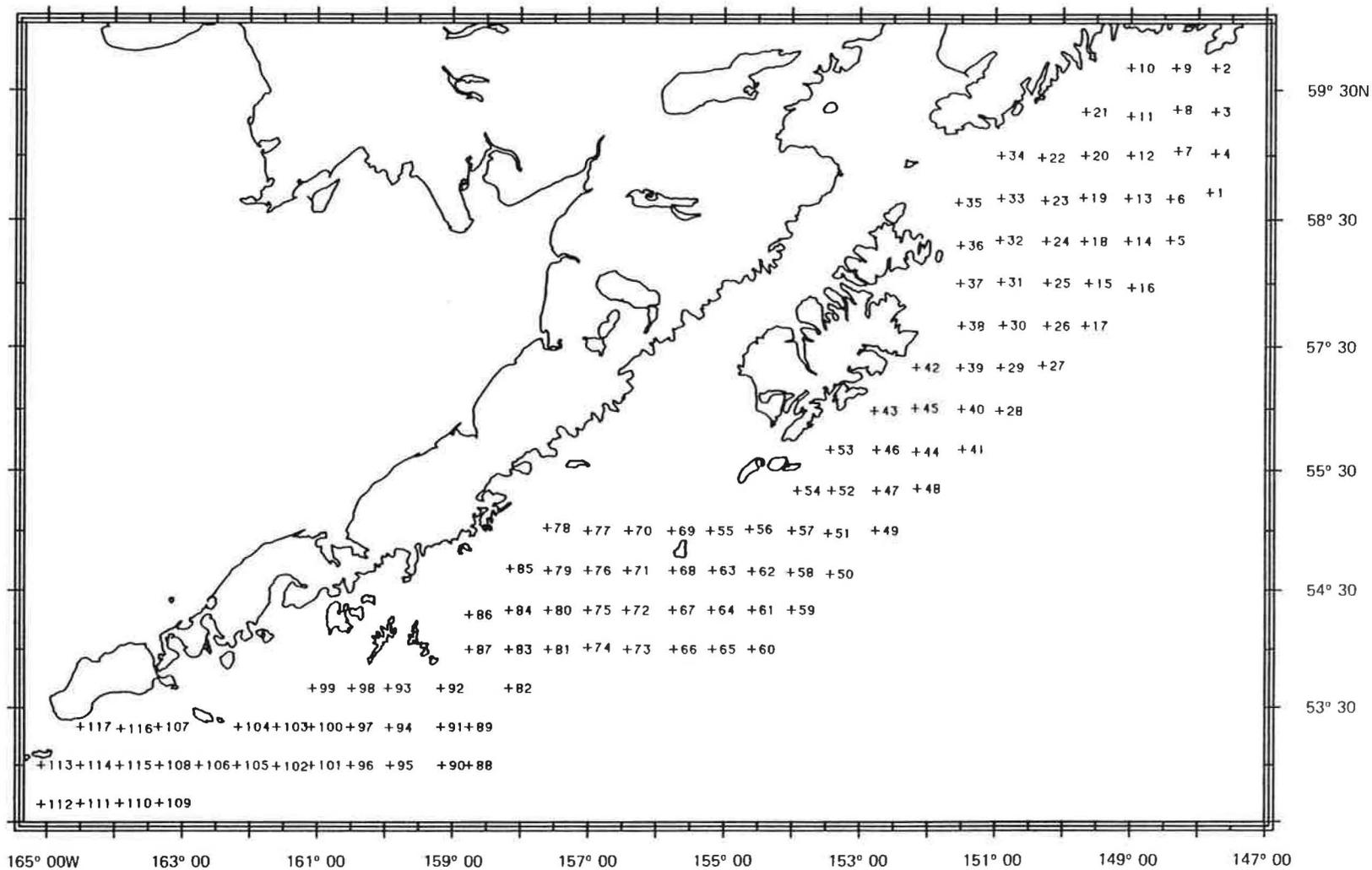


Figure 83.--Station locations for cruise 1BB-87, April 9-27, 1987.

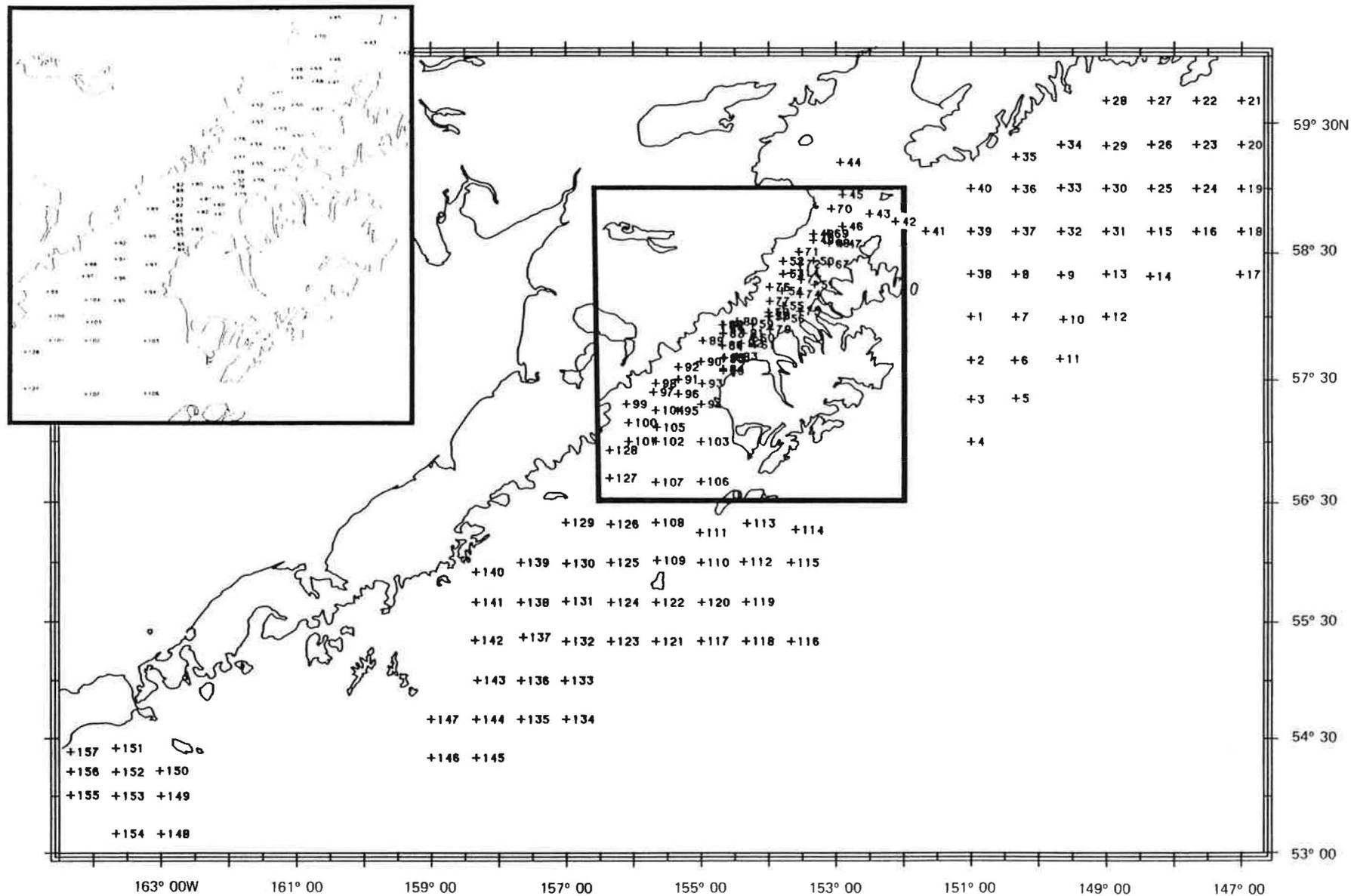


Figure 84a.--Station locations in the Gulf of Alaska for cruise 1DN-88, March 18-May 8, 1988 (inset is enlargement of Shelikof Strait area).

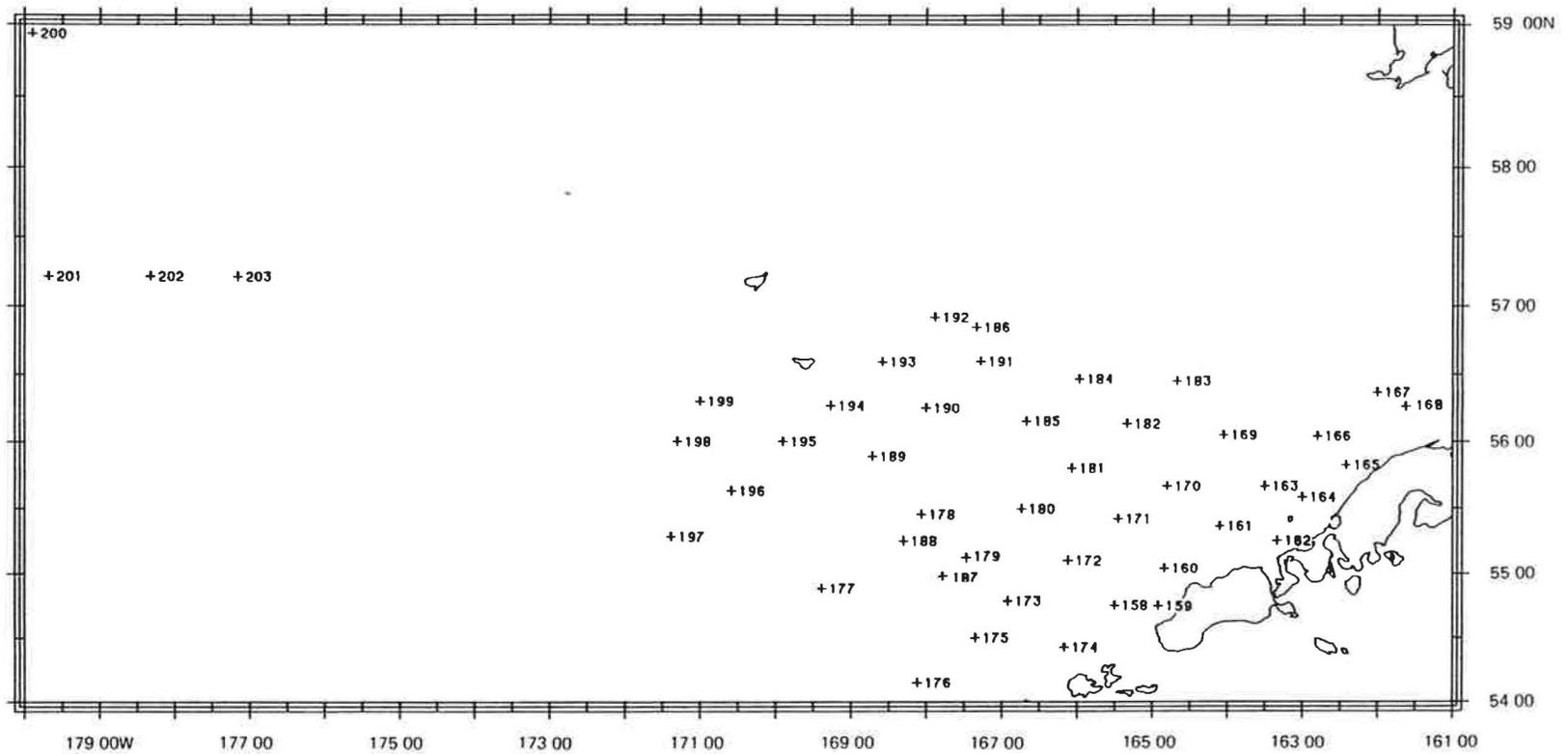


Figure 84b.--Station locations in the Bering Sea for cruise 1DN-88, March 18-May 8, 1988.

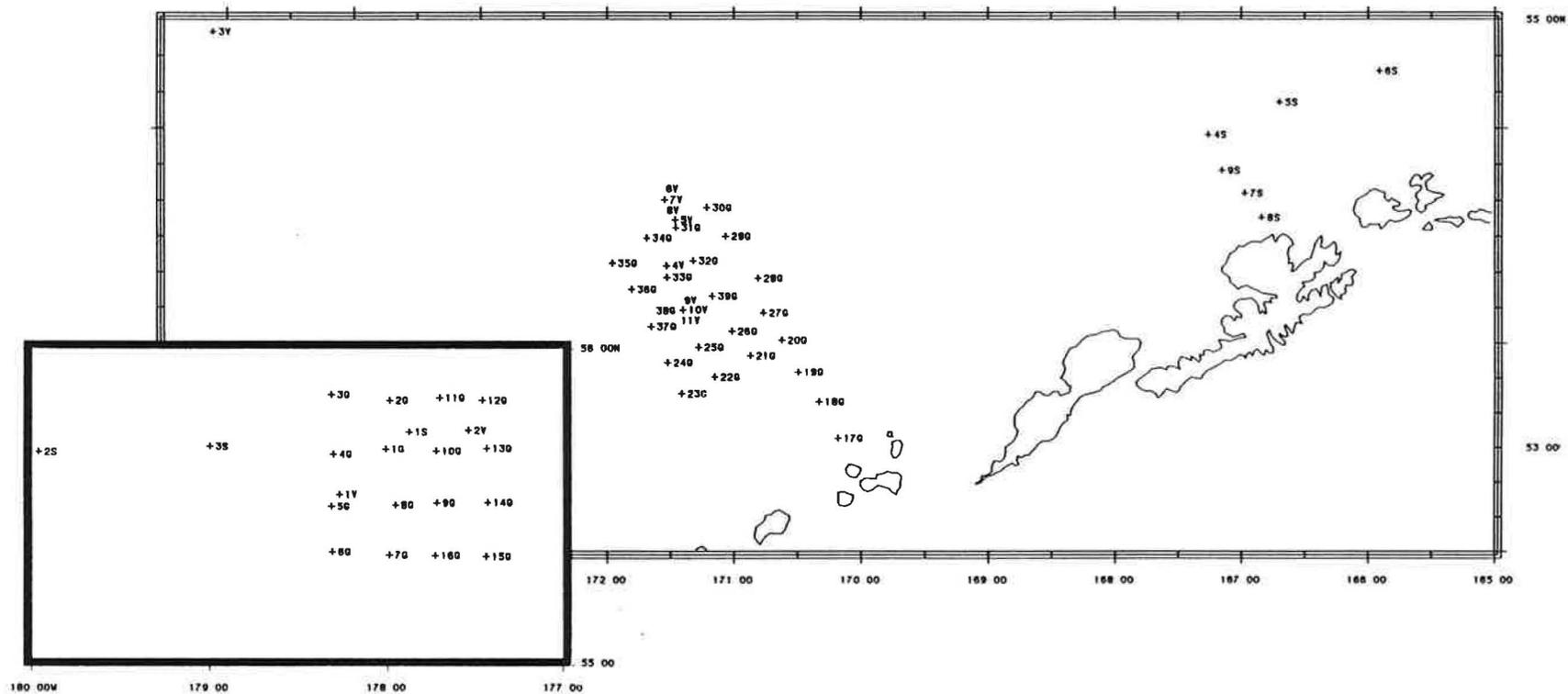


Figure 85.--Station locations for cruise MF86-02, February 2-March 3, 1986.  
 Inset is of sampling area farther to the northeast (v denotes  
 Tucker trawls, G and S denote bongs).

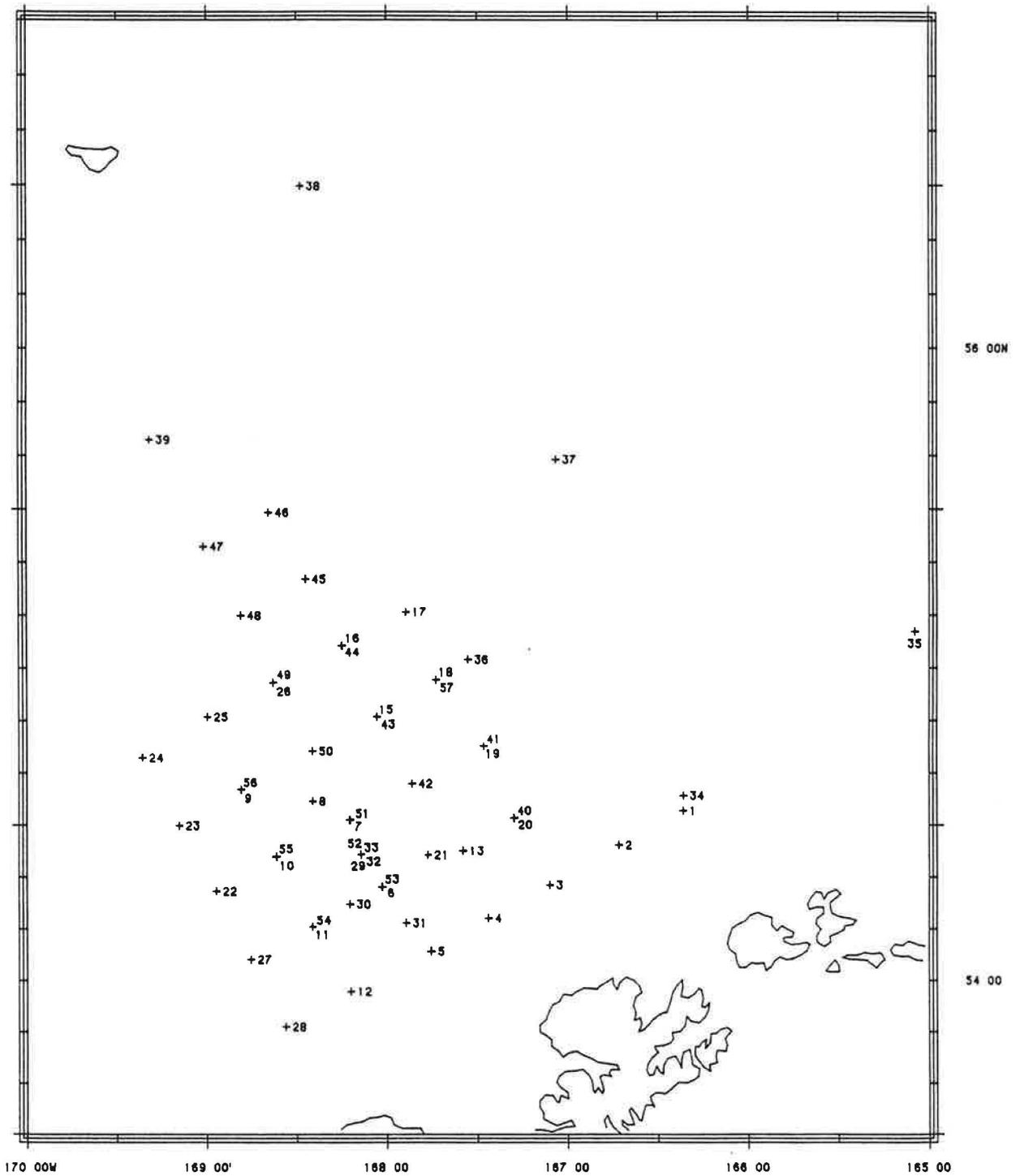


Figure 86.--Station locations for cruise 10C-88, March 11-April 4, 1988.

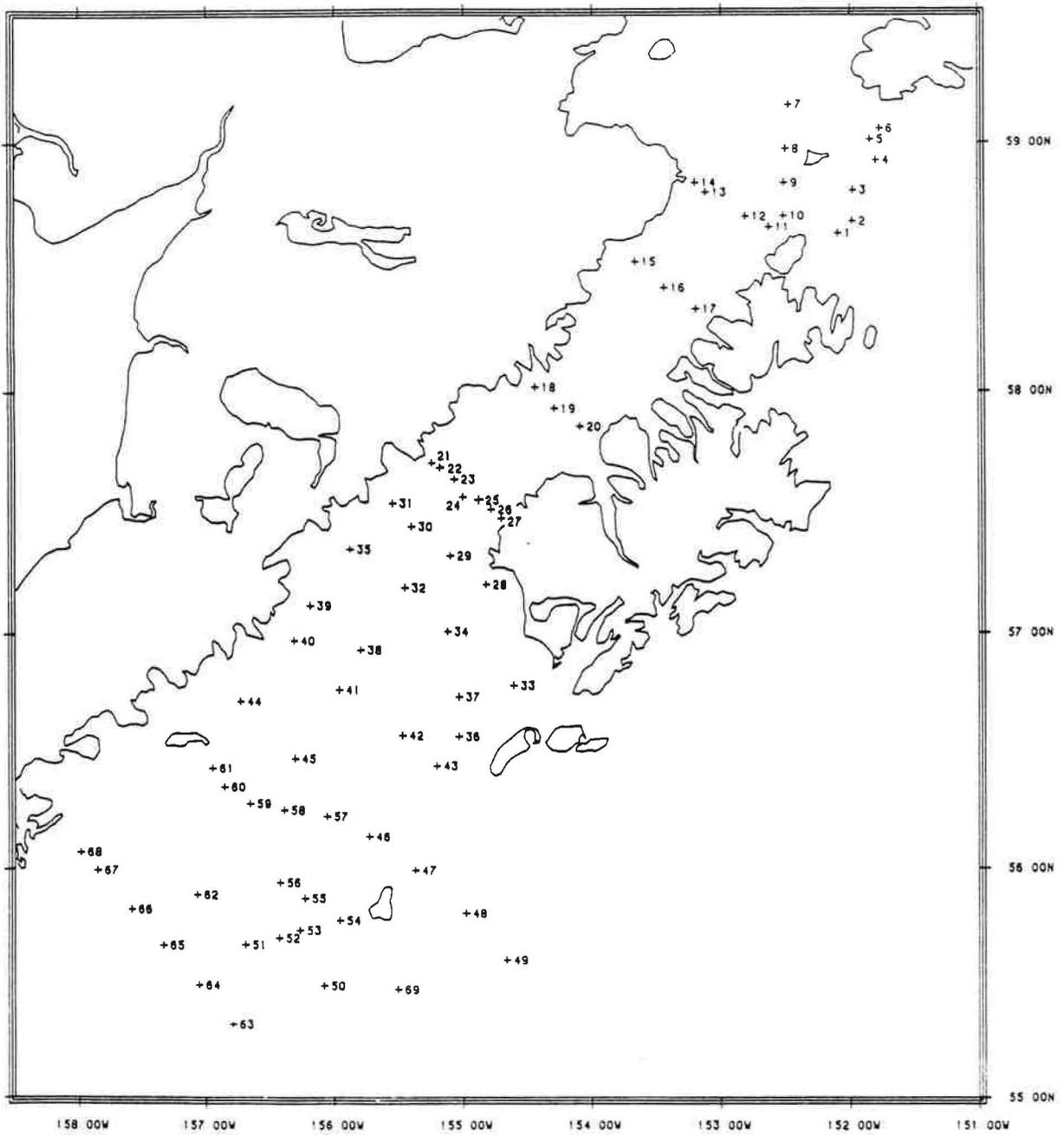


Figure 87.--Station locations for cruise 1DI-85, March 11-April 2, 1985.

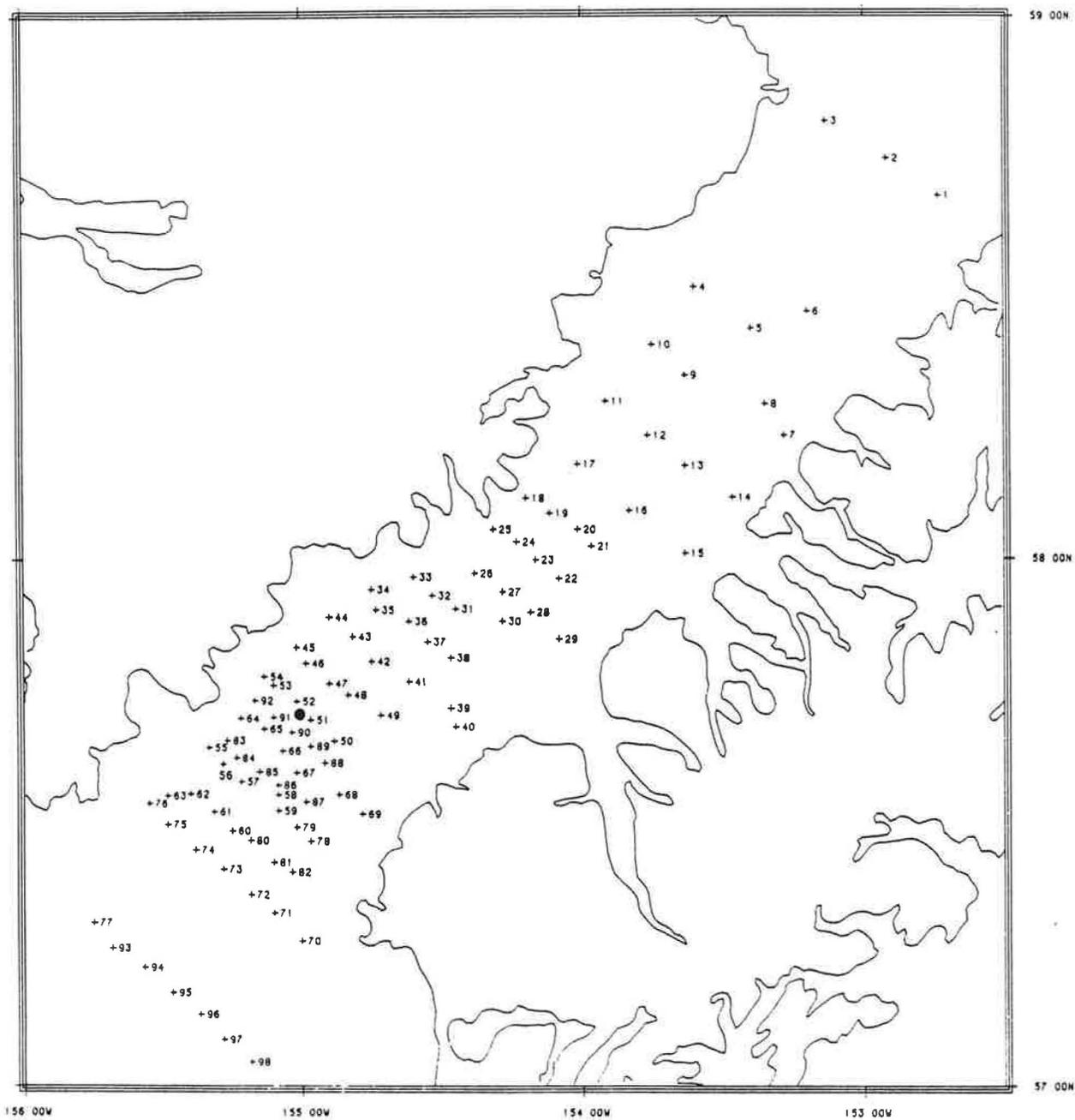


Figure 88.--Station locations for cruise 1MF-85, April 1-12, 1985. Dot indicates location of drogue station.

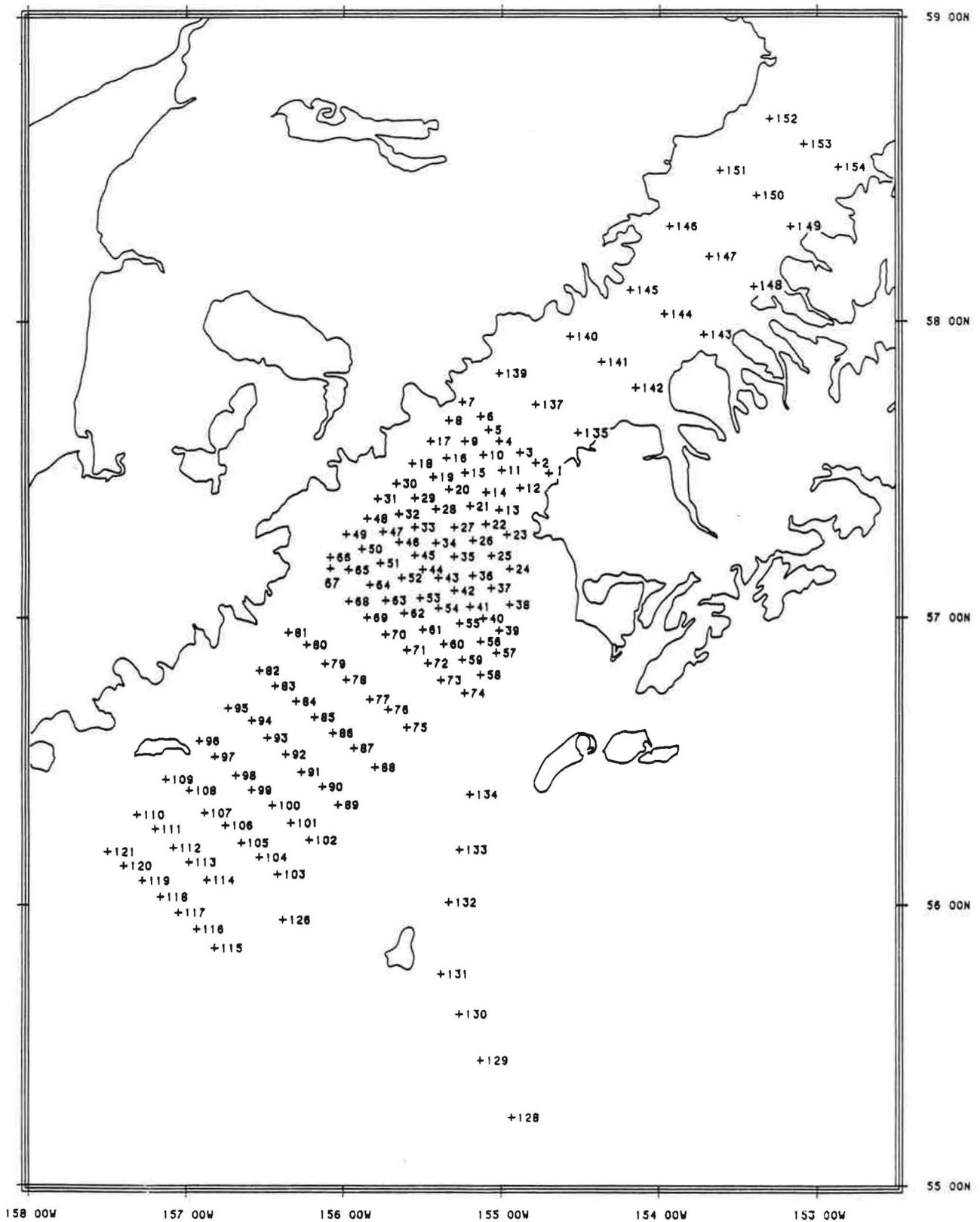


Figure 89.--Station locations for cruise 2MF-85, May 1-12, 1985.

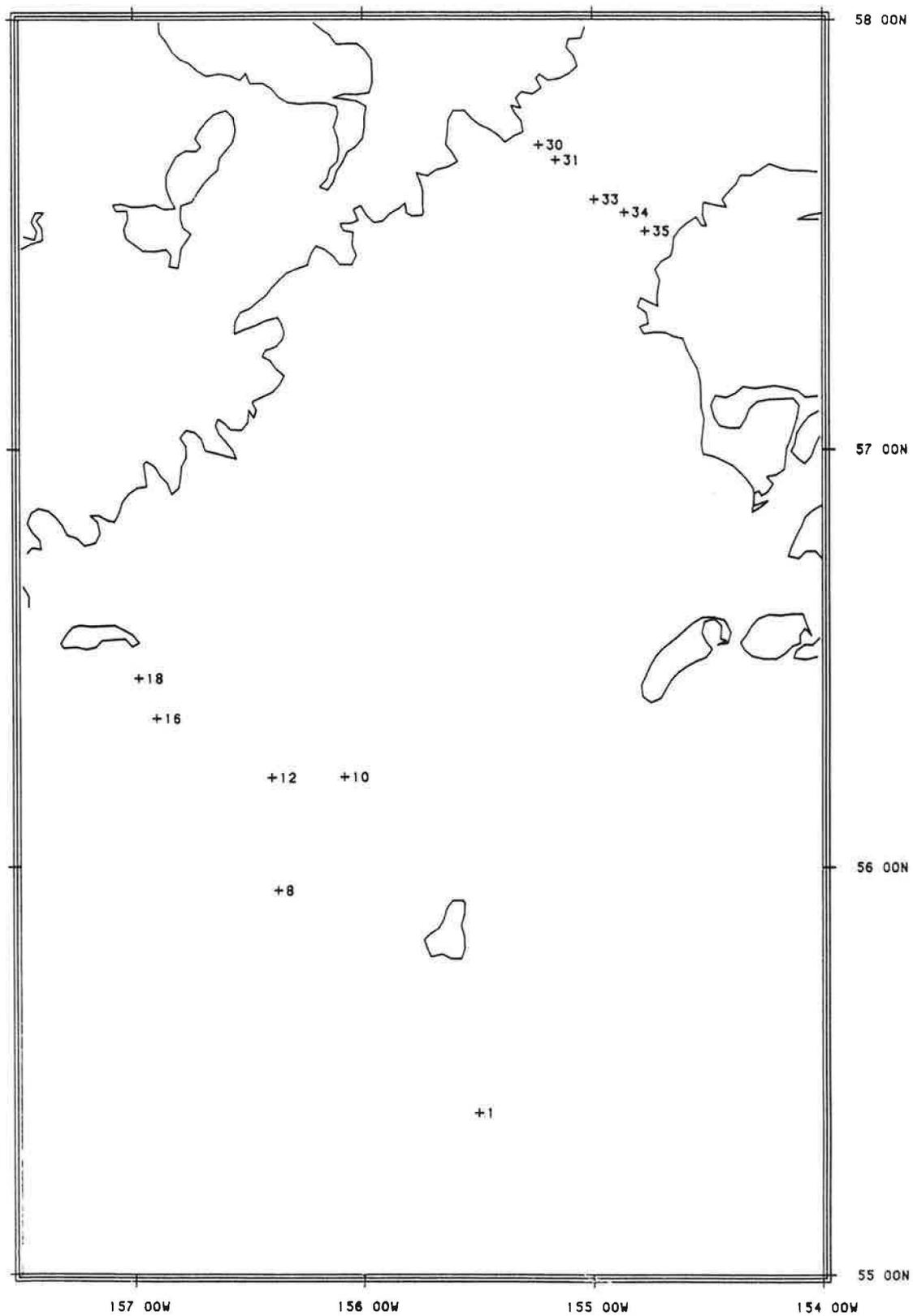


Figure 90.--Station locations for cruise 2DI-85, July 23-August 2, 1985.

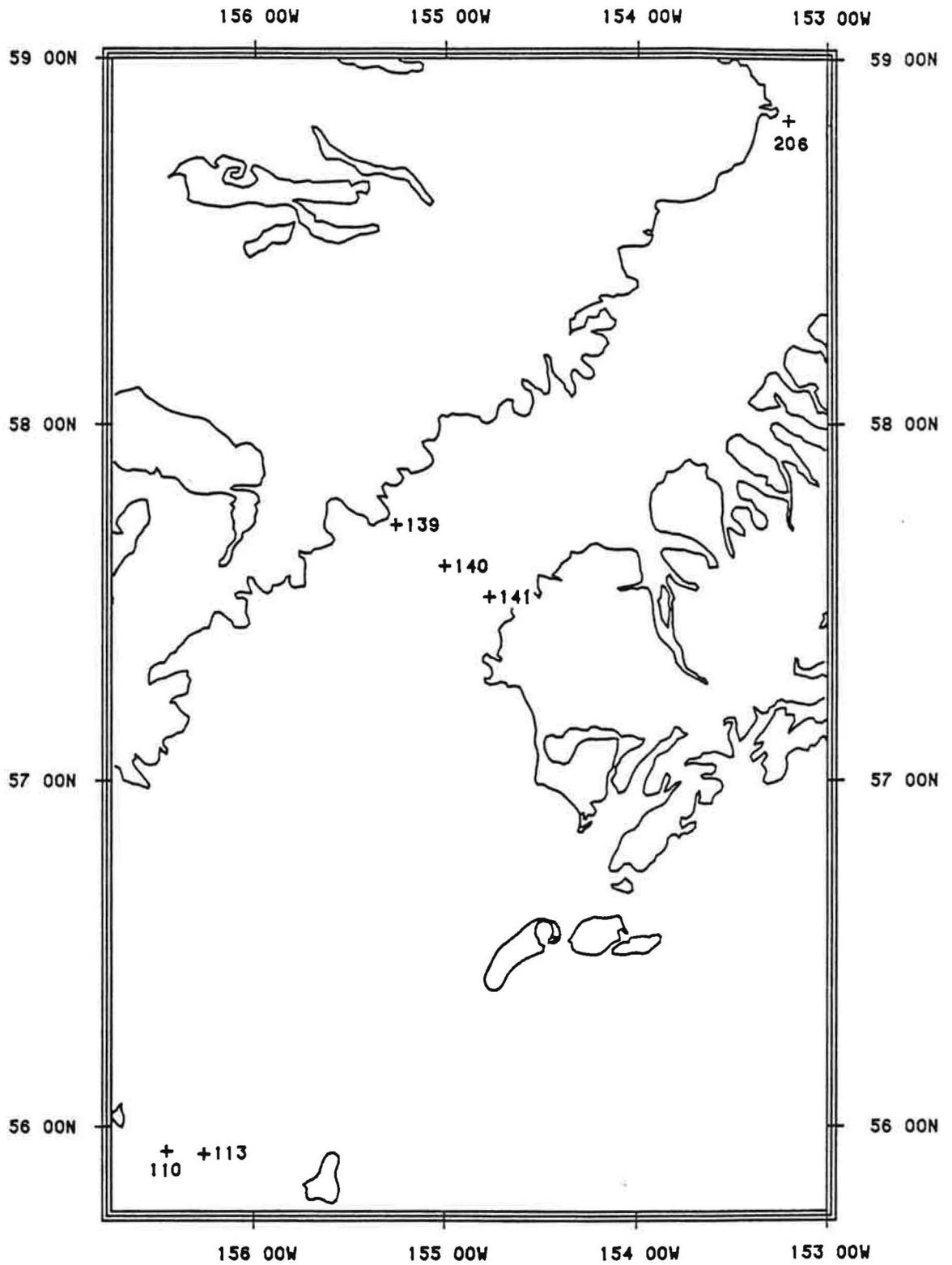


Figure 91.--Station locations for cruise 3MF-85, October 1-November 2, 1985.

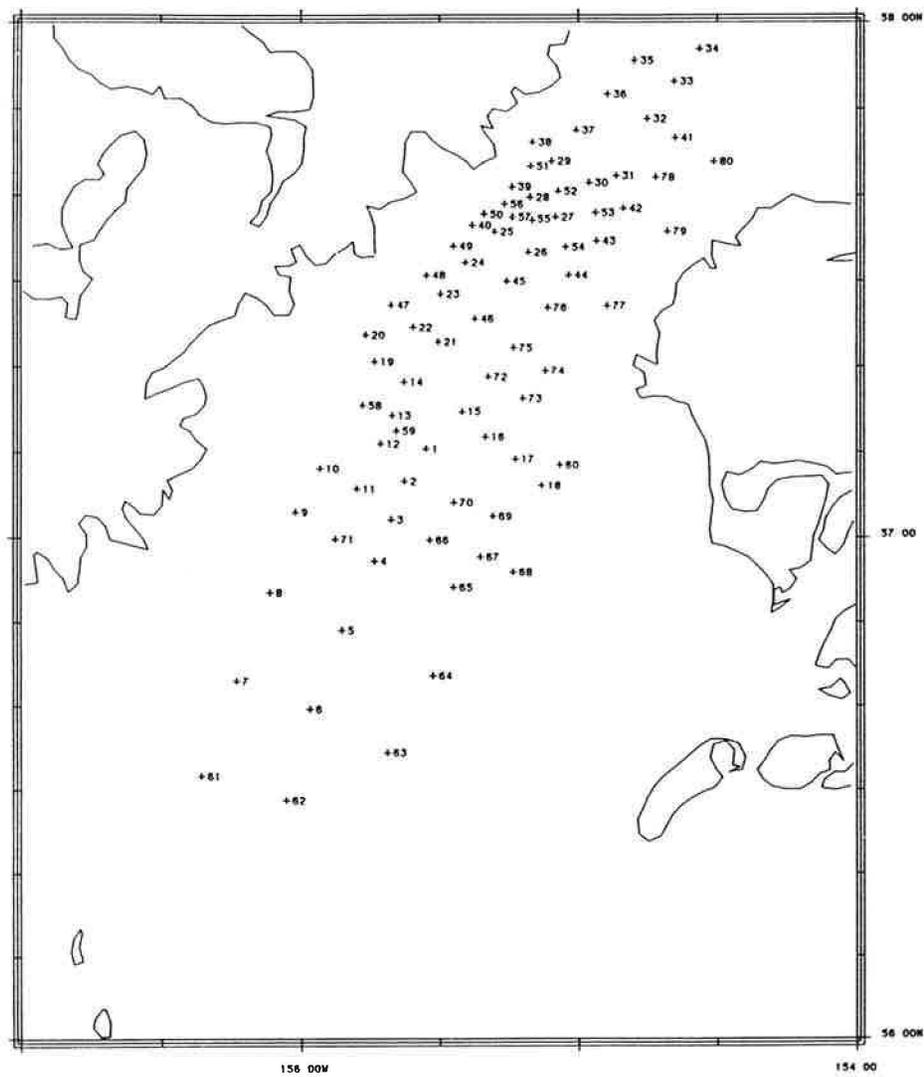


Figure 92a.--Bongo station locations for cruise 1MF-86, April 2-13, 1986.

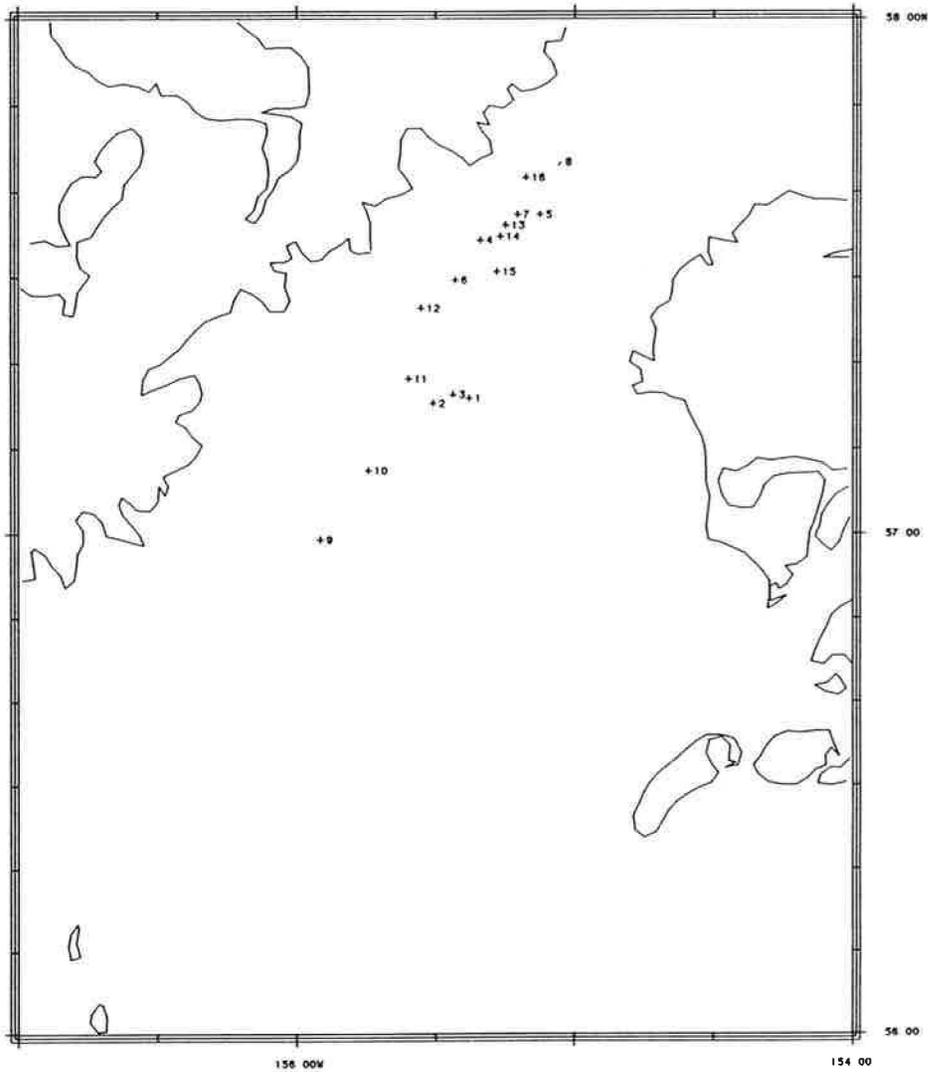


Figure 92b.--Large and small Clarke-Bumpus station locations for cruise 1MF-86, April 2-13, 1986.

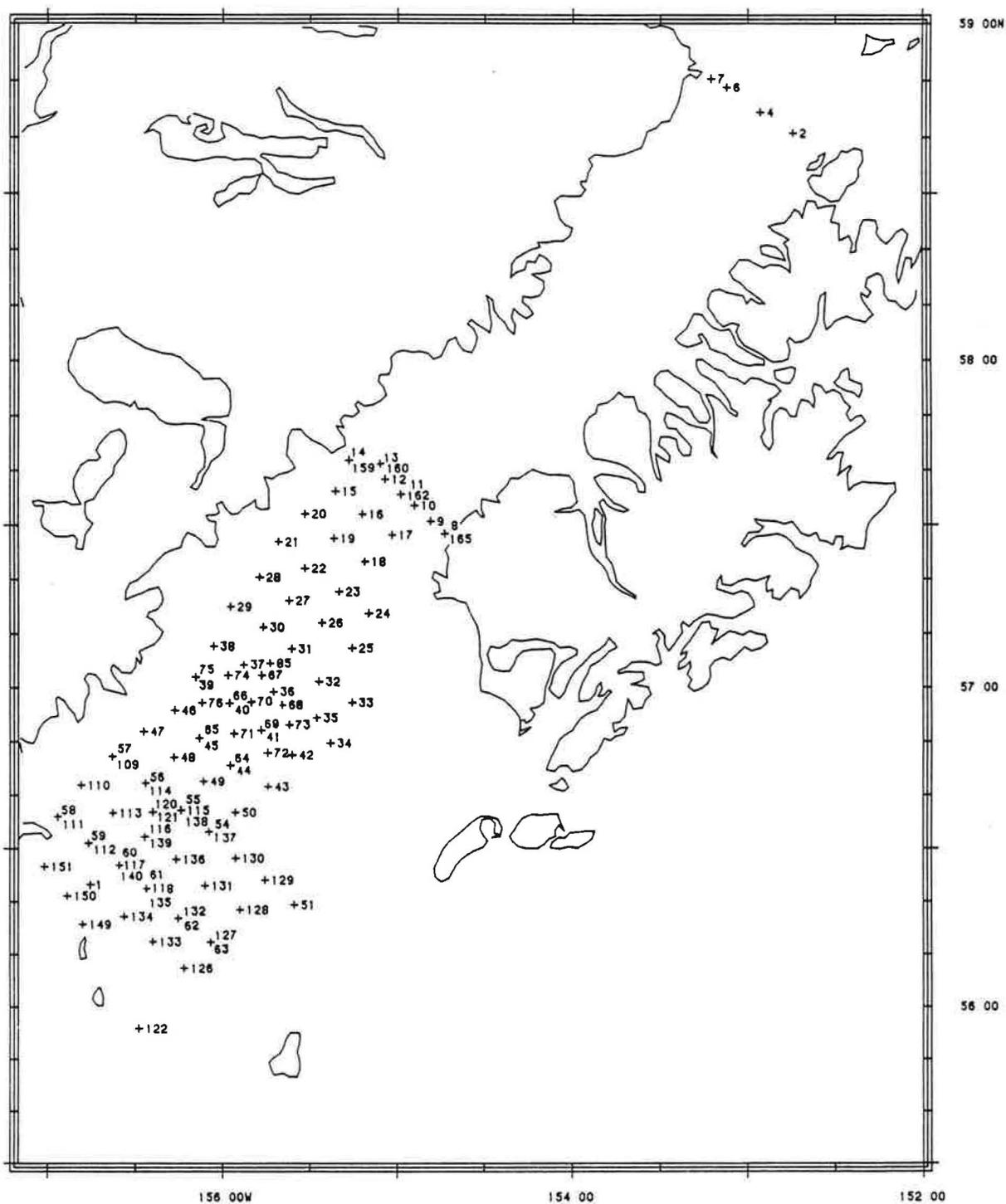


Figure 93.--Stations locations for cruise 2MF-86, May 1-19, 1986.

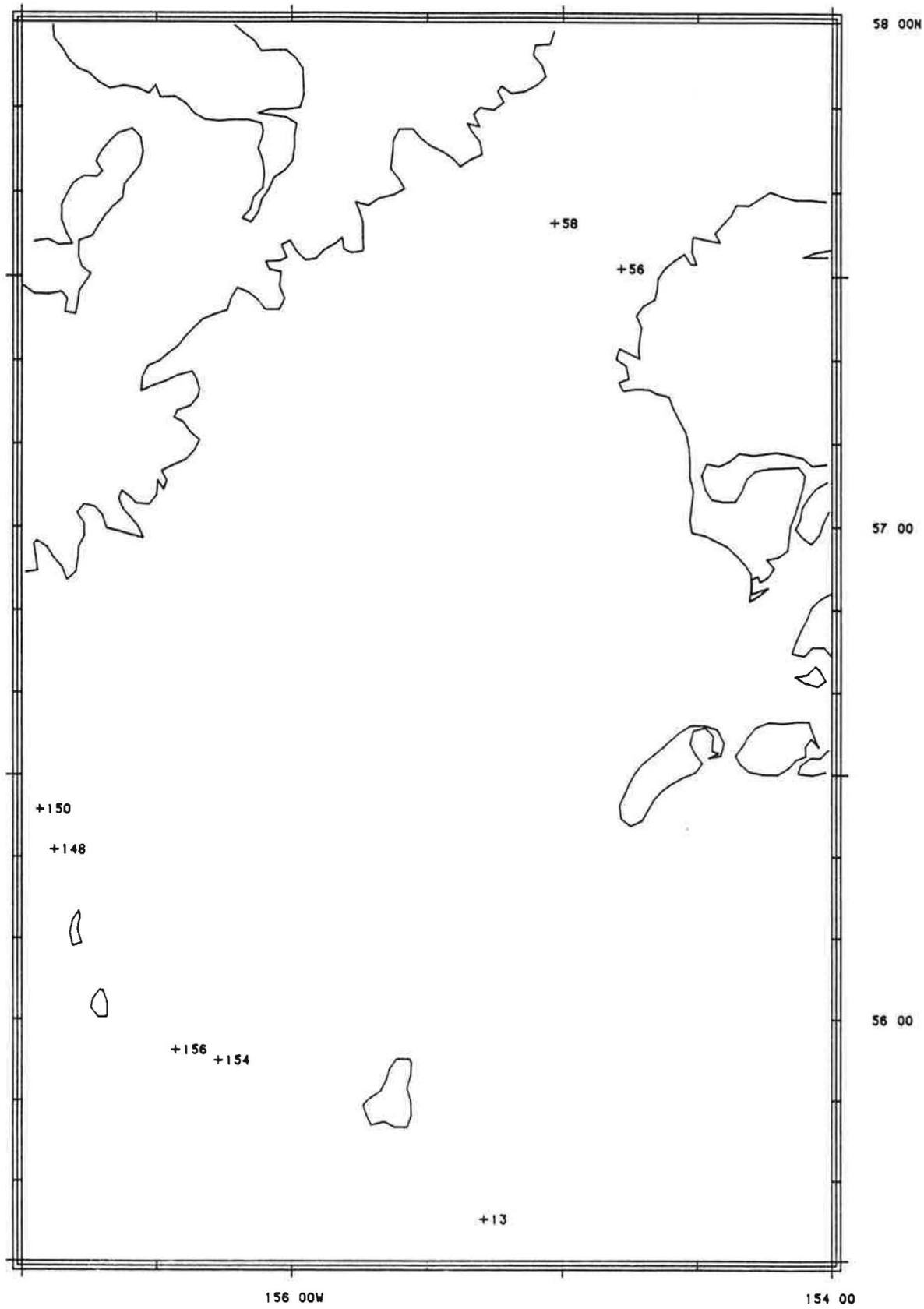


Figure 94.--Station locations for cruise 10C-86, July 28-August 16, 1986.

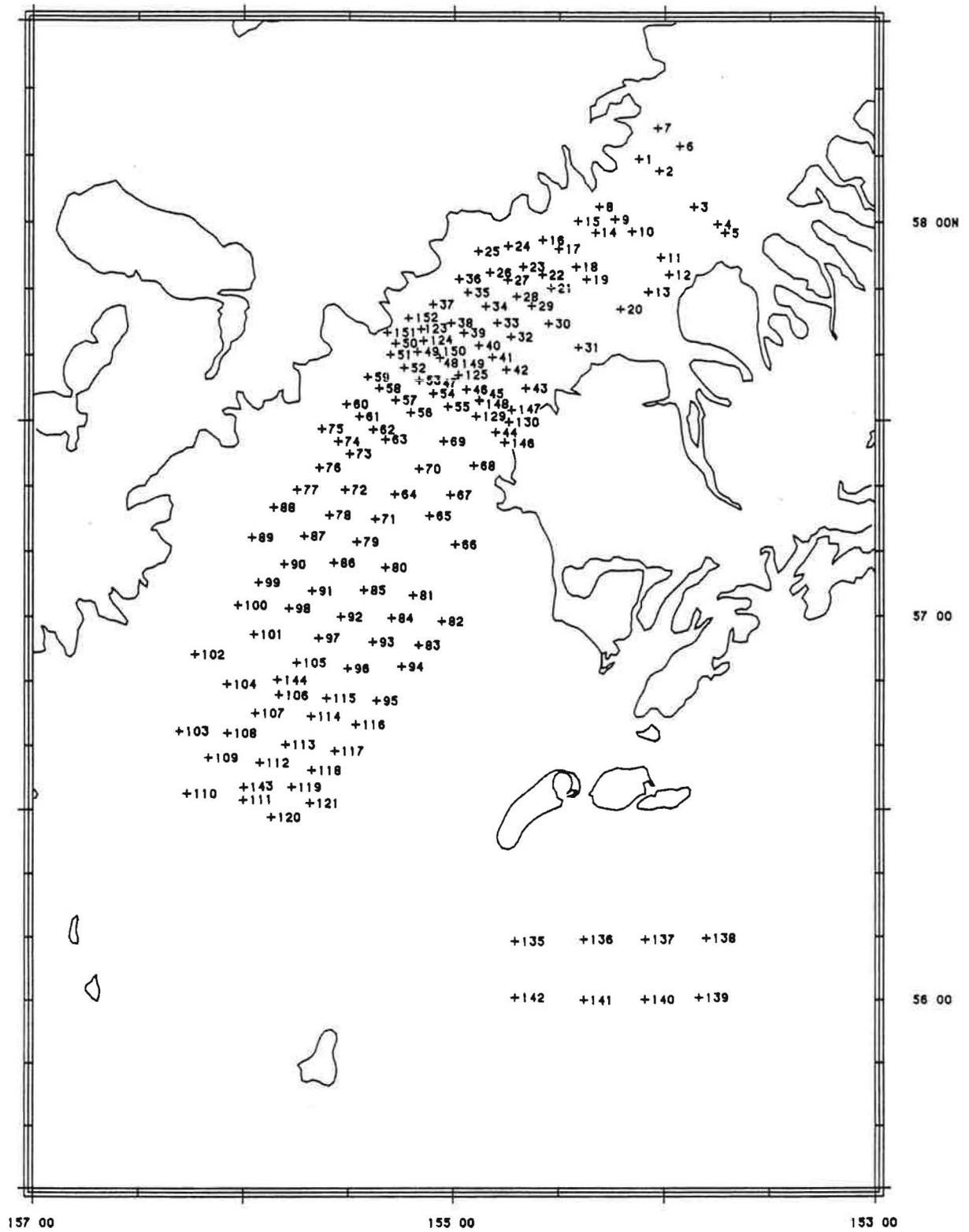


Figure 95.--Station locations for cruise 2MF-87, April 2-17, 1987.

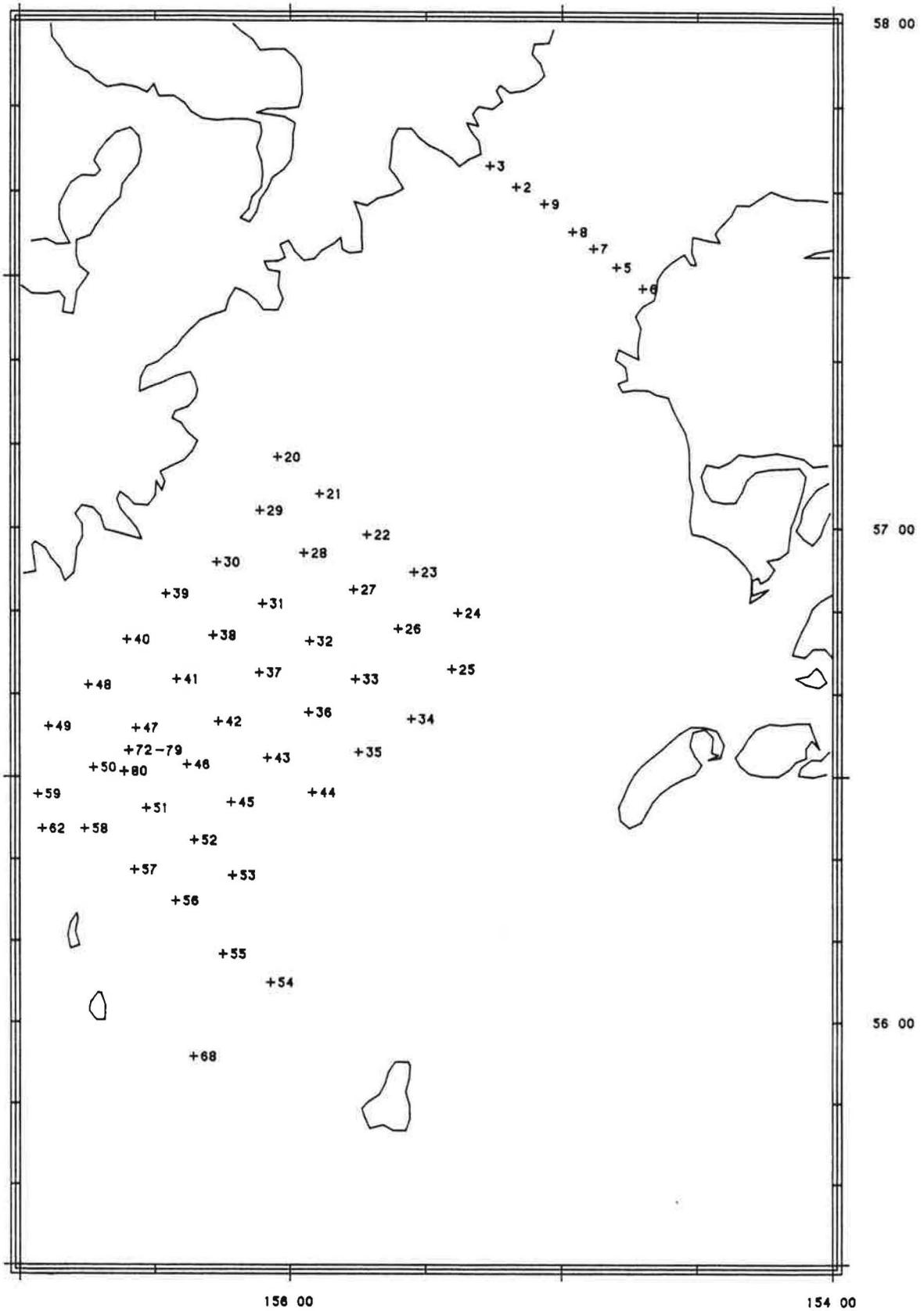


Figure 96.--Station locations for cruise 3MF-87, May 18-29, 1987.

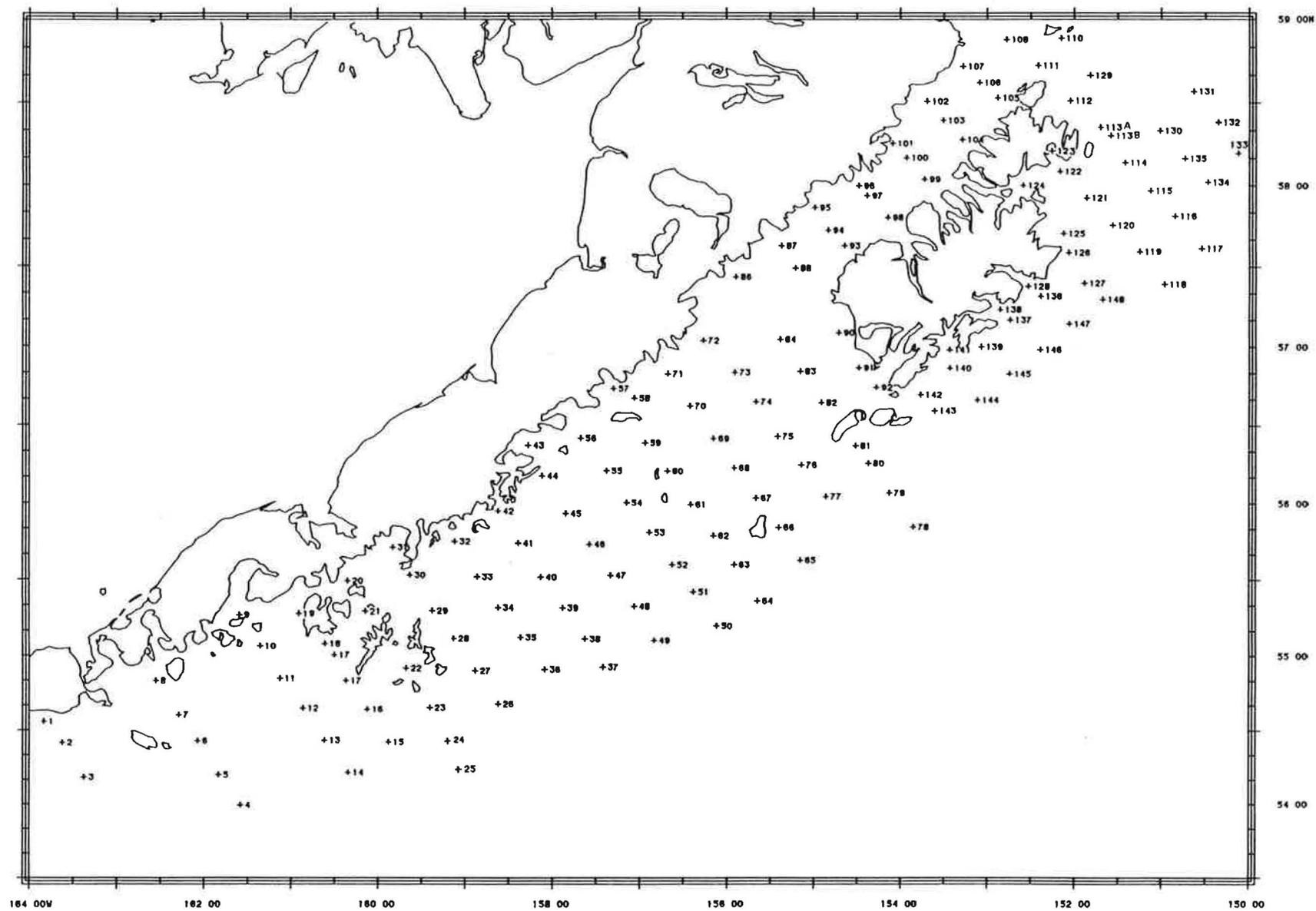


Figure 97.--Station locations for cruise 4MF-87 (legs I and II), June 17-July 16, 1987.

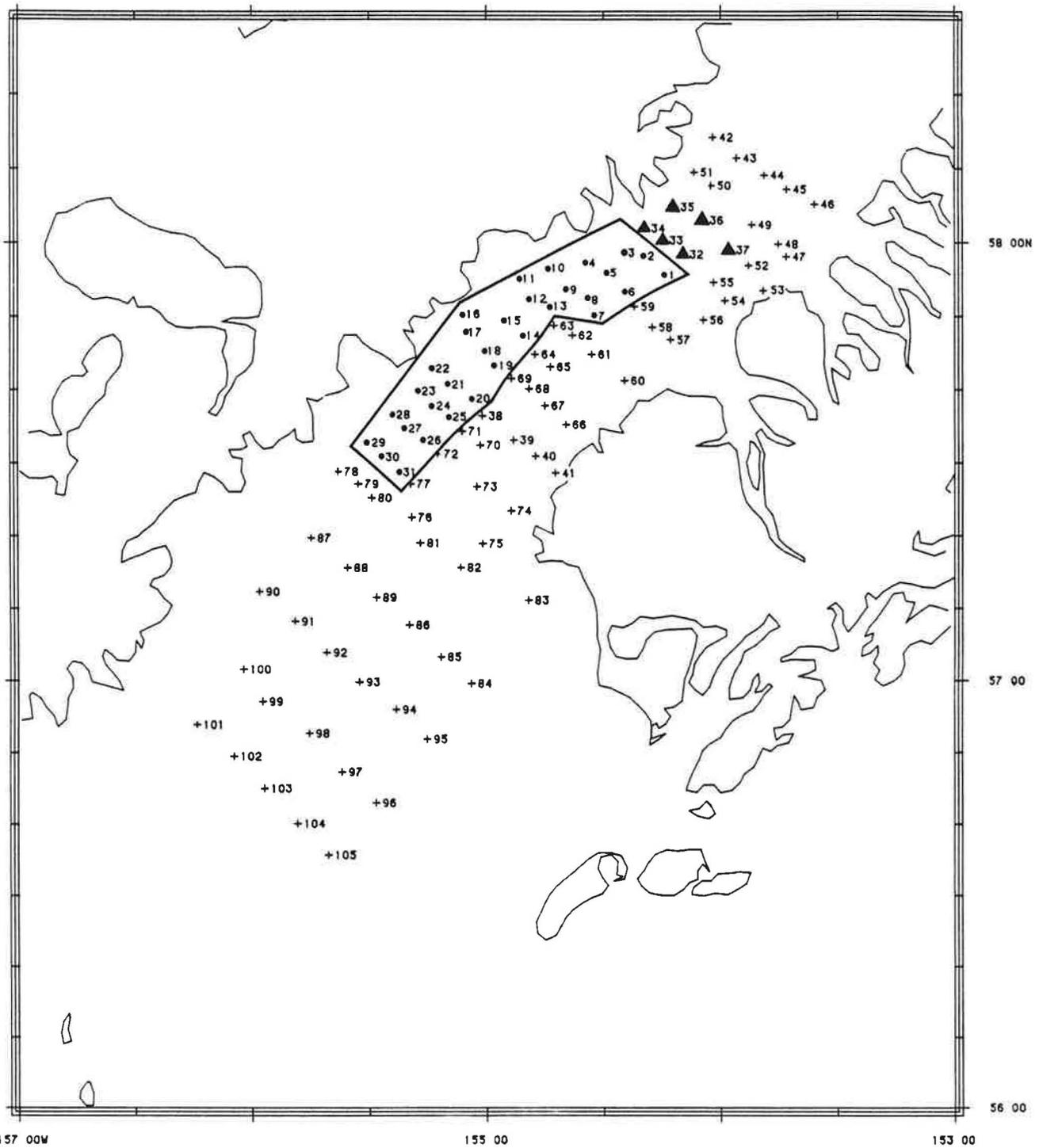


Figure 98.--Station locations for cruise 1MF-88, March 31-April 13, 1988 (● denotes stations sampled 3 times, ▲ denotes stations sampled twice, + denotes stations sampled once. The black border encases the presurvey area).



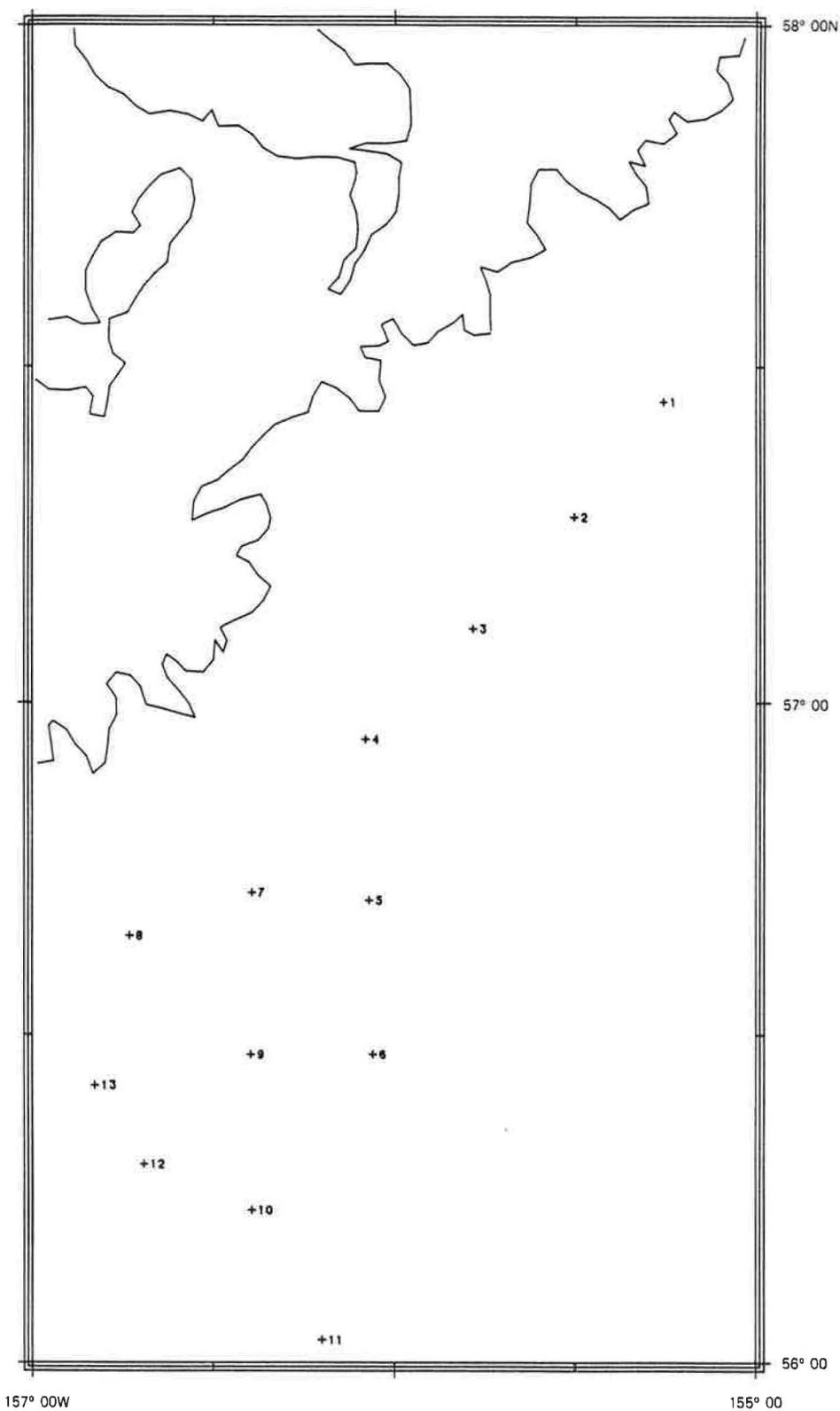


Figure 100.--Station locations for cruise 3MF-88, May 5-14, 1988.

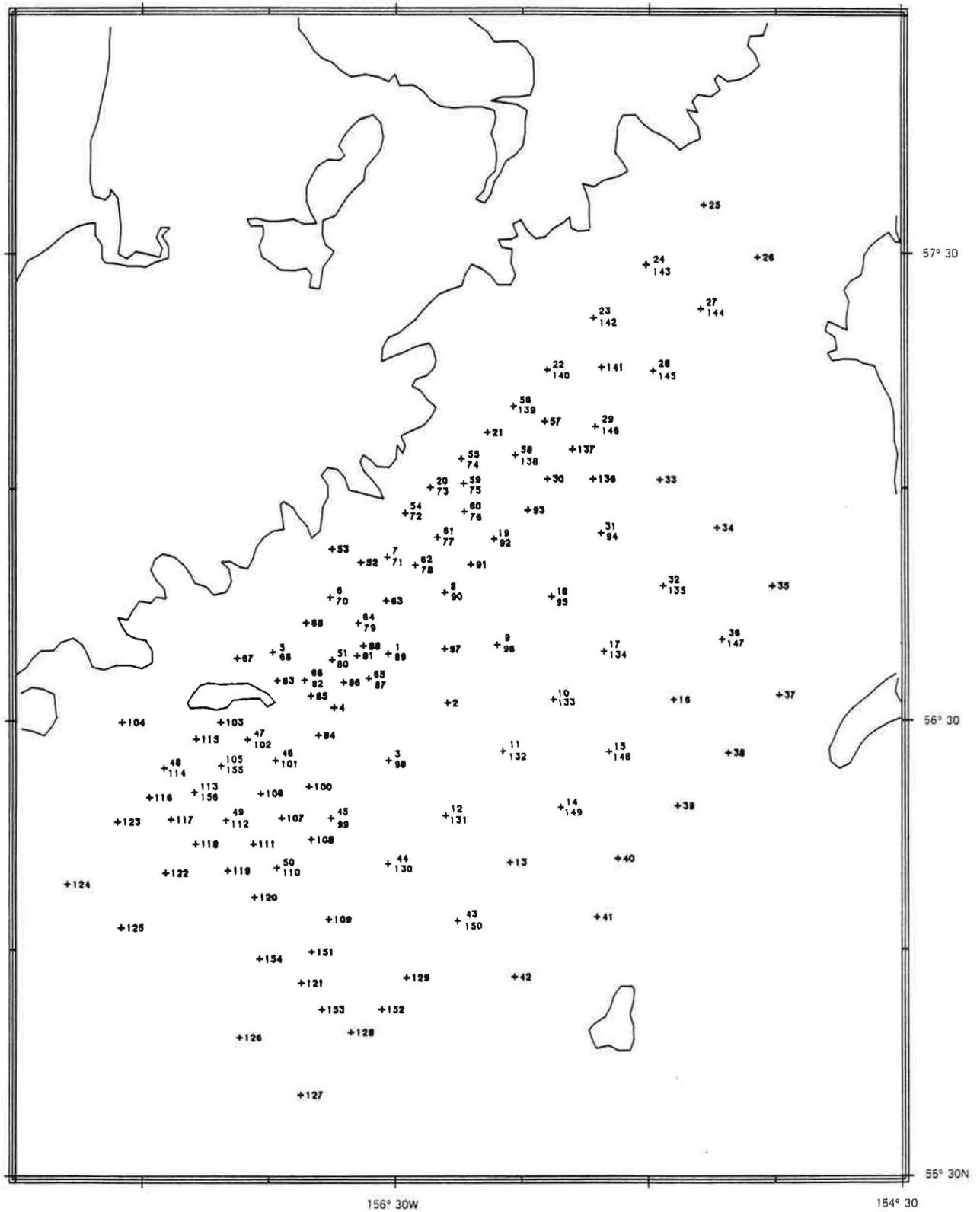


Figure 101.--Station locations for cruise 4MF-88, May 20-June 6, 1988.