NOAA Technical Memorandum NMFS-AFSC-118

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

September 2000

NOAA Technical Memorandum NMFS

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This document should be cited as follows:

Wilson, C. D., M. A. Guttormsen, K. Cooke, M. W. Saunders, and R. Kieser. 2000. Echo integration-trawl survey of Pacific hake, Merluccius productus, off the Pacific coast of the United States and Canada during July-August, 1998. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-118, 103 p.

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September 2000

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ABSTRACT

Results are presented for the eighth triennial echo integration-trawl (EIT) survey of Pacific hake, *Merluccius productus*, along the west coasts of the United States and Canada during the summer 1998. Scientists from the United States and Canada conducted the joint survey aboard two research vessels. The increased Canadian effort during this coastwide survey occurred because of an anticipated northward displacement and possible expansion of the Pacific hake distribution in response to the strong 1997-98 El Niño conditions. Results from an intership calibration of the acoustic systems aboard each country's vessel are also reported.

The total area surveyed, based on the efforts of both countries, was greater than any previous EIT survey. The U.S. survey was conducted from 6 July to 27 August 1998, and extended along the Pacific coast from Monterey, California (37°N), to Queen Charlotte Sound, British Columbia (51°N). The Canadian survey was conducted from 4 to 24 August, 1998, and covered the area beginning at the northern limit of the U.S. survey and progressed northward to Cape Spencer (58°N), then southward through Dixon Entrance, Hecate Strait, and Queen Charlotte Sound.

Aggregations of Pacific hake were detected throughout the study area. The heaviest Pacific hake echo sign observed from the U.S. vessel occurred off south-central Oregon between about 42-44°N, near the U.S. (Washington)–Canada border, and along the continental shelf break in Queen Charlotte Sound. Canadian survey results documented concentrations along the central portions of the west coasts of the Queen Charlotte and Chichagof Islands, near the entrance to Dixon Entrance, in northern sections of Hecate Strait, and throughout Queen Charlotte Sound. Trends in size composition for Pacific hake exhibited a latitudinal cline over the study area, with larger fish generally more abundant in the northern areas. Overall, 68% of the population was composed of the 1993-96 year classes. The coastwide estimate of Pacific hake was 2.6 billion fish weighing 1.19 million metric tons (t), which represents a decrease of about 14% from the 1995 estimate of 1.39 million t.

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INTRODUCTION

Pacific hake (*Merluccius productus*), also called Pacific whiting, is an important commercial marine fish off the west coast of North America, with annual harvests in excess of 200,000 metric tons (t) by U.S. and Canadian fishermen (Dorn et al. 1999). Echo integration-trawl (EIT) surveys to assess the distribution, abundance, and biology of Pacific hake have been conducted triennially along the U.S. and Canadian Pacific coast since 1977 by Alaska Fisheries Science Center (AFSC), National Marine Fisheries Service (NMFS) scientists (Wilson and Guttormsen 1997), and annually along the Canadian west coast since 1990 by Pacific Biological Station (PBS), Department of Fisheries and Oceans (DFO) researchers (Cooke et al. 1996; Cooke and Kieser 1997). The triennial surveys in 1995 and 1998 were carried out jointly by AFSC and DFO researchers and included inter-ship calibrations of the acoustic systems. All surveys were conducted in the summer months (July-September) when Pacific hake are in feeding aggregations along the continental shelf break from northern California to Queen Charlotte Sound. Movement is believed to be minimal and the stock fully available to the survey during this time of year (Nelson and Dark 1985).

The surveys are a key data source for the joint Canada/U.S. Pacific hake stock assessment (Dorn et al. 1999). The time series of survey estimates of abundance and age composition is used in an age-structured assessment model to estimate Pacific hake abundance. The most recent estimates of stock size from the model are used in forward projections to provide advice on future harvests.

Bottom trawl surveys conducted by the AFSC in the summer during the same years as the AFSC EIT surveys assess the near-bottom component of the stock (Nelson and Dark 1985). Stock assessments before 1993 added abundance estimates derived from the U.S. bottom trawl and the EIT surveys. Subsequent modelling efforts have treated each survey time series separately in evaluating trends in the population and have considered estimates from EIT surveys since 1992 as the best estimates of total population biomass (Dorn 1996).

This document summarizes the results of the eighth triennial survey, conducted jointly by U.S. and Canadian scientists aboard the NOAA ship *Miller Freeman* and the Canadian Coast Guard ship (CCGS) *W.E. Ricker*, respectively, during the summer of 1998.

METHODS

The U.S. survey (cruise number MF98-10) was conducted aboard the NOAA ship *Miller Freeman*, a 66 m stern trawler equipped for fisheries and oceanographic research. The Canadian survey (cruise number 98HAK2/9821) was conducted aboard the CCGS *W.E. Ricker*, a 58 m stern trawler, similarly equipped.

Acoustic Data Acquisition

Both vessels collected acoustic data with a Simrad EK500 quantitative echosounding system (Simrad 1993a, Bodholt 1990, Bodholt and Solli 1992). Simrad 38 kHz and 120 kHz split-beam transducers were located on retractable mounts on each vessel. Transducers remained lowered during all scientific operations. The NOAA ship *Miller Freeman*'s centerboard positioned the transducers 9 m below the ocean surface; the CCGS *W.E. Ricker*'s ram extended the transducers to 4.5 m below the surface. Results presented here are based on data collected with the 38 kHz transducers. Acoustic backscatter data from the Simrad EK500 echosounders were logged with Simrad BI500 software to SUN workstations (Foote et al. 1991, Simrad 1993b). Echo integration data were collected aboard the CCGS *W.E. Ricker* at greater than 1 to 0.5 Hz ping rate with a vertical resolution of 1 m and a horizontal resolution of about 5 – 10 m at a typical vessel speed of 4.6 m/sec. Echo integration data were sampled aboard both vessels with a horizontal resolution of about 9 m and vertical resolution of 1-2 m.

Digital echograms were scrutinized using Simrad BI500 echo editing/integration software to partition the acoustic information into major species groups and to remove noise. Color echograms were recorded on Hewlett-Packard printers to aid researchers in assigning echo sign and to compare fish distributions and species assignments from both vessels. SeaPlot (Advanced Marine Technology Corp., Box 1848, Seattle, WA 98111-1848) navigation and charting software was used to log position information on both vessels. Additional data processing and mapping methods unique to each agency are described later in this report.

Survey Design

The survey effort was split between the two vessels. The NOAA ship *Miller Freeman* covered the area from Monterey, California (37°N), to Queen Charlotte Sound, British Columbia (51°N; Fig. 1a), and the CCGS *W.E. Ricker* surveyed the area from Queen Charlotte Sound to about the northern limit of the Pacific hake distribution near Cape Spencer, Alaska (58°N; Fig. 1b). As in previous surveys, a pre-determined series of parallel east-west transects at 18.5 km spacing were used for areas south of about Queen Charlotte Sound. Transect spacing off southwest Vancouver Island was reduced to 9.3 km to more closely correspond to the survey pattern historically used by Canadian scientists (Andrews et al. 1994, Cooke et al. 1996). A combination of parallel and zigzag transects were used to survey the areas north of Queen

Charlotte Sound (Fig. 2). This pattern was chosen because a northward shift in Pacific hake distribution was expected to occur in response to changing ocean conditions and the northern limit of the distribution was not well defined. The trackline pattern enabled the vessel to cover more area than would have been possible using only parallel transects.

Bottom depths at the nearshore ends of transects covered by the NOAA ship *Miller Freeman* (excluding four transects north of Vancouver Island) ranged between about 20 and 100 m (mean 60 m) while the offshore ends were often in waters deeper than 1,500 m. Transects were extended if fish echo sign was found at or near the predetermined transect endpoints.

Typical vessel speed was about 6.0 m/sec for the NOAA ship *Miller Freeman* and 4.6 m/sec for the CCGS *W.E. Ricker* when running transects. Transects were only run during daylight hours (about 15 hours per day) by both vessels. Nighttime hours on the NOAA ship *Miller Freeman* were used on an opportunistic basis to collect Pacific hake target strength data, conduct trawl hauls on Pacific hake echo sign not sampled during the day, investigate aggregations of other midwater fishes and macrozooplankton, and conduct other ancillary projects. Night operations on the CCGS *W.E. Ricker* were used to conduct conductivity-temperature-depth (CTD) sampling.

Trawling Operations

Trawling operations were conducted from both vessels to aid in the interpretation of the acoustic data. U.S. researchers aboard the NOAA ship *Miller Freeman* sampled midwater echo sign using an Aleutian Wing 30/26 trawl (AWT), a full-mesh wing trawl constructed of nylon except for polyethylene toward the aft section of the body and the codend. The headrope and footrope both measured 81.7 m. Stretch mesh sizes tapered from 3.25 m in the forward section of the net to 8.9 cm in the codend. The codend was fitted with a 3.2 cm mesh liner. The AWT was fished with 82.4 m of 1.9 cm diameter 8 by 19 non-rotational dandylines, 227 or 340 kg tom weights on each side, and 5 m^2 Fishbuster doors (1,250 kg).

Scientists aboard the NOAA ship *Miller Freeman* sampled fish on and near the bottom with a polyethylene Nor'eastern (PNE) high-opening bottom trawl equipped with roller gear. The trawl was constructed with stretch mesh sizes that ranged from 13 cm in the forward portion of the net to 8.9 cm in the codend. The codend was fitted with a 3.2 cm mesh liner. The 27.2 m headrope held 21 floats (30 cm diameter). A 24.7 m chain fishing line was attached to a 24.9 m footrope constructed of 1 cm diameter 6 by 19 wire rope wrapped with polypropylene rope. The 24.2 m roller gear was constructed with 36 cm diameter rubber bobbins spaced 1.5-2.1 m apart. A solid string of 10 cm diameter rubber disks separated some of the bobbins in the center section of the roller gear. Two 5.9 m wire rope extensions with 10 and 20 cm diameter rubber disks spanned the two lower flying wing sections and were attached to the roller gear. The roller gear was attached to the fishing line using chain toggles (2.9 kg each) comprised of five links and one ring. The trawl was rigged with triple 54.9 m galvanized wire rope dandylines. The net was fished with the Fishbuster doors.

Midwater and bottom trawl hauls aboard the NOAA ship *Miller Freeman* were monitored with a WesMar TCS600E third wire trawl sonar or a Furuno CN-10B wireless net sounder system attached to the headrope of the trawl. Vertical net opening, depth, and temperature at depth were measured. The AWT and PNE vertical mouth openings averaged 23 m and 7 m, respectively.

Canadian trawling operations were carried out with a midwater Polish rope trawl with a 20 m vertical opening and 1 cm cod end mesh with a pair of 5 m^2 'USA JET' combination trawl doors (1,100 kg), and 80 m sweep wires with 300 kg chain weights. A Simrad FS3300 third wire headrope trawl sonar and a Simrad ITI net mensuration system were used to monitor and guide the fishing process.

Macrozooplankton were sampled from the NOAA ship *Miller Freeman* by conducting oblique tows to 250 m depth with a Methot trawl (Methot 1986). The mouth of the trawl was a rigid square frame with 2.3 m sides. A 1.83 m dihedral depressor modified from an Isaacs-Kidd midwater trawl was suspended below the frame. Mesh sizes were 2 by 3 mm in the main part of the net and 1 mm in the codend. The Methot trawl was attached to a single cable fed through a stern-mounted A-frame. The volume of water filtered was measured with a calibrated General Oceanics flow meter attached to the mouth of the net. The trawl was lost at sea on 21 July when the cable broke. A 0.5 m Bongo net (333 μm mesh size) was used as a substitute until a replacement Methot trawl was obtained on 6 August.

Canadian researchers collected zooplankton samples at discrete depths using a Tucker trawl with a 1 m^2 mouth opening and 335 micron black nitex mesh. Each of the three nets on the Tucker trawl was equipped with a calibrated General Oceanics flowmeter

Physical Oceanographic Data Collection

Various physical oceanographic data were collected by U.S. and Canadian researchers to contribute to ongoing studies of the bio-physical factors influencing the distribution and movement of Pacific hake. Information was systematically collected to describe ocean temperature, salinity, and current velocity.

U.S. researchers collected vertical profiles of salinity and temperature data with a Seabird CTD system at the acoustic calibration sites, some trawl haul locations, and a few other locations during the survey. Expendable bathythermograph (XBT) data were systematically collected north of 41°N to generate vertical temperature profiles every 0.5 degree of latitude along transects at the offshore endpoints, and over bottom depths of 150 and 400 m, and at several haul sites. Temperature/depth profile data were collected during most trawl hauls by attaching a micro bathythermograph (MBT) to the trawl headrope or the Methot frame. Sea surface temperature, salinity, meteorological, and sea state data were collected using the NOAA ship *Miller Freeman*'s Scientific Collection System. Ocean current velocity profile data were obtained using a 150 kHz narrow band acoustic Doppler current profiler (ADCP) system (RD Instruments, 9855 Businesspark Ave., San Diego, CA 92131) with the transducer mounted in the centerboard. The ADCP was slaved to the EK500 to avoid interference. It was operated continuously throughout the cruise.

Canadian scientists collected CTD data at pre-selected stations using a Guildline CTD (8770 series) with 1 m resolution. CTD stations, separated by approximately 1 km, were located on selected transects near the shelf break. Sea surface temperature and salinity measurements were recorded every 15 seconds from a Seabird thermosalinograph (SBE21). Ocean current velocity profile data were collected continuously using a 150 kHz narrow band ADCP with a ram-mounted transducer. The ADCP was not slaved to the EK500 and may have interfered to some degree with 120 kHz data collection.

Biological Sampling

Trawl hauls were made on selected echo sign to provide information on Pacific hake and to identify the biological composition of associated fish and other organisms. The U.S. researchers used standard catch sorting and enumeration procedures to process the catches (Hughes 1976). Catches less than 900 kg were completely sorted, while larger catches were subsampled. Total numbers and weights were determined for all species. Weights were determined to the nearest 0.1 kg for the sorted portions of the catch using an electronic, motion-compensating scale (Marel M60). Pacific hake were subsampled to determine fork length (FL) composition by sex, as well as to collect stomachs, otoliths, maturity and length-weight measurements of individual fish. Individual fish weights to the nearest 2 g were determined using a Marel M60 scale, and lengths to the nearest centimeter were determined using a polycorder measuring device (Sigler 1994). Sexual maturity was determined by visual inspection using an 8-stage scale (ADP Code Book, 1999, RACE Division, AFSC, Seattle WA 98115). Stomach samples were preserved in 10% buffered formalin and otoliths in 70% ethanol.

Trawl catches on board the CCGS *W.E. Ricker* were spilled from the codend into a below-deck hopper and sorted by species off a conveyor belt into tubs. All tubs of fish were weighed to the nearest 0.5 kg on a Marel M60 scale. Representative subsamples of Pacific hake were selected by retaining at least 3 tubs of fish from the start, middle and end of the hopper load for routine biological sampling. For small hauls, the entire catch was sampled. Sex, maturity (Weir et al. 1978), fork length to the nearest millimeter, and weight to the nearest gram were recorded for all Pacific hake sampled. Individual fish weights were determined using the Marel M60 scale. Otoliths were collected and stored in a 1/1 glycerine/freshwater solution with thymol at 0.3% for subsequent age determination. Stomach contents of Pacific hake from 1 or 2 tubs were examined, and prey items were identified to the lowest possible taxon. The volume of each prey item was estimated visually to the nearest 1 cc. The state of digestion was recorded for each prey item, and any identifiable Pacific herring (*Clupea pallasi*) remains were counted and measured.

Data Analysis

Echo integration data were examined for Pacific hake echo sign from 5 m below the transducer to generally within 0.5 m of the bottom echo, or to a depth of 500 m in deeper water. Considerable quantities of small, non-hake scatterers were encountered throughout much of the water column in the Monterey, Eureka, and Columbia International North Pacific Fisheries Commission (INPFC) statistical areas. An acoustic volume backscattering (S_V) threshold value of –58.5 dB was used for these regions, whereas -69 dB was used for all other areas, where small scatterers were less abundant. The higher threshold was used in the south to avoid including significant quantities of non-hake scatterers in biomass estimates. This was the same procedure that was applied to the 1992 and 1995 U.S. West Coast Pacific hake EIT survey data (Dorn et al. 1994, Wilson and Guttormsen 1997).

Estimates of Pacific hake absolute abundance were derived from the echo-integration and trawl data in the following manner. Echograms and catches were examined to define geographic areas with similar Pacific hake echo signatures and fish length distributions. The process was carried out to combine aggregations of Pacific hake with similar echo features and length distributions.

The nautical area backscattering coefficient (s_A) estimates for geographic areas with regular spaced transects were based on the average of all s_A values from a given area. For the CCGS *W.E. Ricker* data, an area-weighted average s_A was used in areas with irregularly spaced transects using GIS procedures that weighed each s_A by its surrounding area (Kieser et al. 1998). Both methods generated similar results.

The average s_A values for each geographic area were then scaled to age- and length-specific fish numbers and biomass using Pacific hake length distributions, a length-weight relationship and age-length keys derived from trawl catches, and a standard target strength (TS) and fish length relationship (TS= 20 log L - 68; Traynor 1996). Estimates of age- and length-specific numbers and biomass were then summed across geographic strata to provide estimates for each area and a total coastwide estimate.

Acoustic System Calibration

The U.S. and Canadian acoustic systems were calibrated in the field before and after the survey (Table 1). The calibration procedure involves suspending copper spheres with known backscattering cross sections below the transducers and measuring the acoustic returns following standard procedures (Foote et al. 1987, MacLennan and Simmonds 1992). Each vessel was anchored at the bow and stern during the calibration. Sphere diameters were 60 and 23 mm for the 38 and 120 kHz transducers, respectively. Split-beam target strength and echo-integration data were collected to calculate echosounder gain parameters and transducer beam pattern characteristics. Sounder gain parameters were adjusted, if needed, to include the calibration results.

U.S./Canadian Acoustic Systems Comparison

An intercalibration of the Simrad EK500 acoustic systems aboard the NOAA ship *Miller Freeman* and the CCGS *W.E. Ricker* was conducted 21-23 August. Acoustic data at 38 kHz were collected along 20 southeast-northwest oriented transects about 80 km northwest of the northern end of Vancouver Island. A portion of data from one transect was discarded because vessel tracks did not correspond owing to a navigational error. Transects were run over bottom depths of 60 to 260 m and varied in length from 13 to 21 km. The vessels alternated lead position after each pair of transects with the following vessel about 0.9 km directly astern of the lead vessel. Vessel speeds were about 3-4 m/sec.

Target Strength Data Collection

When conditions were suitable for collection of *in situ* TS data (e.g., low fish density, single-species aggregations, unimodal size distribution, and calm seas), the NOAA ship *Miller Freeman* would repeat passes at speeds of less than 2 m/sec over aggregations of Pacific hake. If the echo sign was deeper than about 150 m, the vessel was stopped and a 38-kHz transducer was lowered to a depth just above the fish sign. A CTD unit mounted onto the transducer housing was used to measure tilt angles of the transducer. Trawl hauls were conducted in conjunction with the acoustic TS data collection to gather biological data of the targeted aggregation.

Acoustic Buoy Observations

The behavior of Pacific hake in response to vessel noise was assessed by scientists aboard the NOAA ship *Miller Freeman* using a freely drifting buoy capable of acoustic data collection. The buoy consisted of an aluminum cylinder (length 130 cm, 60 cm diameter) with a donut-shaped Ionomer foam floatation collar and mast on top. A bulkhead separated the cylinder into an upper instrument and lower battery compartment, which were accessed by removing the appropriate aluminum end cap at either end of the buoy. The acoustic-buoy electronic components included a Simrad EY500 echosounder operating at 38 kHz, communications hardware, and other instrumentation. Four 100 ampere-hour gel cell batteries powered the buoy; one battery powered the Argos/GPS transceiver while three powered the remaining instruments. The total weight of the buoy was about 300 kg.

Data were stored onboard the buoy and telemetered directly to the NOAA ship *Miller Freeman*. A UHF radio link between the buoy and vessel was used to control the echosounder, receive buoy positions based on GPS, and generate echograms aboard the vessel in real time. The GPS data from the buoy were also transmitted via an Argos satellite system to the vessel to locate the buoy in the event that visual, radar, and direct radio contact were lost. A split-beam transducer and heading sensor were suspended 6.5 m below the buoy, and a copper calibration sphere was suspended about 25 m below the transducer. Transducer heading data from the buoy were collected and used in analyses to assess the direction of the fish response to the approach of the vessel.

The primary objective of the acoustic buoy deployment was to determine whether a change occurred in the estimates of total water-column s_A estimates attributed to Pacific hake as a result of vessel noise generated while free-running at normal survey vessel speed (6 m/sec). Acoustic data were collected from the buoy while the vessel steamed as close as possible past the buoy after starting from a distance about 2 km away. The NOAA ship *Miller Freeman* maintained its speed and direction until it was at about 2 km past the buoy, where it remained until beginning another pass 10-15 minutes later. The vessel path during each pass was conducted perpendicular to the buoy drift-trajectory to minimize the disturbance to fish that were in the path of the buoy and that might be encountered during subsequent passes.

RESULTS

The area of operations for the joint U.S.-Canada survey extended along the west coast of North America from Monterey, California, to Cape Spencer, Alaska (Fig. 1). The survey area was divided into geographical subareas which were used for the analysis of the survey data (Table 2, Fig. 2). Geodetic positions are reported in degrees and decimal minutes. The total area surveyed, based on the efforts of both countries, was greater than any previous Pacific hake EIT survey. The U.S. survey (Fig. 1a) was conducted from 6 July to 27 August 1998, and extended from Monterey, California (37°N), to Queen Charlotte Sound, British Columbia (51°N). About 6,700 km of parallel acoustic transect lines (excluding north-south cross transects) were run by the NOAA ship *Miller Freeman*. The Canadian survey (Fig. 1b) was conducted between 4 and 24 August 1998. It started in Queen Charlotte Sound (51°N) and progressed northward to Cape Spencer (58°N), then southward from Dixon Entrance through Hecate Strait and Queen Charlotte Sound. About 4,500 km of zigzag and parallel transects (including cross transects) were run by the CCGS *W.E. Ricker*. Location, date, and time of each transect of the Canadian survey are listed in Appendix Tables 1a-d and shown in Appendix Figures 1a-d.

Biological and Oceanographic Sampling

Researchers aboard the NOAA ship *Miller Freeman* conducted 95 midwater trawls and 13 bottom trawls (Fig. 1a; Table 3), and aboard the CCGS *W.E. Ricker* conducted 33 midwater trawls (Fig. 1b; Table 4; Appendix Table 2) to identify echo sign and collect biological data. Pacific hake was the dominant fish species by both weight and number from midwater trawls aboard the NOAA ship *Miller Freeman* (Table 5). The most common bycatch species were Pacific herring (4.0% of the total midwater catch by weight), yellowtail rockfish (*Sebastes jordani*, 1.8%), and jack mackerel (*Trachurus symmetricus*, 1.7%). Pacific herring were caught mostly in the South Vancouver, U.S. Vancouver, and North Columbia INPFC areas. Yellowtail rockfish was caught mostly in the South Vancouver and U.S. Vancouver INPFC areas. Most of the jack mackerel (87%) were caught in Haul 11 (Monterey INPFC area).

Pacific hake was the dominant fish species by both weight and number in midwater trawls conducted aboard the CCGS *W.E. Ricker* (Table 6). The most common species of bycatch by weight were yellowtail rockfish (2.2%), walleye pollock (*Theragra chalcogramma*, 2.1%) and widow rockfish (*Sebastes entomelas*, 0.7%). The walleye pollock were mainly found in Dixon Entrance and to the north. Pacific sardines (*Sardinops sagax*) were caught in Hecate Strait (Haul 24) and in the Gulf of Alaska (GOA, Haul 14) just south of 56°N. The sardines in Hecate Strait were caught with Pacific herring at about 40 m whereas the GOA haul was a surface (0-12 m) tow that caught only sardines and pink salmon (*Oncorhynchus gorbuscha*).

Pacific hake was the dominant fish species by weight in bottom trawls conducted aboard the NOAA ship *Miller Freeman* although shortbelly rockfish (*Sebastes jordani*) were more numerous (Table 7). The most commonly caught bycatch species by weight were shortbelly rockfish (22.3%), spiny dogfish (*Squalus acanthias*, 13.7%), redstripe rockfish (*Sebastes proriger*, 7.5%), sablefish (*Anoplopoma fimbria*, 2.5%), chilipepper (*S. goodei*, 2.4%) and Dover sole (*Microstomus pacificus*, 2.0%). Haul 1 contained all but one of the shortbelly rockfish and most of the spiny dogfish bycatch. Haul 29 contained most of the redstripe rockfish bycatch. The sablefish bycatch was taken mostly in the North Columbia INPFC area. All of the chilipepper bycatch occurred in the Monterey INPFC area. The Dover sole bycatch was primarily taken in the Eureka INPFC area.

Researchers aboard the NOAA ship *Miller Freeman* conducted 18 Methot trawls and 5 bongo tows (Fig. 3; Table 8), and those from the CCGS *W.E. Ricker* conducted 6 Tucker trawls (Appendix Fig. 1b; Table 9) to target echo sign believed to be primarily macrozooplankton and micronekton. Physical oceanographic data consisted of 89 MBT, 38 CTD, and 95 XBT casts from the NOAA ship *Miller Freeman* (Fig. 4; Tables 3,10,11) and 46 CTD casts from the CCGS *W.E. Ricker* (Fig. 5; Table 12).

Pacific Hake Distribution and Abundance

Aggregations of Pacific hake were observed throughout the study area except south of 38°N, where no echo sign was assigned to Pacific hake (Figs. 6a-b). The densest Pacific hake echo sign observed from the NOAA ship *Miller Freeman* occurred off California near 42°N, off central Oregon from 43° to 44°N, over Juan de Fuca Canyon near Cape Flattery, and off northern Vancouver Island from 50°30'N to Queen Charlotte Sound at 51°28'N (Fig. 6a). Pacific hake echo sign observed from the CCGS *W.E. Ricker* was distributed as far north as about Cape Spencer (58°N) along the shelf break, and in Dixon Entrance, Hecate Strait, and Queen Charlotte Sound (Fig. 6b). The heaviest concentrations were found in Queen Charlotte Sound, the central section of the west coast of the Queen Charlotte Islands, and in southern Dixon Entrance.

The coastwide estimates of Pacific hake abundance were 2.6 billion fish weighing 1,194,000 t. The U.S. estimates for areas south of the Queen Charlotte Islands were 2.2 billion fish, weighing 905,000 t. Canadian estimates for the remaining survey area were 400 million fish weighing 289,000 t.

Pacific hake were observed over all bottom depths surveyed (80–2,000 m); however, bottom depth preference varied with latitude. The largest concentrations offshore occurred in 300-600 m from 42°N to 44°N, whereas the densest concentrations occurred over bottom depths of 100-200 m from 44°N to 50°30'N. From 50°30'N to the northern boundary of the survey area, much of the echo sign was detected over bottom depths greater than 300 m. At 51°N a significant amount of Pacific hake was observed over bottom depths exceeding 1,500 m. Throughout the waters of Dixon Entrance, Hecate Strait, and Queen Charlotte Sound, Pacific hake biomass was densest over bottom depths ranging from 80 to 200 m.

Pacific hake size composition differed over the study area (Fig. 7; Tables 13 and 14). Smaller fish (≤40 cm FL) dominated abundance estimates in the Monterey and Eureka INPFC area. In the Columbia INPFC area, however, roughly similar numbers of smaller (≤40 cm FL) and larger (>40 cm FL) fish occurred. Adult fish (>40 cm FL) were generally most abundant in the northern areas. The size of adult fish tended to increase with latitude. For example, the modal length for adult fish was 41 cm FL in the Monterey INPFC area, 43 cm FL in the Eureka and South Columbia INPFC areas, 44 cm FL in the North Columbia and U.S. Vancouver INPFC areas, 45 cm FL in the South and North Vancouver and Charlotte INPFC areas, 47-48 cm FL for the Queen Charlotte Islands and the southern portion of the GOA zone, and 49-50 cm FL in the northern GOA zone. Average fish weights were about 0.42 kg from the U.S. estimates and 0.73 kg from the Canadian estimates. The size composition data for Pacific hake for each haul are presented in Appendix Figures 2-3.

Age-specific distributions for Pacific hake exhibited similar patterns to those based on length data (Fig. 8, Tables 15-16). Two-year-old fish (1996 year class) were the dominant age group, numerically, in the Monterey and Eureka INPFC areas, whereas 3-year-old fish (1995 year class) were dominant in the Columbia INPFC areas and 5-year-olds (1993 year class) were dominant in the areas north of the Columbia INPFC area. Three-year-old fish were the second-most abundant age group in the Monterey and Eureka INPFC areas, 5-year-old fish in the Columbia INPFC areas and 4-year-old fish (1994 year class) in areas north of the Columbia INPFC area. One-year-old fish were observed intermittently, mostly in the central-northern portions of the survey.

Target Strength Data

In situ target strength data were collected on five occasions from the NOAA ship *Miller Freeman* using the centerboard-mounted transducer (19, 30 July and 8, 9, 12 August) and twice using the lowered transducer assembly (19, 20 August). Catch data from hauls made during nights of TS collections (Hauls 16, 47, 60-61, 64-65, 74, 94, and 96-97) showed unimodal Pacific hake size distributions (Appendix Fig. 2). With the exception of Haul 97, which contained 20% shrimp, Pacific hake made up 92-99% of the catch in numbers from these hauls. Post-cruise analysis of the *in situ* target strength data, however, indicated that targets from smaller scatterers other than Pacific hake likely contaminated the TS data and invalidated the results. Unfortunately, no hauls were made with small mesh nets to verify the presence of contaminant scatterers (e.g., euphausiids) during these nights.

Acoustic Systems Calibration

The two system calibrations were successfully completed on the NOAA ship *Miller Freeman* at the beginning and end of the survey. The 120 kHz acoustic system exhibited a small negative trend in TS and S_V gains with time, while the 38 kHz system remained stable (Table 1).

Because the system parameters did not deviate significantly from previous settings, no adjustments were made for this survey.

Successful calibration of the acoustic system on the CCGS *W.E. Ricker* was carried out before and immediately following the survey (Table 1). Target strength and integration values of the calibration spheres showed high variability owing to fish interference in the acoustic beam. For short periods when fish were not in the beam, however, the observed mean values suggested system gain parameters did not show significant change from the previous calibration and therefore were not adjusted for this survey.

Acoustic Systems Comparison

Results from the inter-ship comparison indicated that the s_A estimates averaged by transect were generally greater for the Canadian system than those for the U.S. system (Fig. 9). The zero-intercept functional regression (Ricker 1973) of transect-averaged U.S. versus Canadian s_A estimates was

$$s_A\,(\text{Can}) = 1.25 * s_A\,(\text{US}).$$

Application of the logarithmic intercalibration model described by Kieser et al. (1987) generated a slope of 1.14 ($P = 0.05$). Application of this model is appealing as it normalizes the rather skewed observed s_A distributions. However, it is less appropriate here as all biomass estimates are based on physical rather than logarithmic units.

The greatest differences in transect-averaged s_A estimates between the two vessels occurred on transects when the Canadian vessel led the U.S. vessel (Fig. 9). In addition, the cumulative plots of 0.1 nautical mile-averaged s_A measurements also indicated that the Canadian data included a greater proportion of larger values than the U.S. data set when the Canadian vessel was leading (Fig. 10). More research is needed to interpret these findings. The noise signature of the Canadian vessel (K. Cooke, PBS, Nanaimo, B.C., unpubl. data) is greater than the U.S. vessel (Gonzalez et al. 1999) and may have tended to scatter the fish distributions just after the vessel had passed. Alternatively, the U.S. vessel may have scattered the fish distributions before the fish were assessed by the vessel. EIT survey results have not been adjusted based on the intercalibration s_A ratios because it is not known which, if either, of the two vessels measures an unbiased s_A. More work needs to be done to understand the density dependence of the s_A ratio and the unexplained leading/trailing effect.

Acoustic Buoy Observations

The NOAA ship *Miller* Freeman deployed the acoustic buoy six times during the survey (Table 17). Areas with reasonably uniform Pacific hake concentrations were selected, and the vessel conducted repeated passes to within 2-20 m of the buoy. A total of 44 passes were completed during daylight periods. Although analyses of the data are in progress, preliminary results suggest that Pacific hake did not exhibit a significant avoidance reaction to the vessel noise.

DISCUSSION

Triennial EIT surveys are designed to cover the entire coastal distribution of Pacific hake. Comparison of abundance trends based on EIT survey results is difficult, however, because of different areal coverage northward and offshore among surveys. In 1983, 1986, and 1989, for example, surveys only sampled seaward to about the 366 m depth contour, while the 1977 and 1980 surveys generally remained inside of the 458 m depth contour. Previous to 1992, the northern limit of the surveys ranged from 48°15'N in 1983 to 50°N in 1977, 1980, and 1989. Dorn (1996) provides a time series of extrapolated biomass estimates for the entire survey history by scaling the 1977-89 survey results to account for differences in areal coverage (Fig. 11). Results show EIT abundance estimates steadily decreased from a high of 2.4 million t in 1986 even after re-scaling. The 1998 biomass estimate of 1.19 million t is the lowest estimate in the history of the surveys and is 14% less than the 1995 estimate of 1.39 million t and is 50% lower than the 1986 estimate.

The strong El Niño conditions of 1997-98 likely affected the summer distribution of Pacific hake. Thus, a greater proportion of the total biomass was observed in Canadian waters in 1998 than in 1995 and 1992. In 1998, 51% of the biomass was observed in U.S. waters, including fish observed off Alaska (5%), whereas 85% of the total biomass was observed in U.S. waters in 1995. In 1992, when weak El Niño conditions existed, about 62% of the total biomass was observed in U.S. waters (Wilson and Guttormsen 1997).

Although no echo sign was assigned to Pacific hake in the area south of about San Francisco, CA (38°N), in the present study, hake were regularly caught in relatively low numbers south of 38°N during the AFSC summer 1998 triennial bottom trawl survey (Dorn et al. 1999). A midwater trawl survey was also conducted concurrently with the NOAA ship *Miller Freeman* survey by the Pacific Whiting Conservation Cooperative (PWCC) aboard the F/V *Predator* and found very few Pacific hake between 34° and 38°N (V. Wespestad, PWCC, 1200 Westlake N. Suite 900, Seattle, WA 98109, unpubl MS.). The inability to detect Pacific hake in this area based on acoustic methods may have occurred because of increased scattering from other species, relatively low densities of hake, and fish which were distributed closer to the bottom than in areas to the north.

Most echo sign from 1-year-old Pacific hake were observed in the northern portion of the survey area, with 72% of the total estimated abundance observed in the Charlotte INPFC area and 10% in the Southeast Alaska INPFC area. In 1992, however, 99.8% of the age-1 estimate occurred in the Monterey and Eureka INPFC areas. Likewise in 1995, about 71% of the age-1 fish occurred to the south in the Eureka and South Columbia INPFC areas, although substantial numbers of age-1 fish were encountered as far north as the North Vancouver INPFC area (Wilson and Guttormsen 1997). Previous to the 1992 EIT survey, 1-year-olds were rarely encountered, although none of those surveys were conducted during years when strong year classes of Pacific hake (i.e., the 1977, 1980, 1984, and 1987 year classes) were present as 1-year-old fish. The estimated abundance of the 1-year-old fish (1997 year class; Table 16) was less than about one-half the estimates of the 1-year-old fish from the 1992 and 1995 EIT surveys (Wilson and Guttormsen 1997). Because the latter year classes were of weak to average strength, there is currently no evidence to suggest that the 1997 year-class strength is above average.

ACKNOWLEDGMENTS

We would like to thank Steve de Blois, NMFS, who drafted the initial cruise report for the U.S. survey. Dan Twohig, NMFS, was instrumental in the acoustic data collection and analyses on board the NOAA ship *Miller Freeman*. Thanks to the captains and crews of the NOAA ship *Miller Freeman* and CCGS *W.E. Ricker* as well to all the others who participated in the survey. Capt. Al Marsden of the Canadian Groundfish Trawl Conservation Society is thanked for his participation and insight on board the CCGS *W.E. Ricker*. Martin Dorn, Bill Karp, and Russ Nelson reviewed the final manuscript.

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Table 1.--Summary of sphere calibrations associated with the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts. TS represents target strength and S_V represents volume backscattering.

Date	Location	Freq (kHz)	Water temp (deg. C) at transducer*	Water temp (deg. C) at sphere	Sphere range from transducer (m)	Gain (dB) TS	Gain (dB) S_V	3dB beam width (deg.	Angle offset along	Angle offset athwart
				Miller Freeman						
30 Jun	Port Susan, WA	38	11.9	9.9	34.2	27.2	27.2	6.81	0.01	-0.04
		120	11.9	10.0	27.5	24.9	25.2	--	--	--
21 Aug	Howe Bay, BC	38	12.7	12.4	29.8	27.2	27.2	6.72	-0.01	-0.04
		120	12.7	12.5	24.0	24.4	24.5	7.20	-0.23	0.16
Jul-Aug	System settings	38	--	--	--	27.1	27.1	6.70	-0.09	-0.02
	during survey	120	--	--	--	25.0	25.0	7.10	0.00	0.02
				W.E. Ricker						
23 Mar	Hotham Sound, BC	38			24.1	27.10	27.16			
		120			22.0	25.35	25.38			
18 Aug	Balcom Bay, BC	38			19.3	27.10	27.00			
		120			16.8	25.15	24.95			
Jul-Aug	System settings	38	--	--	--	27.00	27.10			
	during survey	120	--	--	--	25.80	25.24			

*The NOAA ship *Miller Freeman*'s transducer was located approximately 9 m below the surface.

Note: Gain and beam pattern terms are defined in the "Operator Manual for Simrad EK500 Scientific Echo Sounder (1993)" available from Simrad Subsea A/S , Standpromenaden 50, P.O. Box 111 N-3191 Horten, Norway.

Table 2.--Geographical areas used during the analysis of the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

		Boundaries	
INPFC area	Subarea	Southern	Northern
Conception		32°30'	35°30'
Monterey		35°30'	40°30'
Eureka		40°30'	43°00'
Columbia		43°00'	47°30'
	South Columbia[a]	43°00'	45°46'
	North Columbia[a]	45°46'	47°30'
Vancouver		47°30'	50°30'
	U.S. Vancouver[a]	47°30'	US/Canada border
	South Vancouver[a]	US/Canada border	49°00'
	North Vancouver[a]	49°00'	50°30'
Charlotte[b]		50°30'	54°30'
	Southwest	50°30'	51°40'
	West Coast Queen Charlotte Islands	--	--
	Dixon Entrance	--	--
	Hecate Strait/Queen Charlotte Sound	--	--
Southeast Alaska/Yakutat		54°30	West to 147°00'
	U.S.-Canada Disputed Area[c]	--	--
	Southeast Alaska/Yakutat	54°30	West to 147°00'

[a]Subareas used in analyses by Dorn (1996).

[b]Charlotte subareas, except for Southwest Charlotte, are not easily defined based on latitudinal boundaries. See Figure 2 for portions of trackline that are included with each subarea.

[c]Areas defined in Ketchen (1985). See Figure 2.

Table 3.--Summary of Aleutian wing and bottom trawl stations and catch data for the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Haul no.	INPFC area[a]	Gear[b] type	Date (1998)	Time (GMT)	Duration (minutes)	Start position Latitude	Start position Longitude	Depth (m) Gear	Depth (m) Bottom	Temp. (°C) Gear[c]	Temp. (°C) Surface	MBT	P. hake Kg	P. hake Number	Other (kg)
1	mont	P	10 Jul	19:33	4	36 48.44	122 7.32	157	158	9.0	12.4	1	4.3	13	2,545.7
2	mont	A	12 Jul	21:02	31	38 7.48	123 24.27	160	244	8.9	11.1	3	1,516.3	7,847	3.7
3	mont	P	13 Jul	15:38	13	38 27.99	123 37.15	261	261	8.1	11.4	4	11.8	34	1,794.3
4	mont	A	13 Jul	19:52	30	38 17.48	123 24.28	97	170	9.1	10.8	5	280.9	1,970	16.9
5	mont	P	15 Jul	4:42	50	39 20.84	123 55.62	149	156	8.3	12.5	7	42.0	153	2.7
6	mont	P	15 Jul	15:17	20	39 38.14	123 58.33	231	234	7.8	12.6	9	228.1	583	50.9
7	mont	P	15 Jul	17:14	8	39 38.19	123 57.24	167	167	8.1	12.8	10	253.6	894	111.8
8	mont	A	16 Jul	3:42	21	39 48.10	124 4.45	248	359	7.9	12.7	11	315.1	914	10.9
9	mont	A	16 Jul	10:47	38	39 48.59	123 59.94	125	134	8.3	11.8	--	976.0	4,997	10.5
10	mont	A	17 Jul	1:13	40	40 18.44	124 29.58	378	417	7.3	12.0	--	156.6	531	14.5
11	mont	A	17 Jul	17:52	32	40 28.27	124 36.66	89	129	8.4	10.7	--	2.8	5	2,787.2
12	eur	A	18 Jul	2:05	11	40 48.03	124 30.59	129	454	8.2	12.7	--	688.9	1,435	40.0
13	eur	A	18 Jul	8:51	60	40 48.59	124 44.69	279	1,168	6.6	12.1	--	0.0	0	13.3
14	eur	A	18 Jul	20:11	3	41 8.13	124 22.97	220	310	7.4	12.3	--	1,082.0	5,271	35.9
15	eur	A	19 Jul	0:55	10	41 18.86	124 28.47	207	386	7.3	13.1	--	969.3	4,159	0.2
16[d]	eur	A	19 Jul	6:24	60	41 17.89	124 21.83	92	122	8.0	13.1	--	1,185.7	5,937	36.5
17	eur	A	19 Jul	15:19	16	41 29.22	124 32.41	321	550	6.7	12.5	--	1,188.3	4,565	8.4
18	eur	A	20 Jul	0:43	16	41 47.81	124 40.90	347	719	6.2	13.1	--	1,755.7	3,639	4.3
19	eur	A	20 Jul	6:50	40	41 58.89	124 31.52	112	128	7.8	10.0	--	996.8	3,180	31.4
20	eur	A	20 Jul	16:22	3	41 58.46	124 35.33	213	249	7.1	10.4	--	2,340.0	8,630	10.0
21	eur	A	21 Jul	0:32	7	42 8.03	124 40.78	259	531	6.9	10.4	--	727.2	1,941	15.8
22	eur	A	21 Jul	6:28	30	42 18.60	124 40.06	310	320	6.5	9.8	--	669.4	1,657	8.6
23	eur	A	21 Jul	16:28	15	42 18.38	124 44.59	248	519	7.1	10.1	--	399.2	1,150	0.6
24	eur	A	21 Jul	22:42	25	42 28.17	124 50.30	406	480	6.6	10.9	--	784.8	1,802	34.3
25	eur	A	22 Jul	6:02	15	42 37.83	124 40.39	123	151	7.9	9.8	--	2,054.0	9,768	0.0
26	eur	A	22 Jul	16:01	21	42 37.85	124 45.56	154	634	7.5	13.4	--	1,569.5	6,971	0.5
27	eur	A	22 Jul	18:30	20	42 37.89	124 49.92	310	717	6.8	13.4	--	414.2	1,730	2.9
28	eur	P	23 Jul	4:10	10	42 48.04	124 48.60	348	348	6.4	9.7	--	688.2	1,437	436.1
29	eur	P	23 Jul	15:15	5	42 58.07	124 51.15	123	123	7.5	12.7	--	6.9	14	980.1
30	eur	A	23 Jul	17:22	13	42 57.91	124 54.01	239	335	6.9	12.9	--	2,099.7	4,607	0.3
31	socol	A	24 Jul	4:18	32	43 17.76	124 51.24	266	502	6.5	13.3	--	300.3	638	13.5

Table 3.--Continued.

Haul No.	INPFC area[a]	Gear[b] type	Date (1998)	Time (GMT)	Duration (minutes)	Start position Latitude		Start position Longitude		Depth (m) Gear	Depth (m) Bottom	Temp. (°C) Gear[c]	Temp. (°C) Surface	MBT	P. hake Kg	P. hake Number	Other (kg)
32	socol	A	24 Jul	18:29	6	43	28.49	124	46.38	342	533	6.1	14.3	--	1,723.7	5,374	6.3
33	socol	A	25 Jul	1:02	9	43	37.41	124	42.81	236	504	7.3	13.8	--	2,093.8	5,351	0.2
34	socol	P	25 Jul	18:51	10	43	48.25	124	35.63	231	231	6.6	13.3	--	161.6	580	22.4
35	socol	P	26 Jul	0:51	8	43	57.26	124	34.69	166	166	7.4	14.7	--	412.6	1,619	1.3
36	socol	A	26 Jul	7:13	60	43	57.63	125	1.43	296	990	6.9	15.1	--	1,280.3	3,156	2.8
37	socol	A	26 Jul	15:12	30	44	8.57	125	16.96	278	1,500	6.3	12.5	--	755.7	1,787	64.8
38	socol	P	27 Jul	2:09	12	44	18.08	124	53.10	270	270	6.5	13.3	--	233.3	469	19.7
39	socol	A	27 Jul	5:00	25	44	18.52	125	11.44	332	1,500	6.2	14.8	--	91.4	209	6.3
40	socol	A	27 Jul	8:51	75	44	18.40	124	56.46	177	583	7.2	13.0	--	269.6	674	40.6
41	socol	A	27 Jul	18:26	30	44	28.60	124	53.40	439	469	5.8	14.5	--	1,955.2	4,207	84.8
42	socol	A	27 Jul	21:05	12	44	28.24	124	51.96	308	358	6.3	15.3	--	934.2	2,112	7.8
43	socol	A	28 Jul	23:59	15	44	48.15	124	45.08	371	409	6.2	16.4	--	486.2	969	6.4
44	socol	P	29 Jul	2:12	12	44	48.09	124	36.34	298	298	6.7	16.3	--	15.0	29	35.8
45	socol	A	29 Jul	15:54	17	44	57.80	124	24.99	225	241	7.3	16.3	19	3,591.6	10,655	188.4
46	socol	A	30 Jul	3:45	10	45	18.16	124	17.01	165	179	7.4	16.4	20	1,052.7	3,380	11.0
47[d]	socol	A	30 Jul	8:16	45	45	13.32	124	13.07	149	154	7.8	16.3	21	939.1	2,415	5.3
48	socol	A	31 Jul	6:12	90	45	19.04	124	39.01	353	499	6.2	17.2	22	285.6	599	5.6
49	socol	A	1 Aug	4:22	45	45	47.92	124	16.11	121	141	7.6	16.3	24	234.2	800	7.8
50	socol	A	1 Aug	14:00	30	45	29.00	124	34.84	304	469	6.4	16.8	25	482.9	1,200	2.4
51	socol	A	1 Aug	23:29	19	45	27.85	124	20.06	171	178	7.4	16.7	26	1,562.7	5,277	177.3
52	socol	P	2 Aug	2:44	12	45	37.82	124	31.79	233	233	6.8	16.8	27	21.9	55	16.2
53	nocol	A	2 Aug	9:29	12	45	58.01	124	35.34	126	147	7.7	16.7	28	114.5	294	149.6
54	nocol	A	5 Aug	19:35	25	45	58.15	124	47.02	427	532	6.0	17.5	30	184.2	394	82.2
55	nocol	A	6 Aug	6:52	30	46	17.94	124	31.67	75	137	8.7	16.4	31	339.1	944	1.6
56	nocol	A	6 Aug	20:38	42	46	38.01	124	33.71	135	143	7.8	16.2	33	973.0	2,012	38.3
57	nocol	A	7 Aug	4:07	30	46	47.91	124	48.72	88	169	9.0	16.5	34	49.2	84	355.1
58	nocol	A	7 Aug	20:04	34	46	58.15	124	55.98	153	202	7.6	16.7	37	36.4	81	718.6
59	nocol	A	8 Aug	1:25	26	47	8.10	124	57.57	183	287	7.5	16.3	38	6,210.5	17,247	87.5
60[d]	nocol	A	8 Aug	7:43	40	47	8.06	124	58.28	149	173	7.6	15.8	--	485.6	1,107	11.6
61[d]	nocol	A	8 Aug	11:56	45	47	7.99	124	58.46	160	170	7.6	16.4	40	548.6	1,313	35.0
62	nocol	P	8 Aug	19:26	15	47	18.11	124	43.80	140	140	--	16.3	--	2,263.7	3,898	506.3
63	nocol	A	9 Aug	0:45	6	47	28.03	124	49.85	141	158	7.9	16.3	42	4,808.4	10,698	610.6

Table 3.--Continued.

Haul No.	INPFC area[a]	Gear[b] type	Date (1998)	Time (GMT)	Duration (minutes)	Start position Latitude		Start position Longitude		Depth (m) Gear	Depth (m) Bottom	Temp. (°C) Gear[c]	Temp. (°C) Surface	MBT	P. hake Kg	P. hake Number	Other (kg)
64[d]	nocol	A	9 Aug	7:18	50	47	27.99	124	45.75	113	129	7.8	15.2	43	744.5	1,583	28.9
65[d]	nocol	A	9 Aug	11:56	40	47	28.19	124	45.42	108	121	8.2	15.2	44	651.8	1,396	16.3
66	usvan	A	10 Aug	0:28	10	47	48.25	125	10.22	200	487	7.3	16.4	45	5,301.3	12,036	4.7
67	usvan	A	10 Aug	5:21	30	47	48.20	125	1.04	108	155	8.1	15.8	46	496.1	1,097	10.3
68	usvan	A	10 Aug	16:32	19	47	58.12	125	3.08	115	124	8.1	15.7	47	459.7	952	252.3
69	usvan	A	10 Aug	21:07	4	48	2.96	125	28.37	122	140	8.0	15.2	48	0.0	0	1,004.9
70	usvan	A	11 Aug	5:28	15	47	58.27	125	19.34	78	472	8.8	16.3	49	141.9	344	17.9
71	usvan	A	11 Aug	7:21	60	47	58.16	125	18.94	259	590	6.9	16.7	50	542.9	1,168	10.9
72	usvan	A	11 Aug	14:56	3	48	13.13	125	28.88	117	139	7.4	14.5	--	1,179.4	2,046	226.0
73	sovan	A	12 Aug	1:00	15	48	23.15	125	26.98	126	150	7.3	16.3	53	1,555.4	1,876	18.7
74[d]	usvan	A	12 Aug	8:37	40	48	23.35	124	58.04	99	227	7.6	14.7	54	1,520.4	3,453	2.0
75	sovan	A	12 Aug	16:24	6	48	28.06	125	8.36	125	152	7.1	14.5	55	2,704.7	5,637	25.3
76	sovan	A	13 Aug	1:46	12	48	33.11	124	47.43	114	125	8.3	12.3	--	847.7	1,261	22.2
77	sovan	A	13 Aug	6:19	30	48	32.83	125	9.80	102	109	7.5	12.0	57	1,455.1	2,582	438.9
78	sovan	A	13 Aug	18:48	4	48	34.93	125	22.77	119	140	7.3	13.0	58	1,045.2	1,824	57.1
79	sovan	A	14 Aug	1:48	15	48	42.38	125	43.28	106	176	8.6	16.3	59	1,287.7	2,344	11.6
80	sovan	A	14 Aug	3:30	15	48	42.60	125	43.60	142	192	8.2	16.0	60	1,548.5	2,541	17.4
81	sovan	A	14 Aug	7:19	3	48	34.75	125	39.19	53	62	10.2	15.1	61	9.2	11	1,068.6
82	usvan	A	14 Aug	19:35	7	48	8.02	125	33.27	121	140	7.9	13.2	62	378.8	735	410.4
83	sovan	A	15 Aug	0:30	15	48	17.59	125	55.22	279	290	6.3	16.7	63	537.9	1,025	0.4
84	sovan	A	15 Aug	20:50	18	48	38.11	126	6.84	135	137	8.0	16.0	66	596.5	1,186	110.4
85	sovan	A	15 Aug	23:30	20	48	34.84	126	11.86	441	655	5.6	16.4	67	253.2	471	8.7
86	sovan	A	16 Aug	9:46	20	48	47.79	126	18.96	152	179	8.1	15.4	70	471.0	875	509.7
87	sovan	A	16 Aug	17:51	9	48	48.04	126	10.28	121	128	7.8	15.2	71	1,457.8	2,738	18.3
88	sovan	A	17 Aug	2:34	20	48	58.16	126	13.87	106	117	8.0	16.3	72	726.6	2,284	129.5
89	novan	A	17 Aug	9:18	8	49	7.90	127	20.44	187	1,000	7.4	15.6	74	607.3	1,187	0.0
90	novan	A	18 Aug	0:20	12	49	8.24	126	26.10	100	108	8.1	15.0	75	709.6	1,319	16.4
91	novan	A	18 Aug	5:41	15	49	18.12	126	43.24	109	120	8.1	14.6	76	0.0	0	61.3
92	novan	A	18 Aug	15:51	6	49	18.21	127	9.02	187	245	7.2	15.6	78	114.7	228	72.9
93	novan	A	18 Aug	21:22	8	49	27.88	127	9.39	140	154	7.7	14.8	79	2,381.9	4,831	8.1
94[d]	novan	A	19 Aug	7:17	37	49	38.20	127	9.53	112	128	7.6	15.7	80	539.7	1,013	102.4
95	novan	A	20 Aug	0:18	19	50	7.53	128	4.73	164	568	7.3	14.5	82	3,133.9	7,393	41.1

Table 3.--Continued.

Haul No.	INPFC area[a]	Gear[b] type	Date (1998)	Time (GMT)	Duration (minutes)	Start position Latitude		Start position Longitude		Depth (m) Gear	Depth (m) Bottom	Temp. (°C) Gear[c]	Temp. (°C) Surface	MBT	P. hake Kg	P. hake Number	Other (kg)
96[d]	novan	A	20 Aug	7:08	13	50	7.40	128	2.01	124	527	7.8	14.9	83	462.1	955	17.6
97[d]	novan	A	20 Aug	11:37	10	50	7.59	128	2.07	127	370	7.8	14.4	84	621.5	1,127	12.7
98	novan	A	20 Aug	17:17	10	50	17.56	128	21.96	215	896	7.0	15.2	85	364.8	728	6.6
99	char	A	21 Aug	3:52	8	50	37.29	128	38.39	147	188	7.3	16.0	86	796.3	1,494	30.2
100	char	A	23 Aug	8:41	10	51	22.54	129	4.58	182	216	7.1	14.7	87	580.6	998	50.3
101	char	A	23 Aug	17:02	18	51	37.65	130	23.16	230	385	6.0	14.4	88	1,205.3	2,105	0.0
102	char	A	24 Aug	0:28	17	51	28.16	129	50.29	190	205	6.5	14.4	89	1,099.6	1,678	1,326.4
103	char	A	24 Aug	5:10	12	51	18.21	129	56.82	203	259	6.6	14.8	90	72.3	135	251.1
104	char	A	24 Aug	10:05	20	51	18.10	130	5.15	145	603	7.4	14.9	92	887.0	1,589	0.0
105	char	A	24 Aug	19:26	26	51	8.15	129	47.62	260	659	6.3	15.0	93	1,055.5	1,954	5.0
106	char	A	25 Aug	3:09	5	50	58.19	129	13.95	87	148	9.4	13.3	94	595.3	5,737	6.2
107	char	A	25 Aug	17:32	9	50	48.05	129	26.54	223	605	6.6	14.9	96	731.6	1,363	80.8
108	sovan	A	27 Aug	2:24	20	48	21.93	125	39.14	110	149	7.4	14.0	97	2,235.7	4,902	34.3

[a] mont=Monterey, eur=Eureka, socol=South Columbia, nocol=North Columbia, usvan=U.S. Vancouver, sovan=South Vancouver, novan=North Vancouver, and char=Charlotte.

[b] A = Aleutian wing trawl and P = polyethylene Nor'eastern bottom trawl

[c] Gear temperatures were measured at the headrope.

[d] Target strength data collection haul

Table 4.--Summary of mid-water trawl stations and catch data for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Haul	INPFC	Date	Time	Duration	Start position		Depth (m)		Surface	Catch (kg)	
no.	area*	(1998)	(PDT)	(minutes)	Latitude	Longitude	Gear	Bottom	temp (°C	P. hake	Other
1	char	6 Aug	9:12	92	52 3.3	131 20.0	170	270	13.3	321.7	85.6
2	char	6 Aug	13:32	20	52 11.5	131 40.8	80	1,723	15.2	0.0	0.0
3	char	6 Aug	14:30	25	52 12.3	131 40.8	227	1,912	14.6	0.0	6.7
4	char	7 Aug	9:33	17	53 1.7	132 36.8	202	600	13.3	348.1	24.7
5	char	7 Aug	12:08	30	53 10.2	132 39.3	3	334	14.1	0.0	2.6
6	char	7 Aug	17:40	30	53 19.4	133 6.9	298	401	14.0	511.0	11.8
7	char	8 Aug	12:38	13	53 49.5	133 26.1	269	332	14.3	435.2	8.6
8	char	8 Aug	6:12	6	54 13.6	133 11.6	72	192	13.4	1,122.6	37.2
9	se	9 Aug	12:25	16	54 27.5	133 53.1	285	381	14.1	270.5	12.9
10	se	9 Aug	15:38	23	54 30.0	134 13.0	300	1,682	14.3	0.0	14.0
11	se	10 Aug	9:46	10	55 6.5	134 2.2	164	160	13.5	0.0	65.8
12	se	10 Aug	12:26	9	55 13.0	134 14.2	234	786	13.7	437.4	1.0
13	se	11 Aug	6:58	27	55 50.0	135 20.4	227	680	14.0	0.0	20.7
14	se	11 Aug	7:58	30	55 50.4	135 19.2	25	710	14.0	0.0	4.7
15	se	11 Aug	14:09	14	56 4.0	134 56.2	215	310	13.5	521.7	9.4
16	se	12 Aug	7:32	8	56 48.5	136 2.8	245	350	13.5	84.0	5.9
17	se	12 Aug	14:21	8	57 38.8	136 34.0	201	382	13.4	156.1	42.1
18	se	12 Aug	16:34	32	57 48.0	136 44.7	20	136	14.7	0.0	22.2
19	se	13 Aug	10:58	16	57 56.7	138 32.2	185	3,000	14.2	0.0	2.8
20	char	15 Aug	8:45	35	54 15.7	132 37.9	100	165	11.9	979.5	374.6
21	char	16 Aug	12:37	30	54 24.8	132 3.8	3	301	13.2	0.0	17.3
22	char	16 Aug	13:34	17	54 22.8	132 3.5	101	286	13.1	505.7	8.4
23	char	16 Aug	14:20	55	54 23.3	132 4.3	173	285	13.0	4.6	155.1
24	char	17 Aug	6:42	16	53 45.6	130 52.6	43	66	14.0	0.0	95.0
25	char	17 Aug	7:54	5	53 45.0	130 44.0	69	135	14.0	1,509.5	133.0
26	char	17 Aug	15:42	7	53 12.6	130 33.1	126	151	14.7	942.7	32.3
27	char	17 Aug	9:40	33	51 58.6	130 41.5	253	313	15.1	24.9	4.2
28	char	17 Aug	13:20	17	52 10.2	130 50.6	172	221	14.7	51.9	7.3
29	char	20 Aug	10:29	2	51 28.9	128 39.5	107	174	14.0	974.2	15.5
30	char	20 Aug	15:44	4	51 13.6	128 56.1	110	166	14.8	913.7	67.0
31	char	21 Aug	10:03	9	51 56.5	128 38.3	115	152	14.7	1,286.8	8.3
32	char	21 Aug	15:14	19	51 54.3	129 23.0	130	214	15.3	9,775.0	224.9
33	char	21 Aug	18:15	2	51 50.0	129 29.2	93	153	15.1	1,026.1	292.5

*char=Charlotte and se=southeast Alaska.

Table 5.--Summary of catch by species from Aleutian wing trawl hauls conducted by the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Common Name	Scientific Name	Weight (kg)	Percent	Numbers
Pacific hake	*Merluccius productus*	98,068.9	88.8	257,884
Pacific herring	*Clupea pallasi*	4,404.6	4.0	42,996
Yellowtail rockfish	*Sebastes flavidus*	1,991.6	1.8	1,717
Jack mackerel	*Trachurus symmetricus*	1,841.6	1.7	1,471
Widow rockfish	*Sebastes entomelas*	1,254.2	1.1	2,263
Redstripe rockfish	*Sebastes proriger*	1,085.4	1.0	2,150
Yellowmouth rockfish	*Sebastes reedi*	646.2	0.6	630
Chinook salmon	*Oncorhynchus tshawytscha*	301.0	0.3	100
Chub mackerel	*Scomber japonicus*	147.4	0.1	313
Spiny dogfish	*Squalus acanthias*	141.4	0.1	262
Pacific ocean perch	*Sebastes alutus*	62.1	0.1	61
King-of-the-salmon	*Trachipterus altivelis*	60.0	0.1	11
Ragfish	*Icosteus aenigmaticus*	55.0	<0.1	2
Squid unidentified	Teuthoidea (Order)	47.1	<0.1	284
American shad	*Alosa sapidissima*	43.5	<0.1	67
Brown cat shark	*Apristurus brunneus*	31.3	<0.1	38
Silvergray rockfish	*Sebastes brevispinis*	28.9	<0.1	15
Lanternfish unidentified	Myctophidae	26.1	<0.1	3,615
Jellyfish unidentified	Scyphozoa (Class)	23.2	<0.1	57
Arrowtooth flounder	*Atheresthes stomias*	22.5	<0.1	24
Canary rockfish	*Sebastes pinniger*	19.1	<0.1	8
Salps unidentified	Thaliacea (Class)	18.1	<0.1	28
Bocaccio	*Sebastes paucispinis*	17.4	<0.1	4
Darkblotched rockfish	*Sebastes crameri*	16.7	<0.1	66
Robust clubhook squid	*Moroteuthis robusta*	11.3	<0.1	2
Pacific sardine	*Sardinops sagax*	7.6	<0.1	51
Magistrate armhook squid	*Berryteuthis magister*	5.9	<0.1	25
Shrimp unidentified	Natantia (Suborder)	5.7	<0.1	2,715
Lingcod	*Ophiodon elongatus*	5.1	<0.1	12
Shortraker rockfish	*Sebastes borealis*	4.8	<0.1	3
California market squid	*Loligo opalescens*	3.6	<0.1	20
Starry flounder	*Platichthys stellatus*	2.8	<0.1	3
Sablefish	*Anoplopoma fimbria*	2.5	<0.1	1
Longnose skate	*Raja rhina*	2.5	<0.1	1
Robust blacksmelt	*Bathylagus milleri*	2.3	<0.1	452
Flathead sole	*Hippoglossoides elassodon*	2.3	<0.1	7
Slender sole	*Lyopsetta exilis*	2.1	<0.1	25
Eulachon	*Thaleichthys pacificus*	2.0	<0.1	111
English sole	*Parophrys vetulus*	1.6	<0.1	5
Viperfish unidentified	Chauliodontidae	1.0	<0.1	39

Table 5.--Continued.

Common Name	Scientific Name	Weight (kg)	Percent	Numbers
Spotted ratfish	*Hydrolagus colliei*	0.9	<0.1	1
Chilipepper	*Sebastes goodei*	0.7	<0.1	2
Deepsea smelt unidentified	Bathylagidae	0.7	<0.1	16
Octopus unidentified	Octopoda (Order)	0.6	<0.1	10
Rex sole	*Glyptocephalus zachirus*	0.5	<0.1	4
Pacific lamprey	*Lampetra tridentata*	0.5	<0.1	1
Medusafish	*Icichthys lockingtoni*	0.4	<0.1	2
Eel larvae unidentified	Eel leptocephalus	0.3	<0.1	1
Shining tubeshoulder	*Sagamichthys abei*	0.2	<0.1	2
Pacific sanddab	*Citharichthys sordidus*	0.1	<0.1	1
Shark eggcase		0.1	<0.1	13
Slender barracudina	*Lestidiops ringens*	0.1	<0.1	5
Tubeshoulder unidentified	Searsiidae	0.1	<0.1	2
Barracudina unidentified	Paralepididae	0.1	<0.1	2
Eelpout unidentified	Zoarcidae	<0.1	<0.1	5
Scaleless dragonfish unident.	Melanostomiidae	<0.1	<0.1	2
Northern pearleye	*Benthalbella dentata*	<0.1	<0.1	1
Night smelt	*Spirinchus starksi*	<0.1	<0.1	1
Blue lanternfish	*Tarletonbeania crenularis*	<0.1	<0.1	2
Flatfish larvae	Pleuronectiformes larvae	<0.1	<0.1	1
Totals		110,421.6		317,612

Table 6.--Summary of catch by species from mid-water trawl hauls conducted by the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Common Name	Scientific Name	Weight (kg)	Percent
Pacific hake	*Merluccius productus*	22,202.9	92.4
Yellowtail rockfish	*Sebastes flavidus*	522.9	2.2
Walleye pollock	*Theragra chalcogramma*	508.8	2.1
Widow rockfish	*Sebastes entomelas*	174.7	0.7
Pacific herring	*Clupea pallasi*	93.2	0.4
Redstripe rockfish	*Sebastes proriger*	76.4	0.3
Pacific ocean perch	*Sebastes alutus*	71.2	0.3
Yellowmouth rockfish	*Sebastes reedi*	59.5	0.2
Chum salmon	*Oncorhynchus keta*	40.7	0.2
Jellyfish	Scyphozoa (Class)	38.5	0.2
Spiny dogfish	*Squalus acanthias*	37.5	0.2
Silvergray rockfish	*Sebastes brevispinis*	31.4	0.1
Pink salmon	*Oncorhynchus gorbuscha*	27.4	0.1
Jack mackerel	*Trachurus symmetricus*	26.4	0.1
Myctophids	Myctophidae	20.6	0.1
Arrowtooth flounder (turbot)	*Atheresthes stomias*	19.9	0.1
Bocaccio	*Sebastes paucispinis*	17.0	0.1
Squid	Teuthoidea (Order)	13.7	0.1
Rougheye rockfish	*Sebastes aleutianus*	4.6	<0.1
Yelloweye rockfish	*Sebastes ruberrimus*	4.5	<0.1
Sockeye salmon	*Oncorhynchus nerka*	4.2	<0.1
Eulachon	*Thaleichthys pacificus*	4.2	<0.1
Pacific sardine	*Sardinops sagax*	4.0	<0.1
Coho salmon	*Oncorhynchus kisutch*	3.6	<0.1
Euphausiids		2.8	<0.1
Redbanded rockfish	*Sebastes babcocki*	2.1	<0.1
Rex sole	*Glyptocephalus zachirus*	1.8	<0.1
Greenstriped rockfish	*Sebastes elongatus*	0.8	<0.1
Darkblotched rockfish	*Sebastes crameri*	0.7	<0.1
Rosethorn rockfish	*Sebastes helvomaculatus*	0.7	<0.1
Dover sole	*Microstomus pacificus*	0.4	<0.1
Sablefish (juv)	*Anoplopoma fimbria*	<0.1	<0.1
Eared blacksmelt	*Bathylagus ochotensis*	<0.1	<0.1
Pacific lamprey	*Lampetra tridentata*	<0.1	<0.1
Shrimp	*Pandalas spp.*	<0.1	<0.1
Whitebait smelt	*Allosmerus elongatus*	<0.1	<0.1
Total		24,016.9	

Table 7.--Summary of catch by species from bottom trawl hauls conducted by the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Common Name	Scientific Name	Weight (kg)	Percent	Numbers
Pacific hake	*Merluccius productus*	4,342.9	40.0	9,778
Shortbelly rockfish	*Sebastes jordani*	2,423.2	22.3	16,980
Spiny dogfish	*Squalus acanthias*	1,493.4	13.7	2,650
Redstripe rockfish	*Sebastes proriger*	810.0	7.5	5,580
Sablefish	*Anoplopoma fimbria*	273.3	2.5	218
Chilipepper	*Sebastes goodei*	261.5	2.4	492
Dover sole	*Microstomus pacificus*	212.4	2.0	948
Rex sole	*Glyptocephalus zachirus*	164.2	1.5	1,144
Splitnose rockfish	*Sebastes diploproa*	162.9	1.5	1,386
Sharpchin rockfish	*Sebastes zacentrus*	107.4	1.0	1,127
Yellowtail rockfish	*Sebastes flavidus*	102.0	0.9	110
Pygmy rockfish	*Sebastes wilsoni*	79.5	0.7	1,067
Pacific herring	*Clupea pallasi*	62.6	0.6	601
American shad	*Alosa sapidissima*	58.7	0.5	86
Stripetail rockfish	*Sebastes saxicola*	52.9	0.5	527
Jack mackerel	*Trachurus symmetricus*	47.9	0.4	44
Magistrate armhook squid	*Berryteuthis magister*	26.3	0.2	7
Shortspine thornyhead	*Sebastolobus alascanus*	26.1	0.2	184
English sole	*Parophrys vetulus*	22.2	0.2	78
Bigfin eelpout	*Lycodes cortezianus*	19.2	0.2	159
Longnose skate	*Raja rhina*	19.0	0.2	3
Arrowtooth flounder	*Atheresthes stomias*	16.0	0.1	25
Darkblotched rockfish	*Sebastes crameri*	15.8	0.1	24
Slender sole	*Lyopsetta exilis*	12.9	0.1	256
Lingcod	*Ophiodon elongatus*	8.4	0.1	3
Greenstriped rockfish	*Sebastes elongatus*	6.3	0.1	27
Petrale sole	*Eopsetta jordani*	5.9	0.1	10
Sea urchin unidentified	Echinoidea (Class)	4.5	<0.1	36
Widow rockfish	*Sebastes entomelas*	3.8	<0.1	3
Coho salmon	*Oncorhynchus kisutch*	2.8	<0.1	1
Chub mackerel	*Scomber japonicus*	2.6	<0.1	6
Rosethorn rockfish	*Sebastes helvomaculatus*	2.2	<0.1	11
Silverside unidentified	Atherinidae	2.0	<0.1	13
Spotted ratfish	*Hydrolagus colliei*	1.9	<0.1	11
Pacific ocean perch	*Sebastes alutus*	1.7	<0.1	3
Salps unidentified	Thaliacea (Class)	1.6	<0.1	1
Pacific sanddab	*Citharichthys sordidus*	1.4	<0.1	10
Squid unidentified	Teuthoidea (Order)	1.3	<0.1	2
Canary rockfish	*Sebastes pinniger*	1.1	<0.1	1

Table 7.--Continued.

Common Name	Scientific Name	Weight (kg)	Percent	Numbers
Starfish unidentified	Echinodermata (Phylum)	1.1	<0.1	21
Redbanded rockfish	*Sebastes babcocki*	0.8	<0.1	2
Pacific lamprey	*Lampetra tridentata*	0.8	<0.1	2
Rougheye rockfish	*Sebastes aleutianus*	0.7	<0.1	1
Pink seaperch	*Zalembius rosaceus*	0.6	<0.1	13
Dungeness crab	*Cancer magister*	0.6	<0.1	1
Sea cucumber unidentified	Holothuroidea (Class)	0.5	<0.1	2
Eelpout unidentified	Zoarcidae	0.4	<0.1	3
Shrimp unidentified	Natantia (Suborder)	0.4	<0.1	64
Deepsea skate	*Bathyraja abyssicola*	0.4	<0.1	1
Plainfin midshipman	*Porichthys notatus*	0.3	<0.1	3
Threadfin sculpin	*Icelinus filamentosus*	0.2	<0.1	3
Northern shrimp	*Pandalus borealis*	0.2	<0.1	20
Snailfish unidentified	Cyclopteridae	0.1	<0.1	1
Hermit crab unidentified	Paguridae	<0.1	<0.1	1
Totals		10,866.22		43,750

Table 8.--Summary of Methot trawl and bongo net stations for the NOAA ship *Miller Freeman* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Haul	Date	Time	Duration	Start Position		Depth (m)		Temp. (°C)		
no.	(1998)	(GMT)	(minutes	Latitude	Longitude	gear	bottom	gear	surface	MBT[1]
				Methot Tows						
201	12 Jul	8:20	38	37 42.83	123 13.76	250	1,030	8.5	14.3	2
202	14 Jul	9:08	42	38 57.38	124 4.81	250	869	7.5	13.0	6
203	15 Jul	11:31	50	39 27.04	124 6.04	250	784	7.3	12.2	8
204	16 Jul	6:45	35	39 47.61	124 11.90	246	746	9.4	12.1	12
205	17 Jul	6:02	54	40 18.35	125 8.11	246	1,301	8.9	13.2	15
206	18 Jul	6:24	32	40 46.93	124 34.25	251	553	7.6	12.6	--
207	20 Jul	10:19	57	41 57.18	124 50.29	244	856	6.9	--	--
208	6 Aug	10:13	53	46 26.14	124 59.47	250	1,500	6.8	17.0	32
209	7 Aug	7:14	39	46 57.06	125 2.23	251	774	6.6	16.5	35
210	7 Aug	10:30	41	46 47.04	124 57.69	247	621	6.9	15.6	36
211	11 Aug	11:32	45	48 12.02	125 43.30	250	638	6.5	14.6	51
212	15 Aug	5:34	39	48 17.86	126 8.97	252	767	6.6	15.7	65
213	16 Aug	6:42	43	48 45.70	126 37.24	248	802	6.7	16.3	69
214	17 Aug	6:21	45	48 54.38	126 36.65	259	792	6.3	16.8	73
215	18 Aug	10:39	47	49 7.21	126 59.54	260	514	6.3	15.5	77
216	19 Aug	12:23	15	49 37.81	127 12.21	87	128	7.5	15.5	81
217	24 Aug	7:22	46	51 18.21	130 8.42	207	819	6.6	15.2	91
218	25 Aug	10:09	52	50 48.77	129 27.33	258	873	6.1	15.2	95
				Bongo Tows						
301	22 Jul	9:44	25	42 48.16	124 56.32	254	646	6.7	13.8	32
302	27 Jul	11:45	28	44 18.53	125 1.61	252	772	6.7	13.7	33
303	31 Jul	8:51	23	45 25.55	124 49.30	254	834	6.7	17.2	34
304	1 Aug	7:31	28	45 54.07	124 46.87	253	556	6.7	16.6	35
305	1 Aug	10:30	26	45 38.56	124 41.42	252	397	6.5	16.0	36

[1] CTDs were used for bongo net tows

Table 9.--Summary of Tucker trawl stations for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Station	Date	Time (PDT)	Latitude	Longitude	Target depth (m)	Wire out	Wire angle	Comments
1	14 Aug	10:31	56 0.8	135 33.9	25	35	41	
2	14 Aug	12:14	55 58.9	135 30.2	275	540	58	
3	14 Aug	13:32	55 58.2	135 28.2	120	179	43	
4	14 Aug	14:16	55 59.6	135 29.2	400	556	44	Did not use
5	14 Aug	16:08	55 54.4	135 25.8	25	29	31	No sample, top net did not open
6	14 Aug	16:50	55 53.4	135 24.4	450	730	55	

Table 10.--Summary of conductivity-temperature-depth casts made from the NOAA ship *Miller Freeman* prior to and during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

		Time			Depth (m)	
Number	Date	(GMT)	Latitude	Longitude	Cast	Bottom
cal.	30 Jun	19:36	48 9.00	122 23.81	77	81
1	10 Jul	9:45	36 32.90	123 6.33	1,015	>1,500
2	11 Jul	10:45	36 58.22	122 40.59	756	781
3	12 Jul	7:16	37 43.53	123 14.22	993	>1,000
4	12 Jul	10:08	37 44.17	123 25.49	1,014	>1,100
5	13 Jul	5:31	38 18.16	123 38.71	912	966
6	16 Jul	5:35	39 48.12	124 6.28	603	617
7	16 Jul	7:48	39 47.87	124 11.97	496	748
8	16 Jul	8:51	39 47.36	124 12.76	691	957
9	18 Jul	5:35	40 47.62	124 34.19	543	545
10	22 Jul	7:49	42 38.00	124 43.62	423	427
11	23 Jul	9:08	42 58.45	124 57.96	476	769
12	23 Jul	9:57	42 58.19	124 55.86	453	455
13	26 Jul	11:52	44 8.39	125 33.89	1,218	>1,500
14	31 Jul	9:47	45 25.18	124 48.82	608	804
15	1 Aug	8:56	45 48.48	124 49.60	823	866
16	2 Aug	6:58	46 8.13	124 44.92	823	825
17	5 Aug	5:24	45 58.49	125 10.75	1,015	1,405
18	5 Aug	7:21	45 58.34	124 56.13	578	579
19	5 Aug	8:46	45 58.27	124 41.87	213	219
20	5 Aug	10:11	45 57.77	124 27.42	142	148
21	5 Aug	11:28	45 58.23	124 14.05	98	106
22	6 Aug	11:53	46 33.87	124 55.03	837	839
23	7 Aug	8:30	46 58.26	125 3.29	899	901
24	7 Aug	11:48	46 47.09	125 3.22	678	682
25	15 Aug	4:32	48 18.28	126 11.03	861	925
26	16 Aug	5:26	48 48.13	126 40.55	903	923
27	17 Aug	5:22	48 54.66	126 35.41	790	792
28	17 Aug	10:27	48 59.00	127 6.61	1,522	>1,600
29	21 Aug	19:23	52 0.25	131 1.01	63	64
30	24 Aug	8:43	51 18.19	130 9.46	800	813
31	25 Aug	7:22	50 49.18	129 28.66	671	852
32	22 Jul	9:44	42 48.16	124 56.32	254	646
cal.	23 Jul	17:22	42 57.93	124 53.99	272	335
33	27 Jul	11:45	44 18.53	125 1.61	252	772
34	31 Jul	8:51	45 25.55	124 49.30	254	834
35	1 Aug	7:31	45 54.07	124 46.87	253	556
36	1 Aug	10:30	45 38.56	124 41.42	252	397

Table 11.--Summary of expendable bathythermograph casts made from the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Cast	Date	Time (GMT)	Latitude	Longitude	Bottom Depth (m)
1	7 Jul	17:19	47 7.60	125 26.2	>800
2	11 Jul	22:58	37 40.61	123 49.91	>800
3	12 Jul	19:39	38 8.14	123 25.37	225
4	14 Jul	14:21	38 48.19	123 50.99	179
5	15 Jul	8:46	39 29.80	124 34.23	>800
6	17 Jul	2:41	40 21.91	124 29.33	378
7	17 Jul	19:33	40 31.23	124 38.07	172
8	18 Jul	1:42	40 46.52	124 30.25	351
9	18 Jul	17:21	41 8.11	124 49.35	1,097
10	18 Jul	19:00	41 8.07	124 23.87	397
11	18 Jul	19:15	41 8.09	124 19.84	144
12	19 Jul	0:00	41 18.03	124 30.19	597
13	19 Jul	5:52	41 16.55	124 23.16	156
14	19 Jul	16:13	41 30.52	124 33.87	633
15		*** Bad Probe ***			
16	19 Jul	22:30	41 47.71	124 58.14	1,045
17	19 Jul	23:58	41 47.25	124 37.86	645
18	20 Jul	2:39	41 48.12	124 31.10	408
19	20 Jul	2:53	41 48.21	124 27.79	153
20	20 Jul	5:54	41 58.17	124 31.60	132
21	20 Jul	9:35	41 58.29	124 49.69	847
22	20 Jul	17:32	41 58.16	124 35.37	283
23	20 Jul	19:42	41 58.99	125 5.68	1,256
24	20 Jul	21:24	42 8.33	125 4.98	811
25	20 Jul	23:08	42 8.10	124 39.49	479
26	21 Jul	2:06	42 8.25	124 33.49	151
27	21 Jul	5:31	42 17.84	124 40.15	367
28	21 Jul	8:55	42 18.21	124 53.96	1,011
29	21 Jul	17:31	42 18.29	124 44.93	529
30	22 Jul	0:10	42 28.11	124 48.76	297
31	22 Jul	5:20	42 37.48	124 41.47	176
32	22 Jul	19:26	42 40.32	124 49.67	681
33	22 Jul	21:59	42 39.15	125 23.56	270
34	23 Jul	3:36	42 48.12	124 48.68	328
35	23 Jul	15:51	42 58.20	124 51.16	119
36	23 Jul	22:00	43 8.10	125 12.53	936
37	23 Jul	23:24	43 8.05	124 52.85	406
38	24 Jul	0:18	43 8.07	124 39.70	153
39	24 Jul	17:45	43 26.64	124 45.63	510
40	24 Jul	23:25	43 38.16	124 29.57	150
41	25 Jul	0:06	43 38.09	124 40.11	400
42	25 Jul	3:56	43 38.07	125 11.60	801
43	25 Jul	18:14	43 48.35	124 35.24	225
44	26 Jul	1:13	43 58.09	124 34.17	158
45	26 Jul	8:51	44 2.88	124 59.52	835
46	26 Jul	16:18	44 12.02	125 16.73	802
47	26 Jul	17:41	44 8.18	124 59.15	392

Table 11.--Continued.

Cast	Date	Time (GMT)	Latitude	Longitude	Bottom Depth (m)
48	26 Jul	17:58	44 8.26	124 54.42	151
49	27 Jul	1:32	44 18.28	124 53.03	306
50	27 Jul	5:58	44 20.71	125 13.71	>450
51	27 Jul	20:15	44 28.25	124 52.92	417
52		*** Bad Probe ***			
53	28 Jul	21:33	44 48.20	125 3.96	1,466
54	28 Jul	22:26	44 48.10	124 49.04	388
55	29 Jul	2:50	44 48.04	124 39.07	360
56	29 Jul	3:41	44 48.14	124 26.87	151
57	29 Jul	20:58	45 6.30	125 9.00	>800
58	29 Jul	22:19	45 8.10	124 49.08	>400
59	30 Jul	0:07	45 8.20	124 18.80	200
60	31 Jul	18:36	45 38.08	124 20.90	156
61	31 Jul	19:58	45 38.19	124 41.70	404
62	31 Jul	21:26	45 38.49	125 4.67	1,483
63	5 Aug	15:15	46 8.22	124 34.80	154
64	5 Aug	15:44	46 7.75	124 43.25	728
65	5 Aug	17:04	46 8.14	125 4.75	1,406
66	6 Aug	19:00	46 38.14	124 37.48	150
67	6 Aug	19:18	46 38.22	124 42.26	415
68	7 Aug	0:08	46 38.10	125 13.35	>700
69	7 Aug	23:08	47 7.30	125 19.09	<200
70	8 Aug	0:23	47 8.07	124 59.24	370
71	8 Aug	0:41	47 8.13	124 54.14	150
72	9 Aug	15:28	47 38.09	124 57.19	142
73	9 Aug	16:04	47 38.16	125 7.21	406
74	9 Aug	18:08	47 38.12	125 41.31	1,365
75	11 Aug	1:59	48 8.20	125 14.13	274
76	14 Aug	16:57	48 8.14	126 7.73	1,395
77	14 Aug	18:13	48 8.11	125 45.08	395
78	14 Aug	18:43	48 8.13	125 35.98	151
79	15 Aug	19:15	48 38.13	126 7.74	150
80	15 Aug	19:36	48 38.14	126 13.38	423
81	16 Aug	2:31	48 38.58	126 47.34	1,455
82	17 Aug	17:12	49 8.09	127 24.54	801
83	17 Aug	21:21	49 8.20	126 58.11	403
84	17 Aug	21:54	49 8.16	126 48.00	149
85	19 Aug	1:56	49 38.11	127 18.33	150
86	19 Aug	2:16	49 38.13	127 24.27	419
87	19 Aug	3:46	49 38.01	127 50.85	1,360
88	19 Aug	23:04	50 8.14	128 2.71	264
98	19 Aug	23:11	50 8.15	128 4.79	432
90	20 Aug	2:55	50 8.23	128 34.22	805
91	21 Aug	1:17	50 38.12	128 32.70	155
92	21 Aug	2:14	50 38.08	128 50.30	468
93	23 Aug	14:11	51 38.11	129 47.70	201
94	23 Aug	14:17	51 38.14	129 49.54	204
95	23 Aug	15:19	51 38.15	130 9.54	494
96	23 Aug	19:24	51 38.16	130 48.05	1,005
97	24 Aug	16:31	51 8.13	130 23.00	809

Table 12--Summary of conductivity-temperature-depth casts made from the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Number	Date	Time (PDT)	Latitude	Longitude	Depth (m) Cast	Bottom
1	7 Aug	6:01	52 55.97	132 26.25	105	220
2	7 Aug	6:28	52 55.98	132 28.91	279	580
3	7 Aug	7:12	52 55.99	132 33.40	502	1430
4	7 Aug	8:43	52 55.91	132 43.45	501	1233
5	7 Aug	10:10	52 56.05	132 58.45	499	>1500
6	8 Aug	3:56	53 29.76	132 58.93	65	140
7	8 Aug	4:34	53 30.02	133 3.53	106	224
8	8 Aug	5:05	53 30.04	133 7.18	222	460
9	8 Aug	14:13	53 29.63	133 15.84	500	1022
10	9 Aug	4:34	54 21.71	132 59.86	90	195
11	9 Aug	5:10	54 24.66	133 4.94	200	447
12	9 Aug	6:51	54 21.73	133 21.94	170	353
13	9 Aug	7:56	54 21.74	133 34.05	114	240
14	9 Aug	9:21	54 21.56	133 52.76	326	658
15	10 Aug	5:32	55 0.01	134 32.04	498	1498
16	10 Aug	8:42	55 0.10	134 27.16	445	998
17	10 Aug	9:28	55 0.02	134 23.95	152	380
18	10 Aug	9:57	55 0.05	134 20.89	106	232
19	10 Aug	10:26	54 59.92	134 17.44	99	210
20	10 Aug	10:53	55 0.01	134 14.02	88	196
21	11 Aug	5:23	55 40.04	134 54.52	81	197
22	11 Aug	6:15	55 40.06	135 2.26	92	203
23	11 Aug	7:03	55 39.92	135 7.19	240	520
24	11 Aug	7:42	55 39.99	135 10.60	360	833
25	11 Aug	8:30	55 40.10	135 13.77	537	1130
26	12 Aug	5:18	56 40.12	135 41.04	73	166
27	12 Aug	6:06	56 35.57	135 43.68	95	200
28	12 Aug	6:40	56 33.04	135 45.23	119	250
29	12 Aug	7:19	56 30.71	135 46.54	325	639
30	12 Aug	8:09	56 27.99	135 48.33	505	1100
31	13 Aug	0:28	57 50.94	136 46.38	67	147
32	13 Aug	6:27	58 5.97	136 48.63	110	231
33	13 Aug	8:12	58 1.52	137 4.26	175	364
34	13 Aug	9:53	57 56.29	137 21.72	75	163
35	13 Aug	10:44	57 57.11	137 29.36	173	390
36	13 Aug	11:40	57 52.48	137 34.85	469	923
37	13 Aug	19:29	57 57.03	138 31.63	752	2096
38	13 Aug	21:22	57 58.61	138 30.93	502	2400
39	13 Aug	22:36	58 0.89	138 28.73	500	1100
40	13 Aug	23:26	58 2.55	138 27.34	98	225
41	14 Aug	0:13	58 6.01	138 24.56	80	174
42	16 Aug	7:19	54 11.22	132 21.81	42	106
43	16 Aug	7:54	54 14.58	132 21.67	67	151
44	16 Aug	8:22	54 16.53	132 21.63	87	192
45	16 Aug	9:23	54 23.14	132 21.69	124	262
46	16 Aug	10:03	54 26.01	132 21.77	167	342
47	19 Aug	5:11	52 6.58	131 0.51	12	30

Table 13.--Estimated biomass at length (in 1,000s of metric tons) of Pacific hake by area for the 1998 joint U.S.-Canada echo integration-trawl survey of the U.S. and Canadian west coasts. Area boundaries are defined in Table 2.

			Columbia		Vancouver			Charlotte				SE Alaska		
Length	Monterey	Eureka	South	North	U.S.	South	North	SW	QCI	Hecate	Dixon	disputed	U.S.	Total
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
19	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06
20	0.00	0.00	0.05	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.08	0.16
21	0.00	0.00	0.05	0.01	0.00	0.03	0.01	0.01	0.00	0.04	0.00	0.00	0.19	0.35
22	0.01	0.01	0.04	0.01	0.00	0.06	0.01	0.09	0.00	0.07	0.00	0.00	0.19	0.48
23	0.01	0.00	0.05	0.01	0.00	0.16	0.01	0.28	0.00	0.12	0.00	0.00	0.14	0.79
24	0.01	0.01	0.05	0.01	0.00	0.18	0.00	0.86	0.00	0.12	0.00	0.00	0.06	1.29
25	0.05	0.02	0.02	0.00	0.01	0.08	0.01	1.57	0.00	0.12	0.00	0.00	0.01	1.88
26	0.12	0.02	0.00	0.00	0.00	0.03	0.01	1.73	0.00	0.04	0.00	0.00	0.00	1.94
27	1.02	0.19	0.01	0.00	0.00	0.02	0.00	0.81	0.00	0.03	0.00	0.00	0.00	2.08
28	2.04	0.67	0.00	0.01	0.01	0.00	0.01	0.23	0.00	0.00	0.00	0.00	0.00	2.96
29	2.63	2.62	0.02	0.00	0.00	0.00	0.01	0.08	0.00	0.00	0.00	0.00	0.00	5.35
30	1.99	5.36	0.18	0.02	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	7.57
31	1.07	8.56	0.62	0.07	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	10.34
32	0.90	9.98	2.36	0.27	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.54
33	0.56	9.36	5.00	0.74	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.84
34	0.68	6.33	6.56	1.29	0.49	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.38
35	0.48	3.52	5.54	1.63	0.91	0.11	0.03	0.05	0.00	0.00	0.00	0.00	0.00	12.26
36	0.56	2.83	5.72	1.87	1.12	0.12	0.07	0.11	0.00	0.00	0.00	0.00	0.00	12.39
37	0.94	3.82	9.68	2.26	1.48	0.31	0.31	0.50	0.00	0.00	0.00	0.00	0.00	19.30
38	1.10	4.65	13.25	3.10	2.24	0.59	0.68	1.10	0.02	0.00	0.00	0.00	0.01	26.75
39	1.04	4.50	14.88	3.72	3.11	1.10	1.74	2.81	0.02	0.05	0.00	0.00	0.01	32.98
40	0.67	4.50	14.05	3.91	3.82	1.67	2.91	4.70	0.09	0.06	0.02	0.00	0.06	36.44
41	0.79	3.86	14.84	4.01	4.70	2.53	4.98	8.04	0.11	0.31	0.03	0.01	0.07	44.27
42	0.47	4.31	16.11	4.96	7.11	4.42	8.37	13.58	0.31	1.08	0.08	0.02	0.20	61.02
43	0.42	6.90	23.43	6.44	9.83	6.53	12.98	20.97	0.85	1.61	0.21	0.04	0.54	90.75
44	0.38	6.63	22.12	6.97	12.27	8.54	14.83	23.96	2.42	3.31	0.60	0.12	1.53	103.68
45	0.44	6.80	21.73	6.08	12.75	9.88	17.12	27.66	4.37	5.31	1.08	0.22	2.76	116.21
46	0.38	6.28	19.80	4.38	12.26	10.29	13.70	22.13	7.45	8.09	1.84	0.38	4.70	111.68
47	0.37	4.64	15.47	3.78	10.81	9.20	10.72	17.32	9.70	11.18	2.39	0.49	6.12	102.18

Table 13.--Continued.

			Columbia		Vancouver			Charlotte				SE Alaska		
Length	Monterey	Eureka	South	North	U.S.	South	North	SW	QCI	Hecate	Dixon	disputed	U.S.	Total
48	0.11	3.66	8.83	2.77	8.78	7.40	7.23	11.68	12.79	11.32	3.15	0.65	8.07	86.44
49	0.05	2.00	4.61	2.03	6.00	5.05	4.45	7.19	12.19	13.14	3.00	0.62	7.70	68.03
50	0.08	1.09	1.66	1.36	3.58	2.93	2.47	3.99	11.65	12.29	2.87	0.59	7.35	51.89
51	0.03	0.33	0.72	0.85	2.68	2.19	1.39	2.25	9.00	11.76	2.22	0.46	5.68	39.56
52	0.00	0.28	0.38	0.45	1.68	1.49	0.74	1.20	6.08	8.36	1.50	0.31	3.84	26.31
53	0.02	0.04	0.30	0.42	1.10	0.92	0.51	0.83	4.60	6.33	1.13	0.23	2.90	19.32
54	0.00	0.04	0.15	0.58	0.90	0.49	0.27	0.43	2.68	5.49	0.66	0.14	1.69	13.53
55	0.00	0.07	0.25	0.51	0.69	0.35	0.37	0.60	1.80	3.82	0.44	0.09	1.14	10.13
56	0.16	0.01	0.00	0.36	0.62	0.36	0.14	0.23	1.80	2.33	0.44	0.09	1.14	7.67
57	0.00	0.00	0.07	0.18	0.77	0.63	0.15	0.24	0.96	2.09	0.24	0.05	0.60	5.95
58	0.00	0.04	0.17	0.22	0.21	0.07	0.10	0.16	0.87	1.16	0.21	0.04	0.55	3.80
59	0.02	0.00	0.06	0.05	0.27	0.23	0.12	0.20	0.14	1.13	0.03	0.01	0.09	2.35
60	0.00	0.00	0.09	0.11	0.18	0.11	0.06	0.10	0.48	0.69	0.12	0.02	0.31	2.26
61	0.09	0.01	0.07	0.12	0.49	0.39	0.00	0.00	0.07	0.44	0.02	0.00	0.04	1.74
62	0.10	0.01	0.10	0.13	0.20	0.18	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.96
63	0.00	0.00	0.08	0.19	0.21	0.08	0.00	0.00	0.08	0.19	0.02	0.00	0.05	0.90
64	0.00	0.00	0.10	0.01	0.04	0.04	0.00	0.00	0.09	0.16	0.02	0.00	0.06	0.53
65	0.00	0.00	0.12	0.03	0.01	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.35
66	0.04	0.06	0.00	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
67	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
68	0.04	0.01	0.11	0.01	0.05	0.14	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.55
69	0.03	0.00	0.00	0.00	0.06	0.05	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.20
70	0.00	0.00	0.00	0.05	0.03	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.28
71	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.03	0.03	0.01	0.08	0.34
72	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
73	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
74	0.04	0.01	0.00	0.08	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	20.16	114.21	229.50	66.12	111.82	78.94	106.48	177.69	90.74	113.17	22.35	4.59	57.98	1,193.76

Table 14.--Estimated numbers at length (1,000,000s of fish) of Pacific hake by area for the 1998 joint U.S.-Canada echo integration-trawl survey of the U.S. and Canadian west coasts. Area boundaries are defined in Table 2.

			Columbia		Vancouver			Charlotte				SE Alaska		
Length	Monterey	Eureka	South	North	U.S.	South	North	SW	QCI	Hecate	Dixon	disputed	U.S.	Total
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.01	0.00	0.03	0.11
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.00	0.05	0.02	0.01	0.00	0.03	0.17
18	0.00	0.00	0.27	0.08	0.04	0.00	0.03	0.05	0.00	0.01	0.00	0.00	0.05	0.54
19	0.00	0.00	0.54	0.23	0.14	0.11	0.00	0.00	0.00	0.07	0.00	0.00	0.40	1.49
20	0.00	0.00	1.15	0.15	0.04	0.19	0.03	0.18	0.00	0.72	0.00	0.00	1.68	4.16
21	0.00	0.08	0.95	0.17	0.07	0.63	0.13	0.22	0.00	1.32	0.00	0.00	3.34	6.91
22	0.12	0.08	0.62	0.13	0.05	1.09	0.17	1.53	0.00	1.82	0.00	0.00	2.97	8.57
23	0.16	0.03	0.73	0.08	0.03	2.41	0.21	4.12	0.00	1.66	0.00	0.00	1.87	11.30
24	0.17	0.11	0.59	0.06	0.02	2.27	0.03	11.17	0.00	1.46	0.00	0.00	0.66	16.55
25	0.55	0.20	0.18	0.04	0.07	0.92	0.13	18.03	0.00	0.38	0.00	0.00	0.15	20.64
26	1.26	0.16	0.00	0.01	0.03	0.28	0.04	17.51	0.00	0.29	0.00	0.00	0.03	19.62
27	9.20	1.71	0.07	0.02	0.01	0.17	0.00	7.33	0.00	0.01	0.00	0.00	0.00	18.51
28	16.46	5.42	0.00	0.05	0.06	0.03	0.03	1.82	0.00	0.01	0.00	0.00	0.00	23.89
29	19.00	18.96	0.12	0.01	0.00	0.00	0.04	0.57	0.00	0.00	0.00	0.00	0.00	38.69
30	12.97	34.85	1.17	0.11	0.04	0.03	0.03	0.05	0.00	0.00	0.00	0.00	0.00	49.25
31	6.31	50.32	3.65	0.38	0.01	0.00	0.03	0.05	0.00	0.00	0.00	0.00	0.00	60.77
32	4.81	53.15	12.56	1.44	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72.12
33	2.72	45.34	24.22	3.58	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.72
34	3.01	27.94	28.96	5.71	2.18	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.89
35	1.93	14.21	22.35	6.56	3.68	0.42	0.12	0.19	0.00	0.00	0.00	0.00	0.00	49.46
36	2.06	10.47	21.13	6.90	4.16	0.44	0.25	0.41	0.00	0.00	0.00	0.00	0.00	45.82
37	3.19	12.97	32.88	7.68	5.02	1.05	1.05	1.70	0.00	0.00	0.00	0.00	0.00	65.53
38	3.44	14.54	41.43	9.69	7.01	1.85	2.13	3.45	0.05	0.15	0.01	0.00	0.03	83.78
39	3.01	12.97	42.91	10.74	8.98	3.18	5.02	8.11	0.04	0.17	0.01	0.00	0.03	95.15
40	1.79	11.98	37.45	10.41	10.19	4.44	7.76	12.54	0.22	0.74	0.05	0.01	0.15	97.73
41	1.96	9.53	36.65	9.89	11.60	6.26	12.29	19.86	0.26	2.42	0.06	0.01	0.16	110.93
42	1.08	9.88	36.93	11.38	16.30	10.12	19.18	31.12	0.65	3.35	0.16	0.03	0.41	140.60
43	0.89	14.71	49.93	13.72	20.94	13.91	27.65	44.68	1.65	6.42	0.41	0.08	1.04	196.04
44	0.75	13.16	43.90	13.83	24.35	16.93	29.42	47.54	4.37	9.61	1.08	0.22	2.76	207.93
45	0.81	12.59	40.22	11.25	23.60	18.29	31.68	51.19	7.36	13.65	1.81	0.37	4.65	217.48
46	0.66	10.86	34.23	7.57	21.20	17.79	23.68	38.26	11.74	17.62	2.89	0.60	7.41	194.50
47	0.60	7.51	25.02	6.11	17.47	14.87	17.33	28.01	14.30	16.69	3.52	0.73	9.03	161.19

Table 14.--Continued.

			Columbia		Vancouver			Charlotte				SE Alaska		
Length	Monterey	Eureka	South	North	U.S.	South	North	SW	QCI	Hecate	Dixon	disputed	U.S.	Total
48	0.17	5.55	13.38	4.20	13.30	11.20	10.95	17.69	17.67	18.15	4.35	0.90	11.15	128.66
49	0.07	2.84	6.55	2.88	8.52	7.18	6.33	10.22	15.81	15.94	3.90	0.80	9.98	91.02
50	0.10	1.45	2.22	1.81	4.78	3.90	3.29	5.32	14.19	14.33	3.50	0.72	8.95	64.57
51	0.03	0.41	0.91	1.07	3.37	2.74	1.75	2.82	10.31	9.58	2.54	0.52	6.51	42.57
52	0.00	0.33	0.45	0.53	1.98	1.76	0.88	1.42	6.57	6.83	1.62	0.33	4.14	26.84
53	0.02	0.05	0.33	0.47	1.23	1.02	0.57	0.92	4.69	5.59	1.15	0.24	2.96	19.23
54	0.00	0.05	0.16	0.61	0.95	0.51	0.28	0.46	2.57	3.67	0.63	0.13	1.62	11.63
55	0.00	0.07	0.24	0.51	0.69	0.35	0.37	0.60	1.63	2.11	0.40	0.08	1.03	8.07
56	0.15	0.01	0.00	0.33	0.58	0.34	0.13	0.21	1.55	1.79	0.38	0.08	0.98	6.54
57	0.00	0.00	0.06	0.16	0.68	0.56	0.13	0.21	0.78	0.94	0.19	0.04	0.49	4.23
58	0.00	0.04	0.14	0.19	0.18	0.05	0.08	0.14	0.67	0.87	0.17	0.03	0.42	2.98
59	0.02	0.00	0.05	0.04	0.21	0.18	0.10	0.16	0.10	0.50	0.02	0.01	0.06	1.45
60	0.00	0.00	0.07	0.08	0.14	0.08	0.04	0.07	0.34	0.30	0.08	0.02	0.21	1.44
61	0.06	0.01	0.05	0.09	0.35	0.28	0.00	0.00	0.04	0.17	0.01	0.00	0.03	1.09
62	0.07	0.01	0.06	0.09	0.14	0.12	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.61
63	0.00	0.00	0.05	0.12	0.13	0.05	0.00	0.00	0.05	0.09	0.01	0.00	0.03	0.54
64	0.00	0.00	0.06	0.01	0.03	0.03	0.00	0.00	0.05	0.11	0.01	0.00	0.03	0.32
65	0.00	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
66	0.02	0.03	0.00	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
67	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.15
68	0.02	0.00	0.06	0.01	0.03	0.07	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.22
69	0.01	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.16
70	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.05
71	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.03	0.01	0.00	0.03	0.15
72	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
73	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
74	0.02	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	99.77	404.63	565.75	151.32	215.72	148.24	203.37	389.91	117.81	159.95	28.99	5.95	85.50	2,576.92

Table 15.--Estimated biomass at age (in 1,000s of metric tons) of Pacific hake by area for the 1998 joint U.S.-Canada echo integration-trawl survey of the U.S. and Canadian west coasts. Area boundaries are defined in Table 2.

Age	Monterey	Eureka	Columbia		Vancouver			Charlotte				SE Alaska		Total
			South	North	U.S.	South	North	SW	QCI	Hecate	Dixon	disputed	U.S.	
1	0.1	0.2	0.3	0.1	0.0	0.6	0.1	5.6	0.0	1.0	0.0	0.0	0.7	8.6
2	9.5	40.7	18.3	5.5	3.0	0.4	0.2	0.5	0.0	0.3	0.0	0.0	0.0	78.3
3	6.1	24.5	59.1	15.6	14.1	5.8	10.2	16.5	1.0	5.5	0.2	0.1	0.6	159.3
4	1.2	9.6	25.0	8.9	19.9	15.6	27.6	44.5	15.2	23.4	3.7	0.8	9.6	205.1
5	0.7	12.7	61.3	13.4	22.8	16.6	31.2	50.5	15.4	17.6	3.8	0.8	9.7	256.6
6	0.1	0.5	2.3	1.1	3.6	2.9	1.6	2.7	1.7	2.2	0.4	0.1	1.1	20.2
7	0.5	3.9	10.6	2.6	6.5	5.2	5.5	8.9	15.4	14.4	3.8	0.8	9.7	87.7
8	0.3	10.2	26.2	7.4	15.6	11.8	11.7	18.9	11.5	10.9	2.8	0.6	7.3	135.1
9	0.4	1.3	4.1	0.9	1.6	1.1	1.1	1.8	1.6	1.3	0.4	0.1	1.0	16.8
10	0.1	1.1	0.2	0.2	1.0	1.1	2.6	4.2	6.4	7.4	1.6	0.3	4.1	30.2
11	0.7	2.8	9.6	5.3	10.9	8.1	8.4	13.6	8.4	9.0	2.1	0.4	5.3	84.7
12	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.3	1.6	2.5	0.4	0.1	1.0	6.6
13	0.2	0.8	0.7	0.0	0.2	0.2	0.0	0.0	0.4	0.6	0.1	0.0	0.3	3.7
14	0.3	4.4	10.0	3.6	8.4	6.4	4.6	7.4	9.3	15.4	2.3	0.5	5.9	78.3
15	0.0	0.8	0.9	0.8	1.2	0.6	0.0	0.0	0.5	0.2	0.1	0.0	0.3	5.4
16	0.0	0.4	0.1	0.4	1.1	0.8	0.3	0.5	0.1	0.3	0.0	0.0	0.1	4.2
17	0.0	0.0	0.0	0.0	0.3	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.8
18	0.0	0.0	0.0	0.3	0.6	0.4	0.7	1.1	2.1	1.1	0.5	0.1	1.3	8.2
19	0.0	0.0	0.0	0.0	0.7	0.7	0.1	0.1	0.1	0.1	0.0	0.0	0.1	2.0
20	0.0	0.1	0.8	0.0	0.2	0.2	0.2	0.4	0.0	0.0	0.0	0.0	0.0	2.0
Total	20.1	114.2	229.5	66.1	111.8	78.9	106.5	177.7	90.7	113.3	22.4	4.6	58.0	1,193.8

Table 16.--Estimated numbers at age (1,000,000s of fish) of Pacific hake by area for the 1998 joint U.S.-Canada echo integration-trawl survey of the U.S. and Canadian west coasts. Area boundaries are defined in Table 2.

			Columbia		Vancouver			Charlotte				SE Alaska		
Age	Monterey	Eureka	South	North	U.S.	South	North	SW	QCI	Hecate	Dixon	disputed	U.S.	Total
1	0.9	2.3	5.1	1.0	0.5	8.1	0.8	62.0	0.0	15.6	0.0	0.0	10.8	107.0
2	67.1	224.3	83.8	22.8	11.9	1.4	0.9	1.9	0.0	0.4	0.0	0.0	0.0	414.5
3	22.9	83.6	180.1	45.0	38.2	14.8	25.8	41.7	1.4	7.9	0.4	0.1	0.9	462.6
4	3.1	22.6	58.8	20.1	40.5	30.6	54.9	88.7	20.6	31.7	5.1	1.0	13.0	390.7
5	1.8	27.0	126.8	27.2	44.1	31.5	61.1	98.7	21.0	24.1	5.2	1.1	13.3	482.8
6	0.2	1.0	4.2	2.0	6.6	5.3	3.0	4.9	2.3	2.9	0.6	0.1	1.5	34.6
7	1.1	7.4	19.3	4.7	11.3	9.0	9.5	15.3	20.0	18.7	4.9	1.0	12.6	134.7
8	0.6	17.9	45.9	12.6	25.9	19.3	19.1	30.9	15.0	14.2	3.7	0.8	9.5	215.3
9	0.8	2.4	6.9	1.4	2.4	1.7	1.8	3.0	2.2	1.8	0.5	0.1	1.4	26.2
10	0.0	1.9	0.1	0.1	1.5	1.6	4.2	6.8	7.6	8.7	1.9	0.4	4.8	39.7
11	0.9	4.3	15.3	7.6	15.5	11.5	13.5	21.9	9.9	10.6	2.4	0.5	6.2	120.2
12	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.4	1.9	2.9	0.5	0.1	1.2	7.9
13	0.2	1.3	1.1	0.0	0.4	0.4	0.0	0.0	0.5	0.7	0.1	0.0	0.3	5.0
14	0.3	6.8	15.7	4.7	11.5	9.1	6.6	10.7	11.2	18.7	2.8	0.6	7.1	105.6
15	0.0	1.2	1.3	1.0	1.5	0.8	0.0	0.0	0.6	0.2	0.1	0.0	0.4	7.0
16	0.0	0.6	0.1	0.7	1.5	1.1	0.5	0.8	0.2	0.5	0.0	0.0	0.1	6.2
17	0.0	0.0	0.0	0.0	0.3	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.7
18	0.0	0.0	0.0	0.4	0.6	0.4	0.9	1.4	2.3	1.3	0.6	0.1	1.5	9.5
19	0.0	0.0	0.0	0.0	0.8	0.8	0.1	0.1	0.2	0.1	0.0	0.0	0.1	2.2
20	0.0	0.1	1.3	0.1	0.3	0.4	0.4	0.6	0.0	0.0	0.0	0.0	0.0	3.1
Total	99.8	404.6	565.8	151.3	215.7	148.2	203.4	389.9	116.9	160.9	28.8	5.9	84.5	2,575.7

Table 17.--Summary of acoustic buoy deployments conducted by the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Date	Deployment sequence	Number of passes	Echosign depth (m)
30 Jul	1	7	80-130
	2	4	100-140
1 Aug	3	10	300-350
26 Aug	4	5	100-150
	5	3	100-130
	6	15	80-125

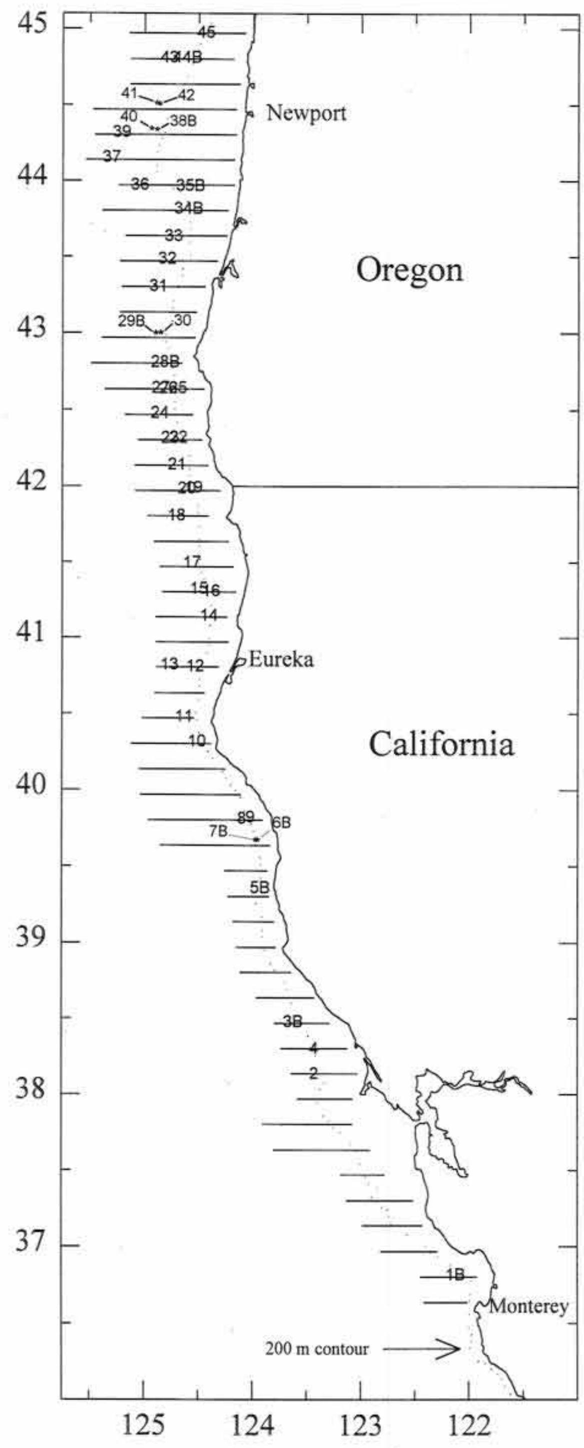


Figure 1a.--Survey trackline and haul locations for the Aleutian wing trawl and poly Nor'eastern bottom trawl (B) for the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

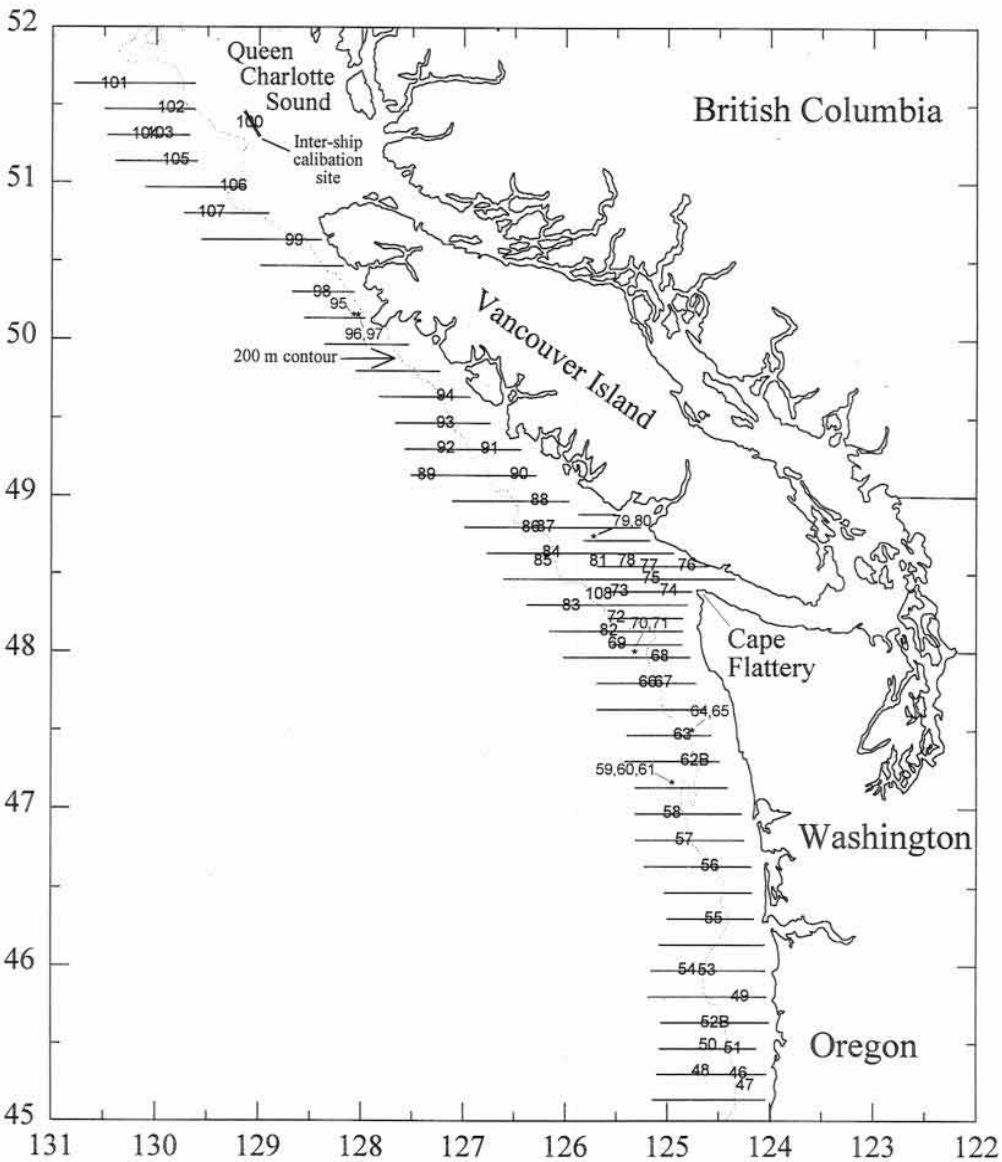


Figure 1a.--Continued.

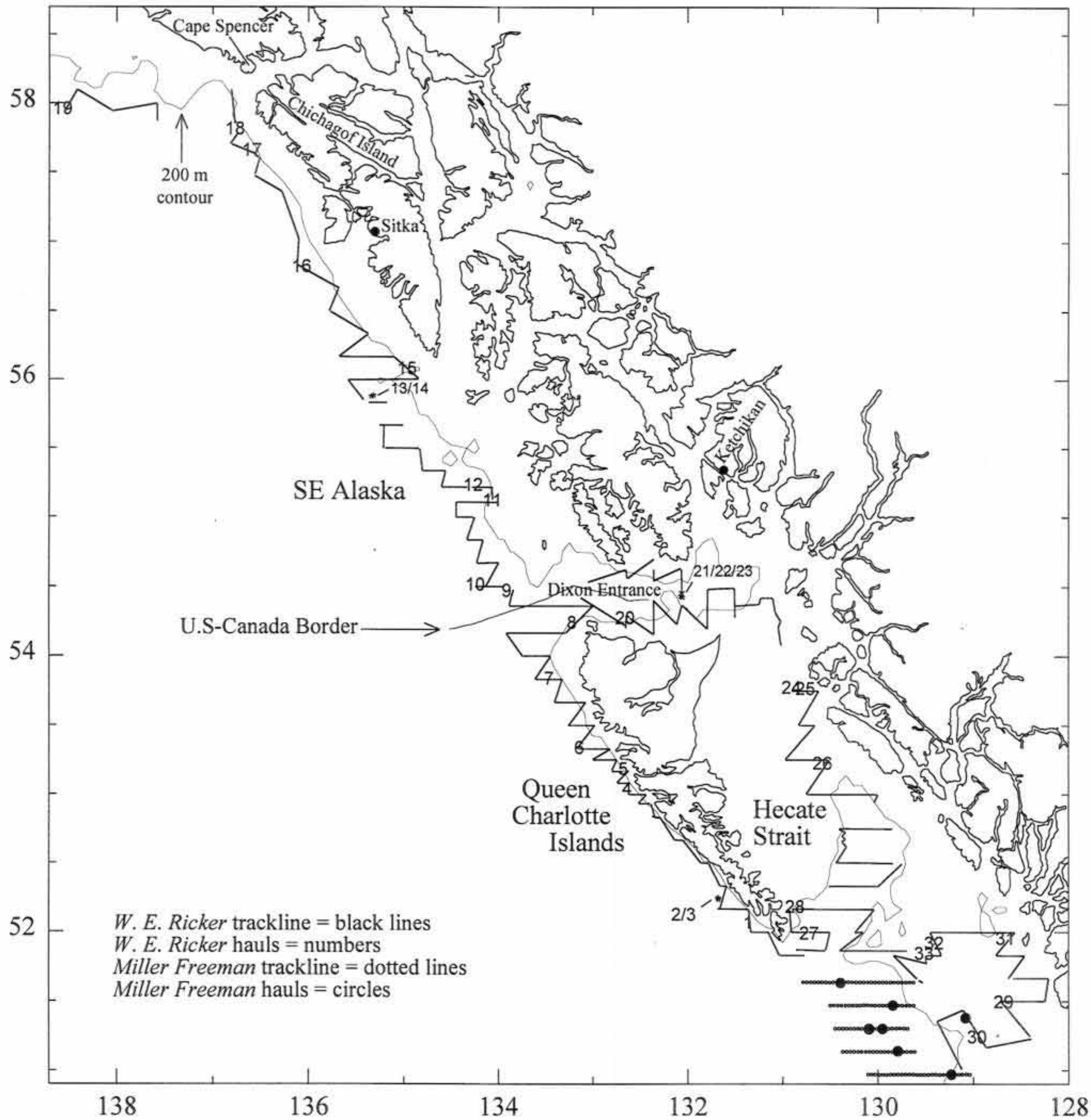


Figure 1b.--Survey trackline and haul locations for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

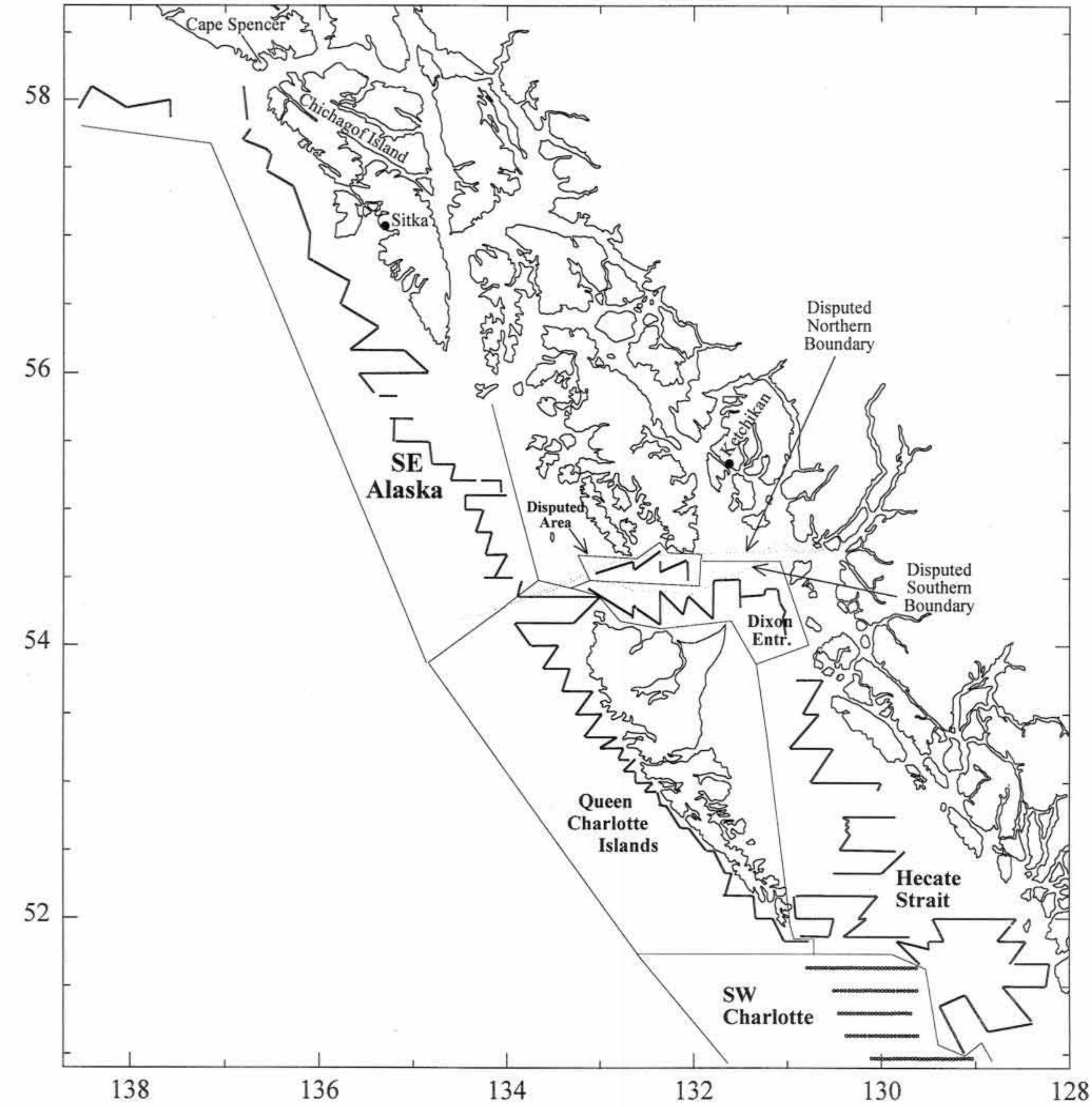


Figure 2.--Geographic subareas (in bold font) used by Canadian researchers for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts. Lines and dots represent Canadian and U.S. tracklines, respectively. The SW Charlotte area was surveyed by U.S. scientists. See Ketchen (1985) for a discussion and description of the U.S.-Canada Disputed area.

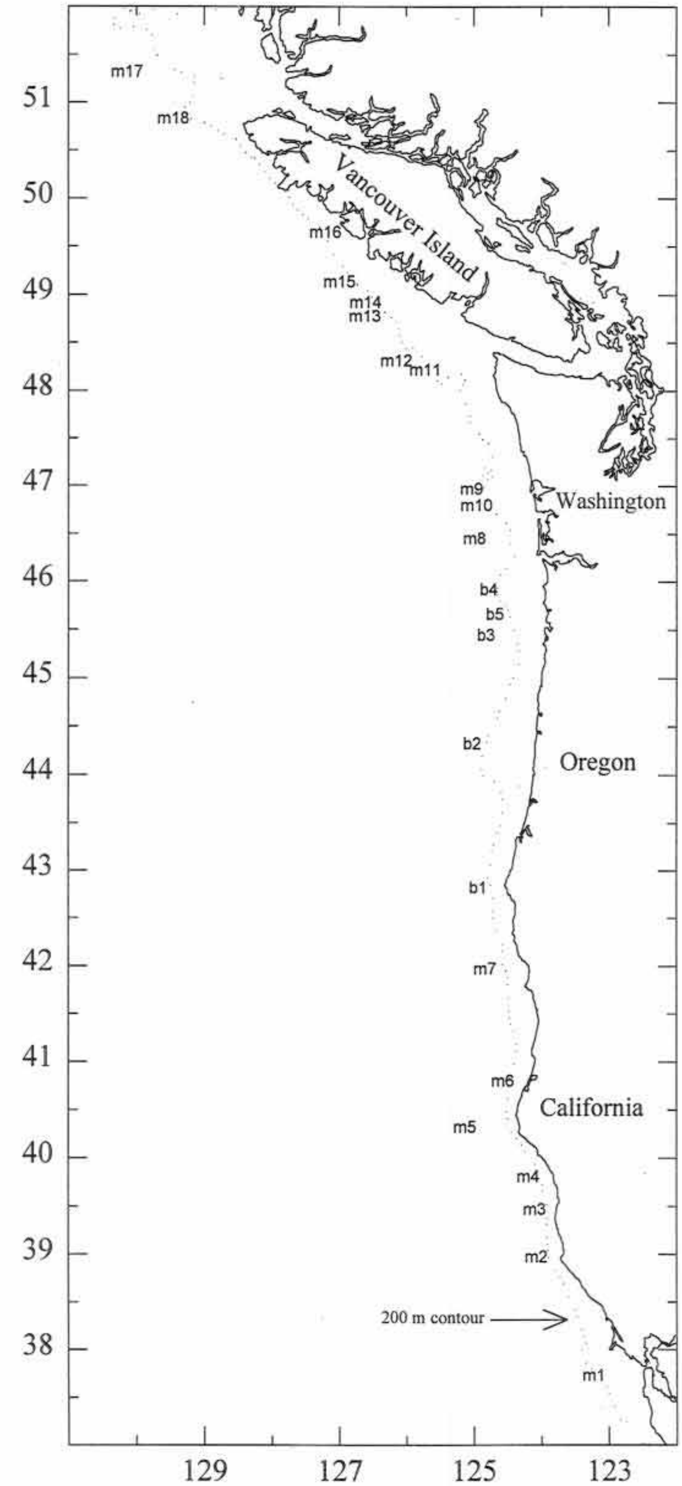


Figure 3.--Methot (m) trawl and bongo (b) net locations for the NOAA ship *Miller Freeman* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

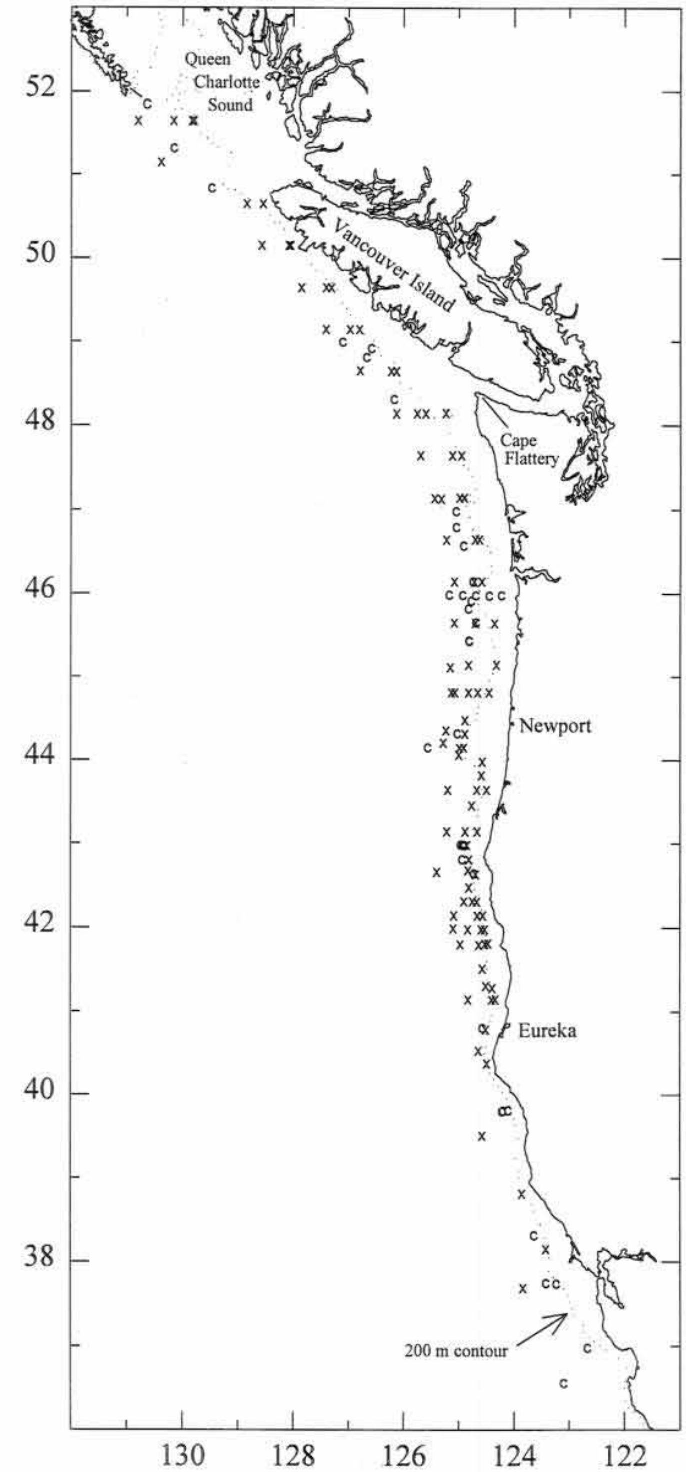


Figure 4.--Conductivity-temperature-depth (c) and expendable bathythermograph (x) cast locations for the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

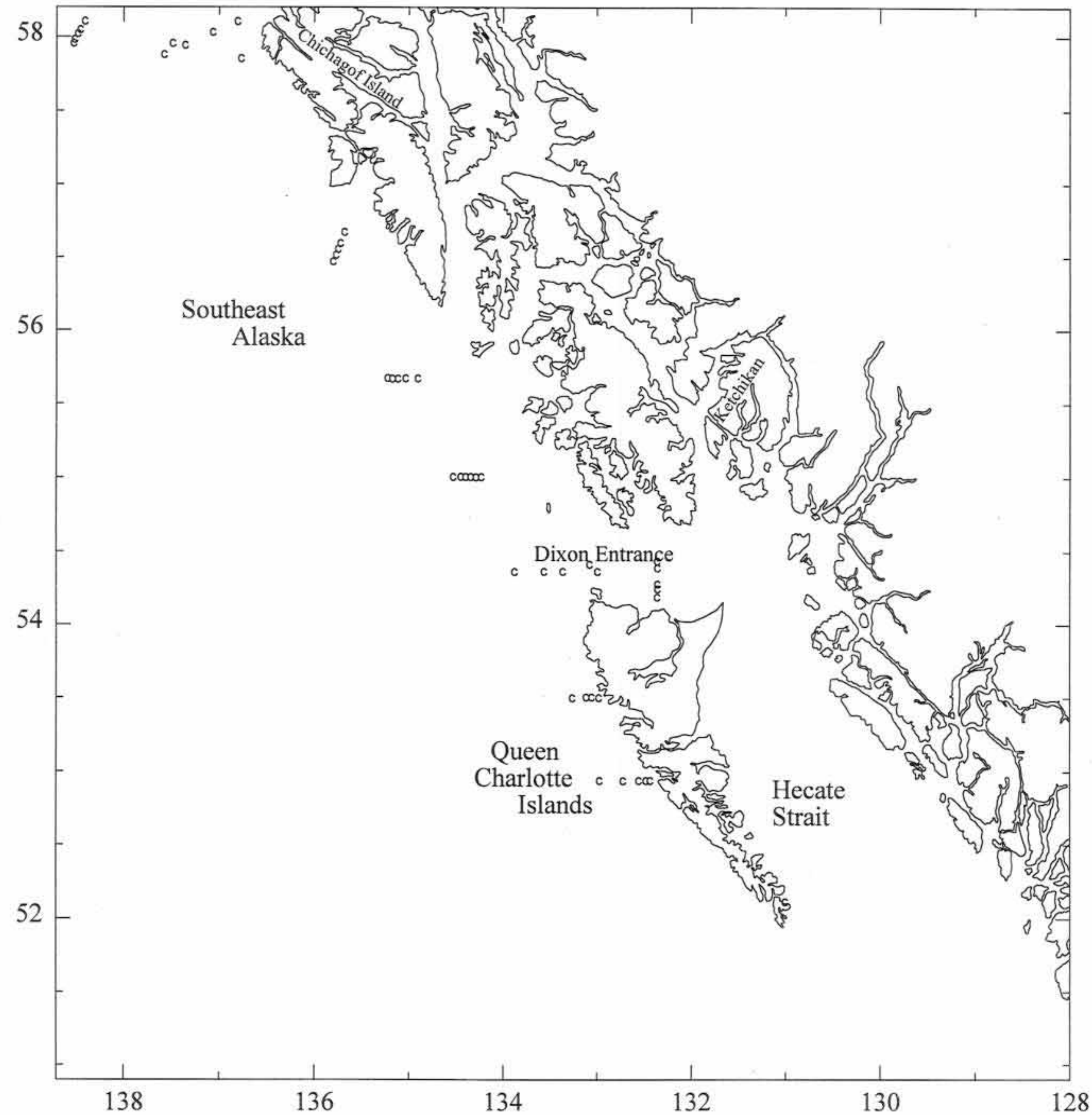


Figure 5.--Conductivity-temperature-depth cast locations for the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

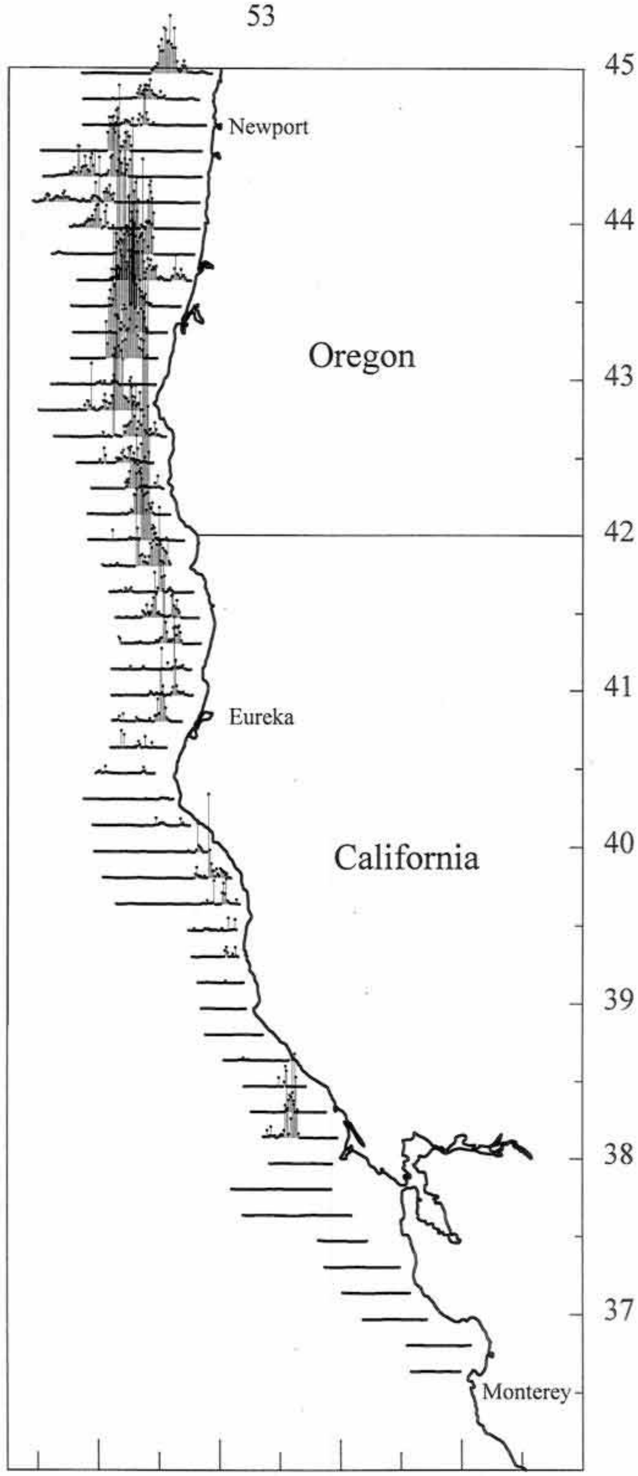


Figure 6a.--Acoustic backscattering attributed to Pacific hake along transects conducted by the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

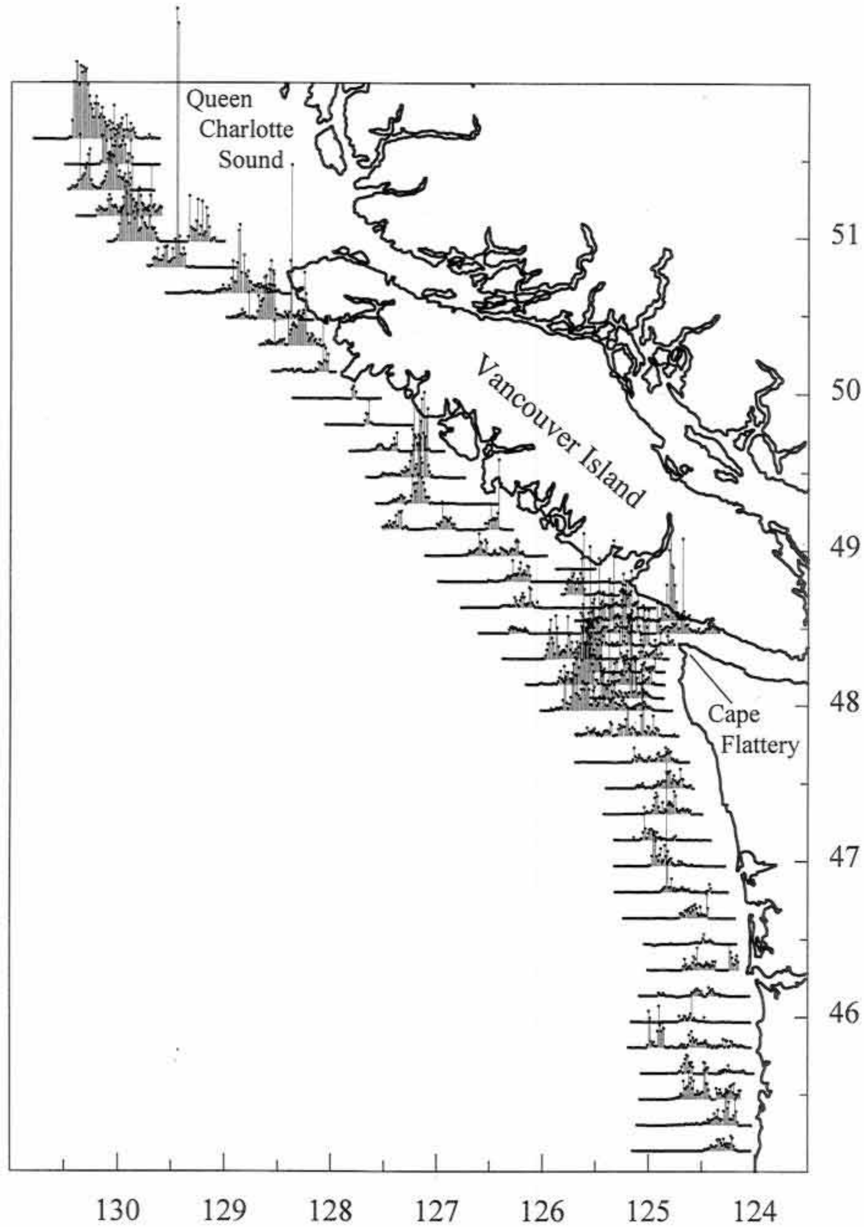


Figure 6a.--Continued.

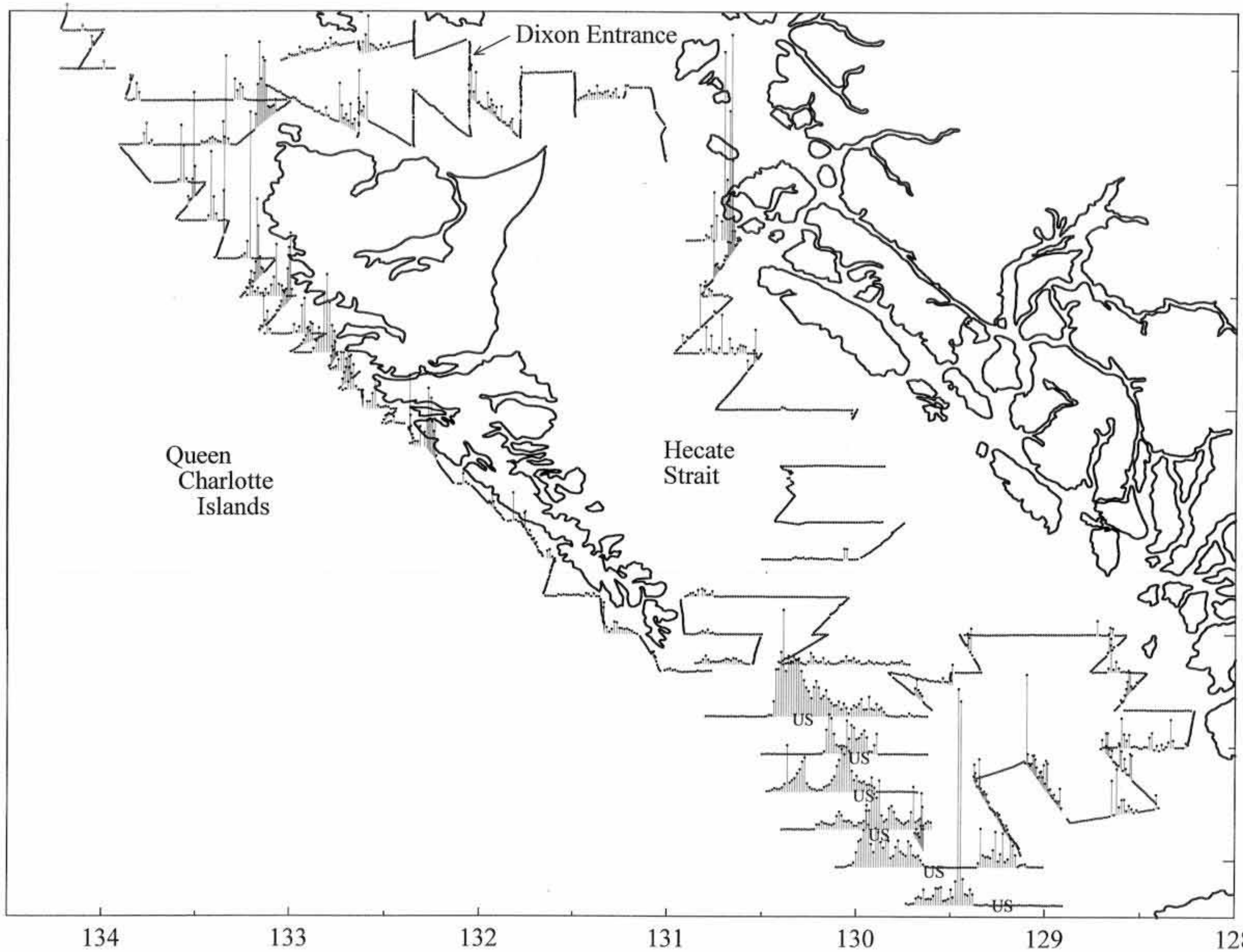
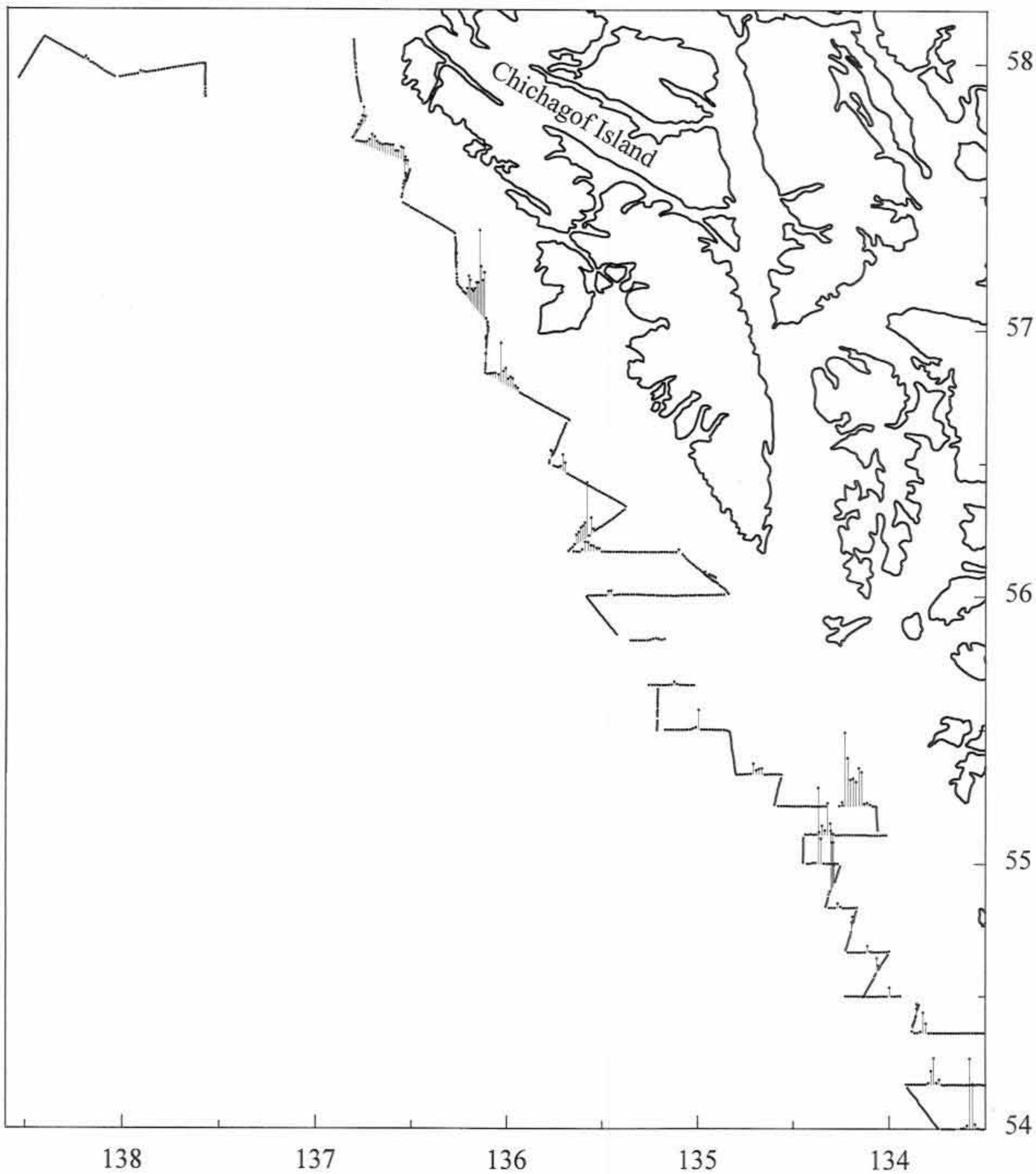


Figure 6b.--Acoustic backscatter attributed to Pacific hake along transects conducted by the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada echo integration-trawl survey of the U.S. and Canada west coasts. Transects conducted by U.S. scientists aboard the NOAA ship *Miller Freeman* are labeled with "US".



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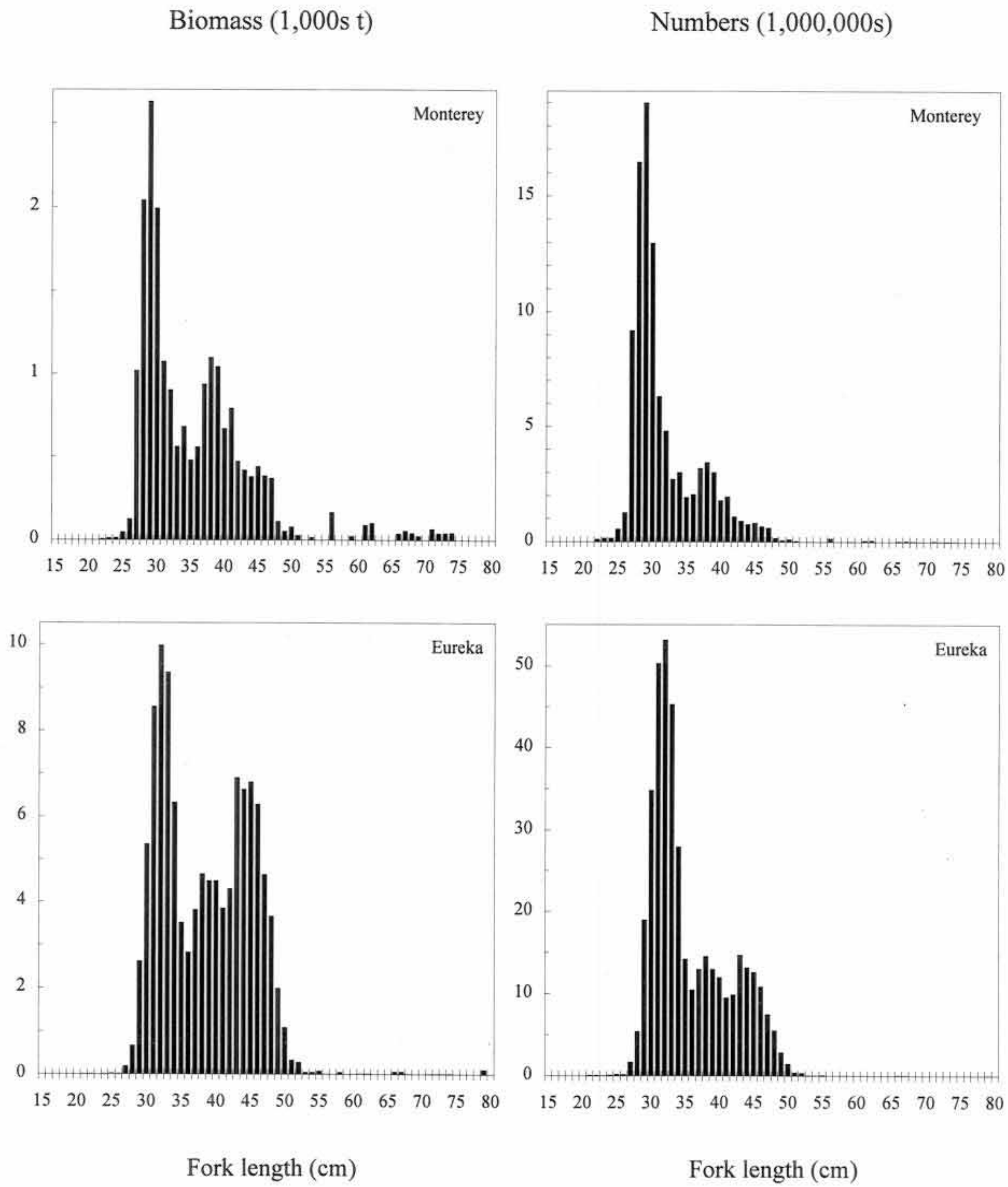
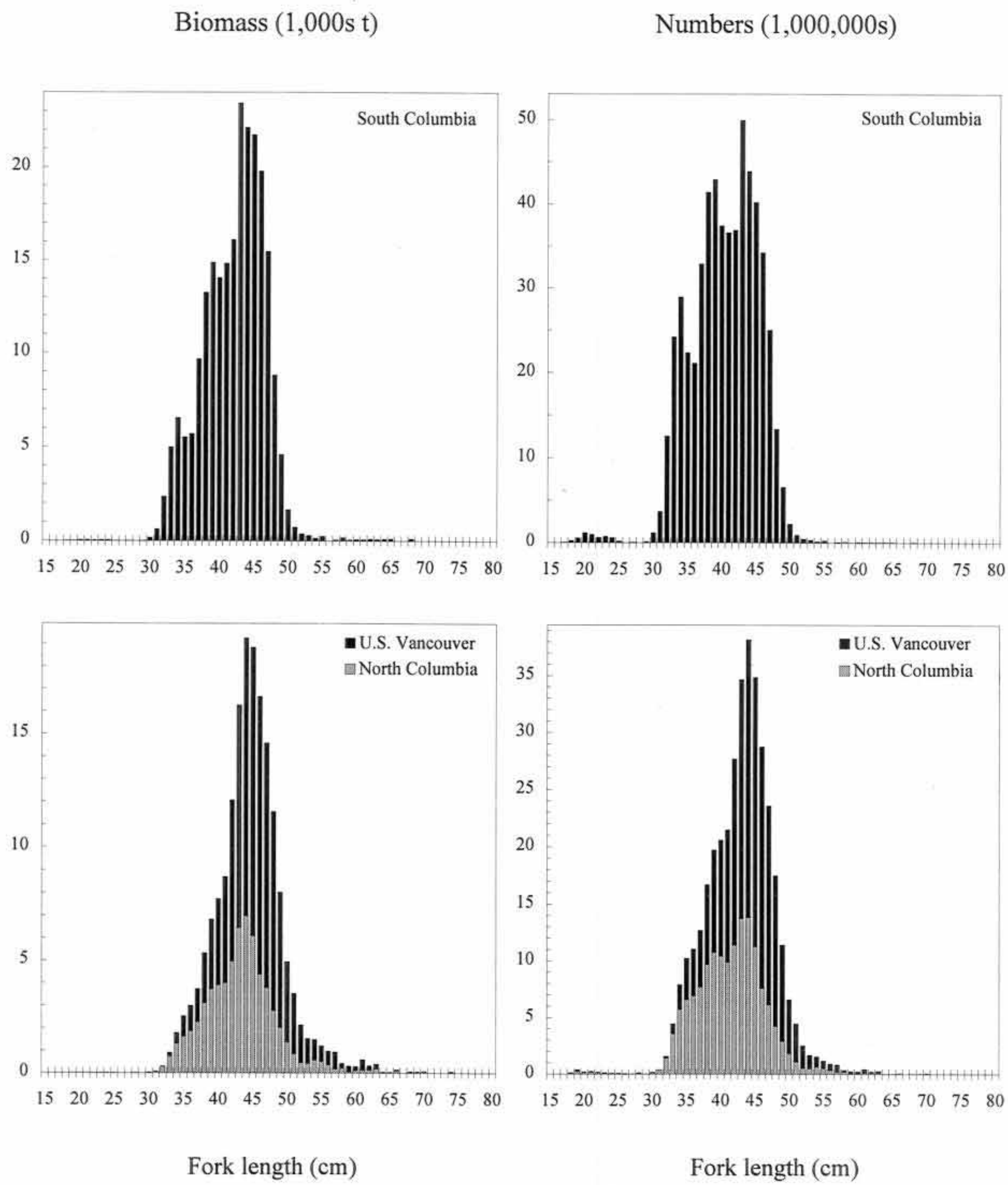


Figure 7.--Biomass (in thousands of metric tons (t)) and numbers at length of Pacific hake by area for the 1998 joint U.S.-Canada echo integration-trawl survey of the U.S. and Canadian west coasts. Area boundaries are defined in Table 2 and Figure 2.



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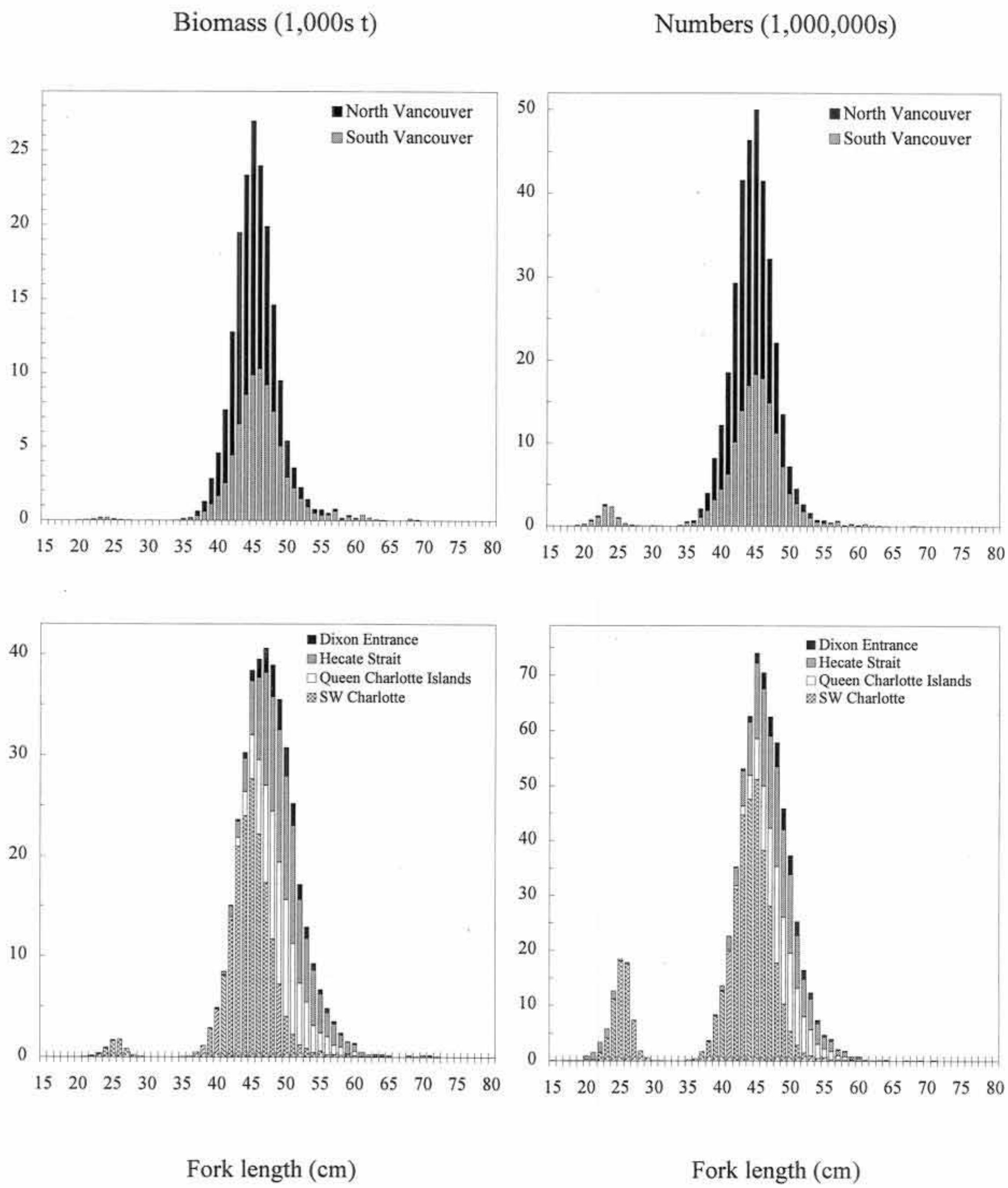

Figure 7.--Continued.

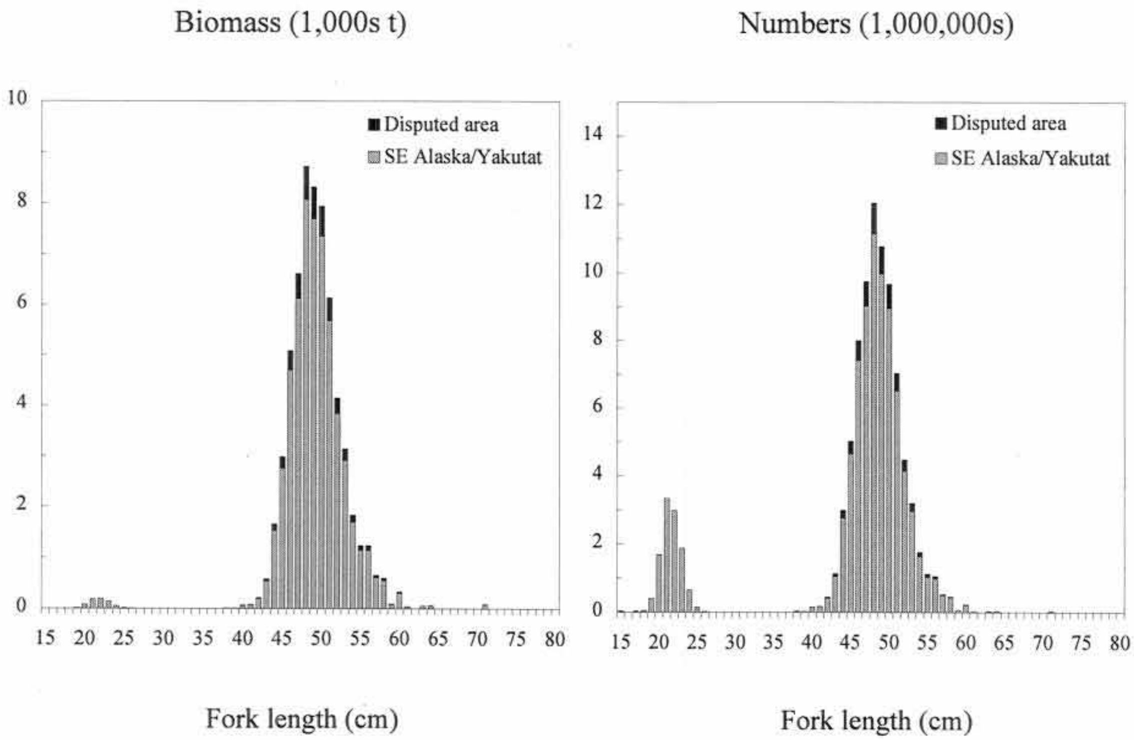

Figure 7.--Continued.

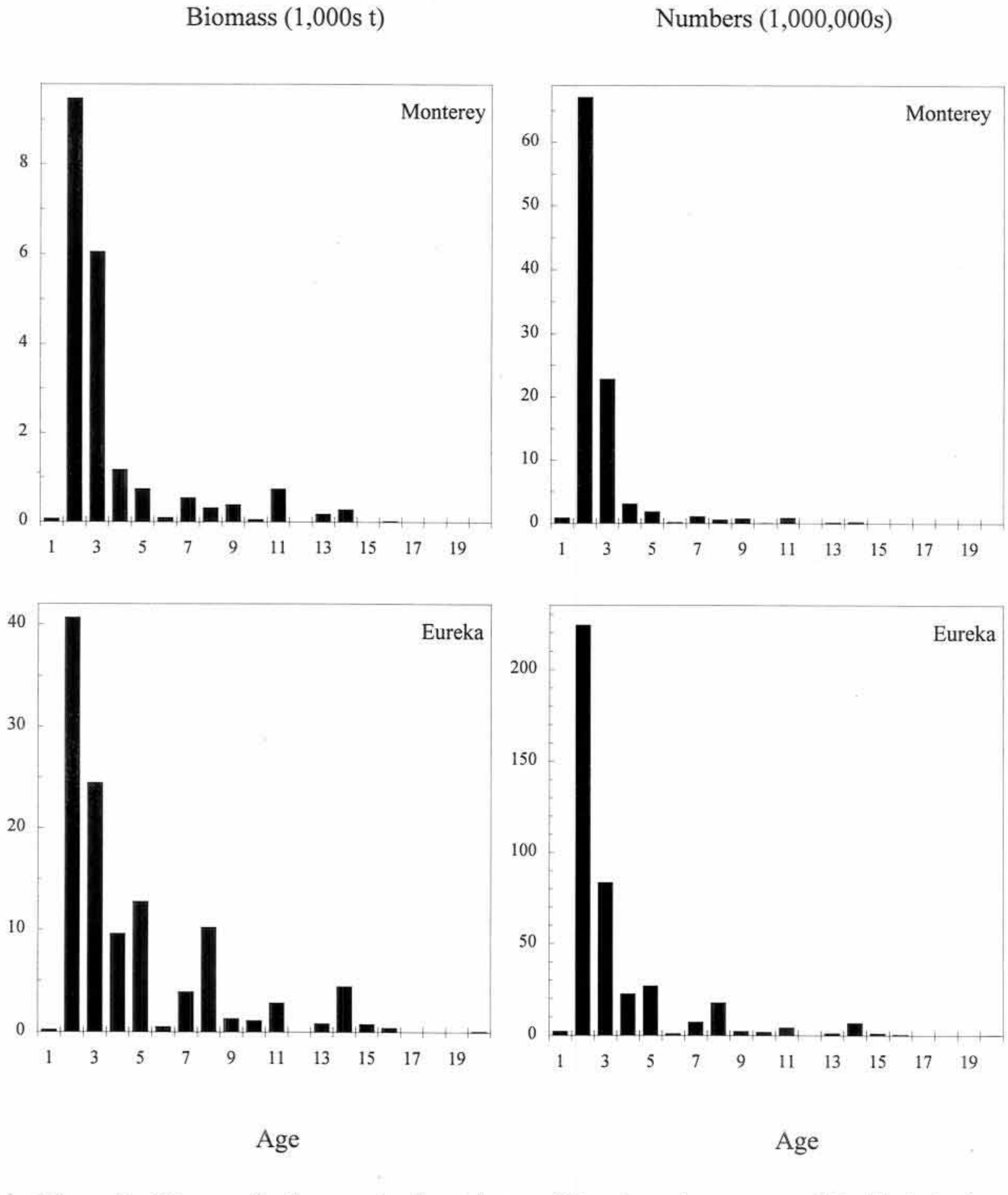

Figure 8.--Biomass (in thousands of metric tons (t)) and numbers at age of Pacific hake by area for the 1998 joint U.S.-Canada echo integration-trawl survey of the U.S. and Canadian west coasts. Area boundaries are defined in Table 2 and Figure 2.

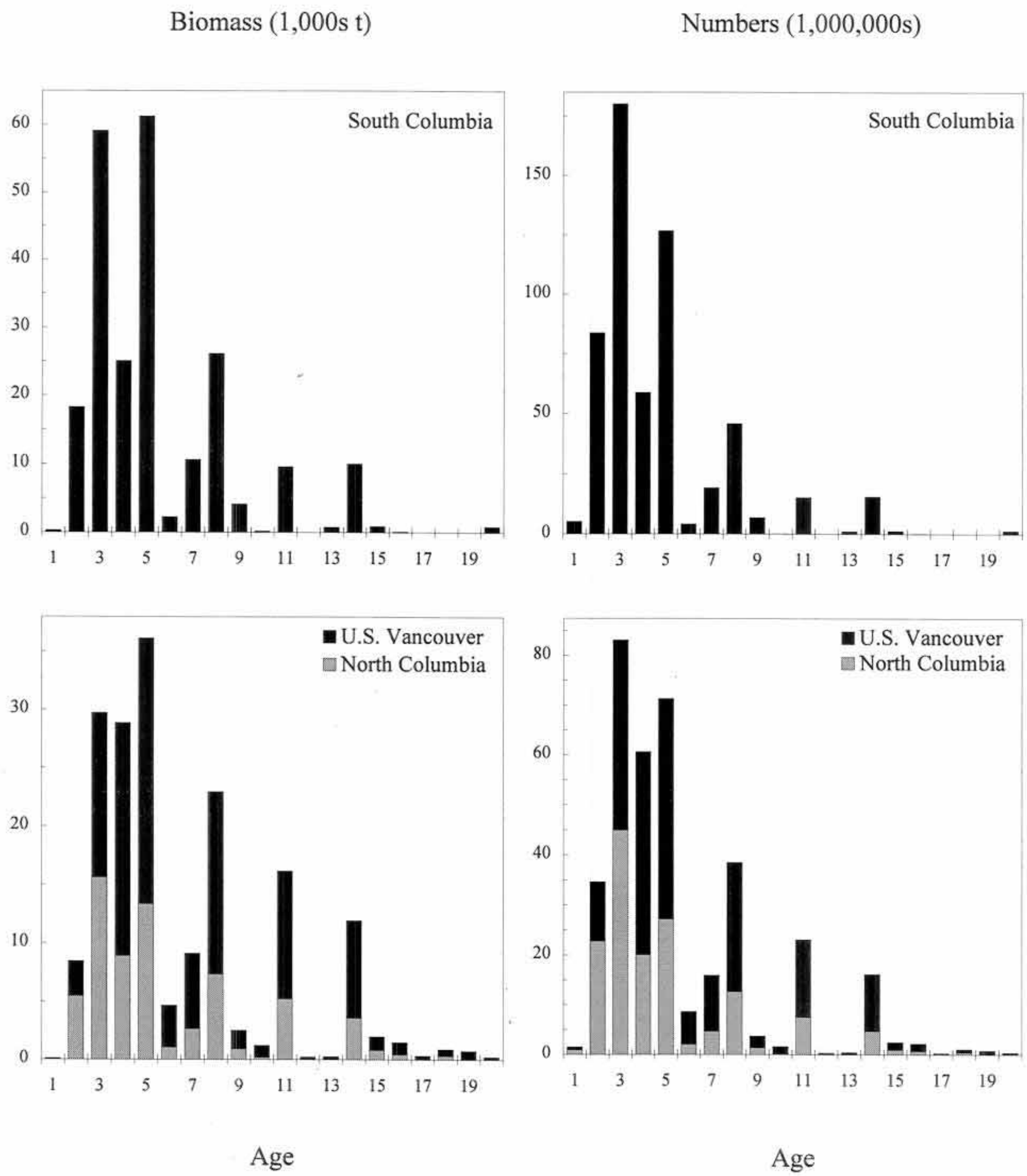

Figure 8.--Continued.

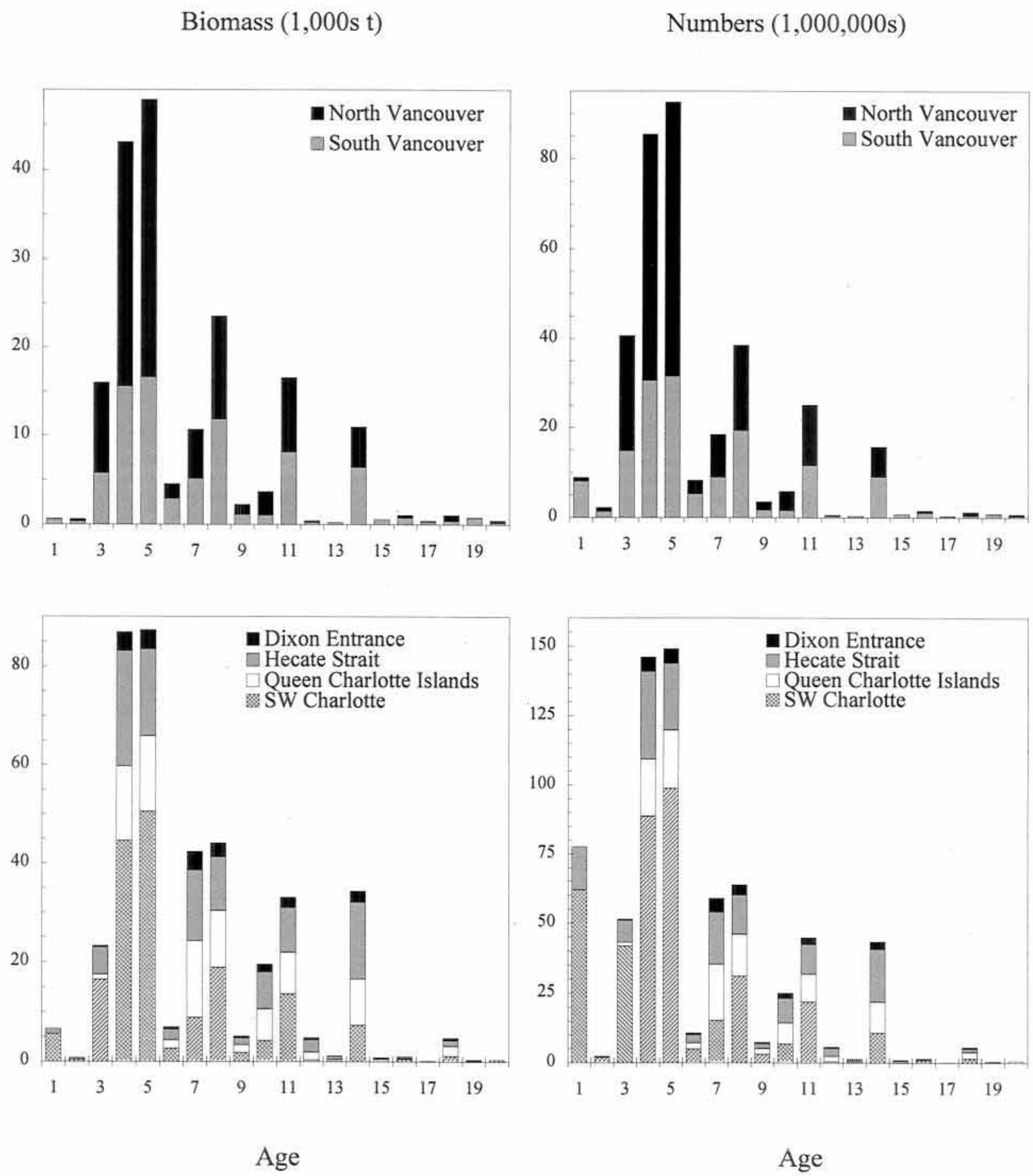

Figure 8.--Continued.

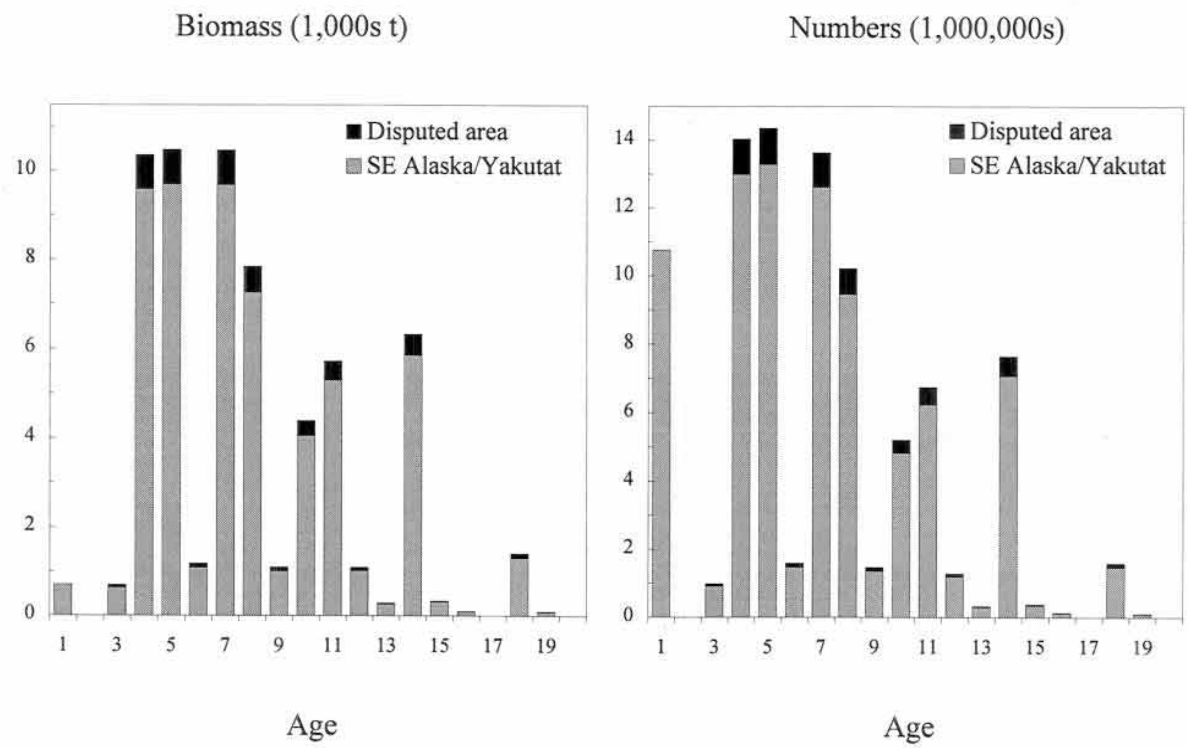

Figure 8.--Continued.

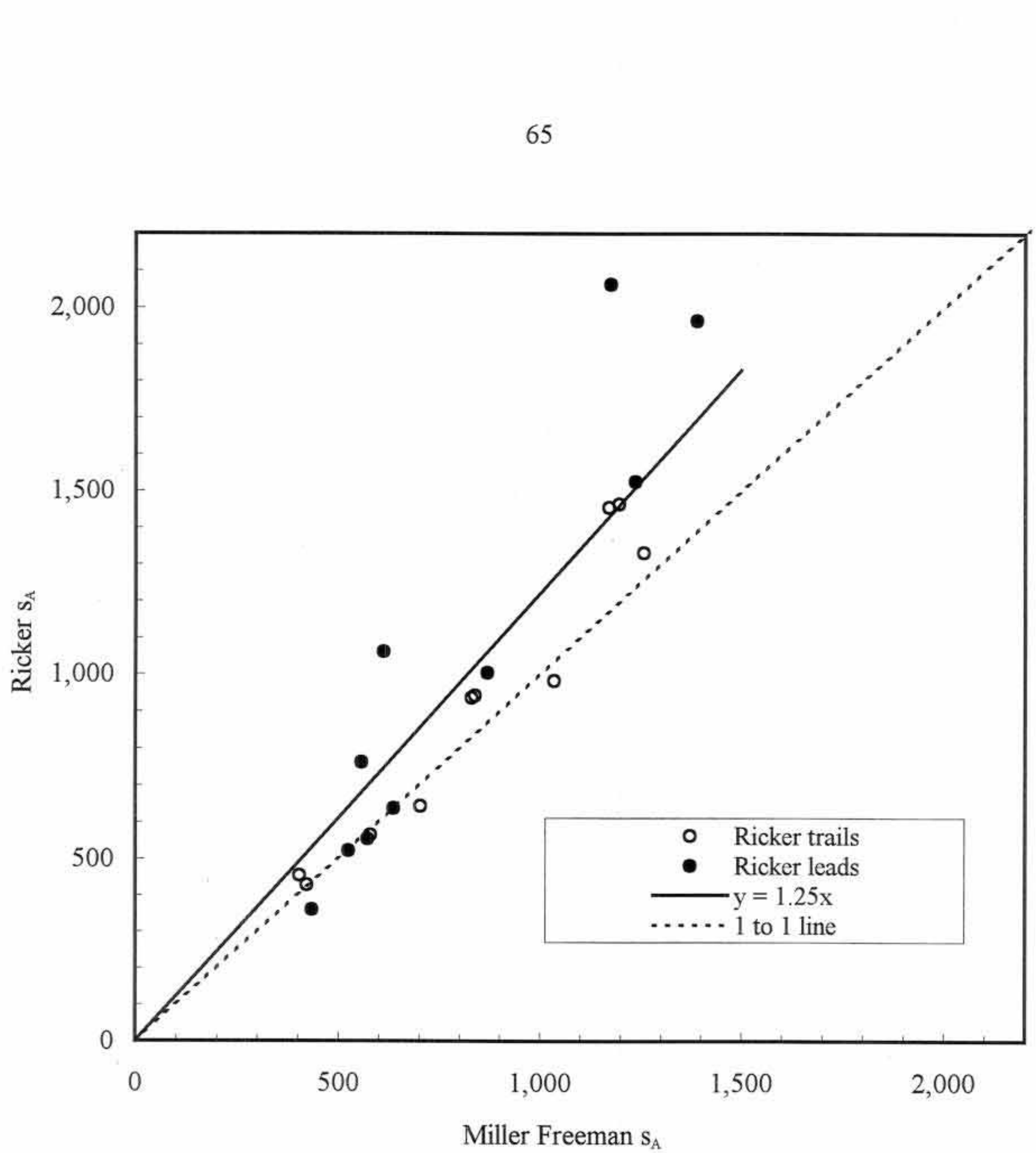

Figure 9.--Comparison of mean backscattering coefficient (s_A) values by transect from the intership calibration of the NOAA ship *Miller Freeman* and CCGS *W.E. Ricker* EK500 acoustic systems. The solid line represents a zero-intercept functional regression that was fitted to the data.

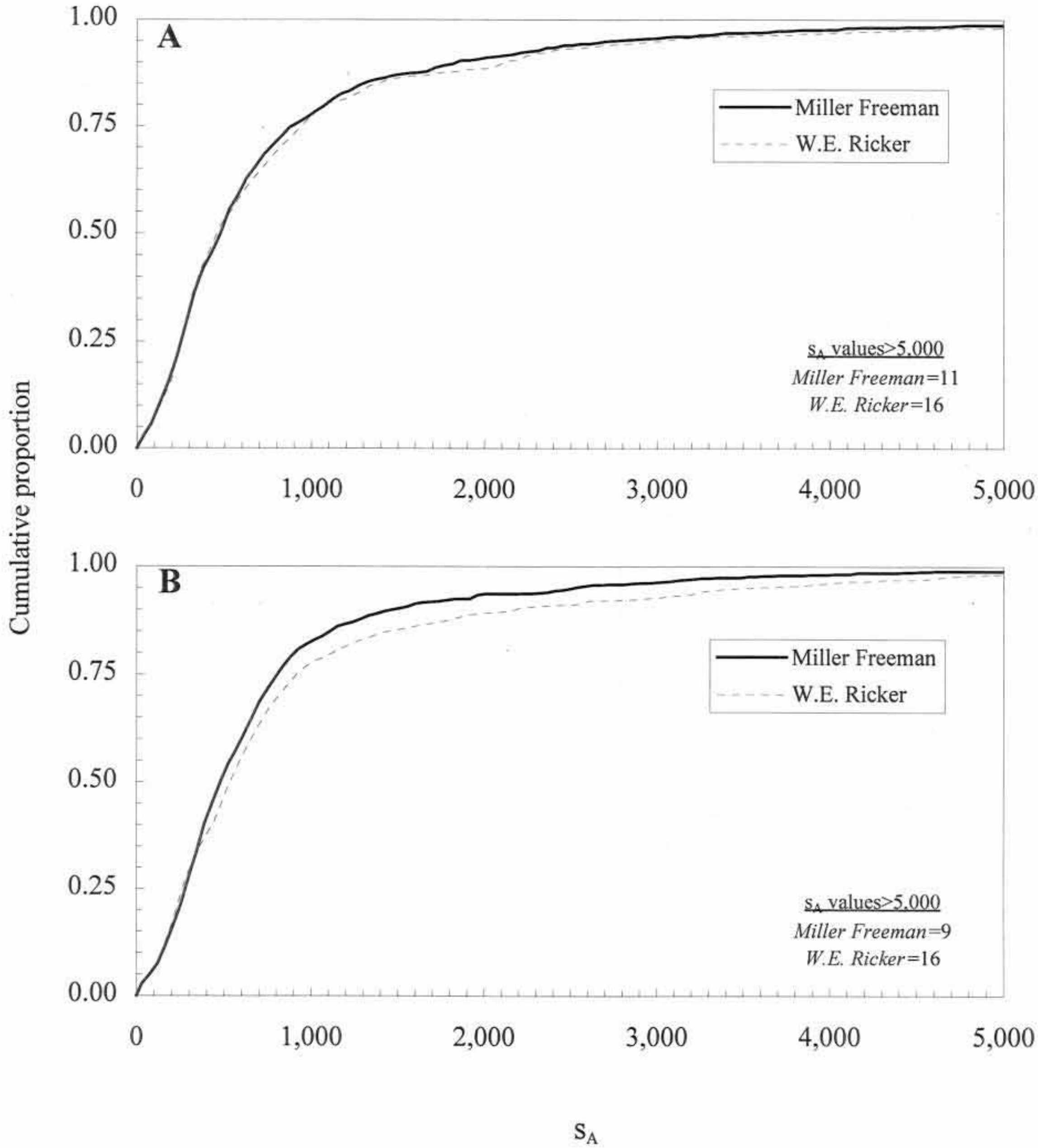

Figure 10.--Cumulative plots of backscattering coefficient (s_A) estimates averaged by 0.1 nautical mile intervals with (A) the NOAA ship *Miller Freeman* leading and (B) the CCGS *W.E. Ricker* leading. Note: s_A values > 5,000 not shown.

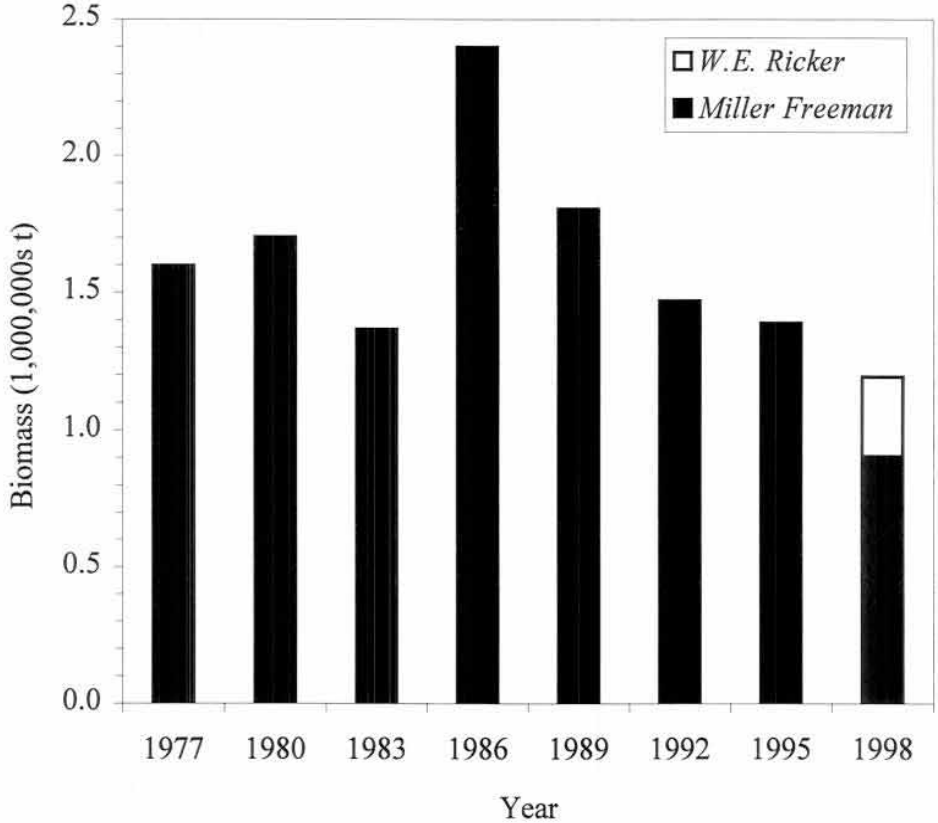

Figure 11.--Pacific hake acoustic-trawl survey biomass (in millions of metric tons (t)) estimates. Estimates for 1977-1989 are adjusted for the increased offshore and northward coverage beginning in 1992 and the change of the target strength (TS) model from -35 dB/kg to TS=20 Log L - 68 (From Dorn 1996).

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APPENDIX

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Appendix Table 1a.--Transect start and end times and locations for the west coast Queen Charlotte Islands area for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

		Time (PDT)		Log (nmi)[a]		Start position		End position	
Transect	Date	Start	End	Start	End	Latitude	Longitude	Latitude	Longitude
Q01	6 Aug	4:43	5:38	350.0	359.7	51 49.99	130 46.20	51 49.95	131 1.82
Q02	6 Aug	5:39	6:48	359.9	370.8	51 50.10	131 2.03	52 0.04	131 9.25
Q03	6 Aug	6:49	7:31	370.9	377.6	52 0.04	131 9.42	52 0.15	131 20.14
Q04.1	6 Aug	10:09	11:03	389.9	399.8	52 0.19	131 20.03	52 10.05	131 21.38
Q05	6 Aug	11:05	12:15	400.0	411.9	52 10.05	131 21.70	52 10.33	131 40.78
Q06	6 Aug	14:17	15:13	419.3	429.2	52 10.52	131 39.45	52 20.05	131 35.45
Q07	6 Aug	15:14	15:27	429.4	431.6	52 20.10	131 35.78	52 20.06	131 39.37
Q08	6 Aug	15:28	16:29	431.8	442.4	52 20.15	131 39.64	52 29.83	131 46.67
Q09	6 Aug	16:30	16:49	442.6	445.4	52 29.87	131 47.00	52 29.98	131 51.57
Q10	6 Aug	16:51	18:09	445.7	457.6	52 30.17	131 51.92	52 39.97	132 3.08
Q11	6 Aug	18:10	18:32	457.7	460.7	52 39.97	132 3.25	52 40.03	132 8.17
Q12	6 Aug	18:33	19:44	460.9	472.2	52 40.16	132 8.38	52 50.06	132 17.47
Q13.1	7 Aug	4:52	5:09	525.6	528.4	52 50.42	132 22.30	52 49.78	132 17.87
Q13.2	7 Aug	5:12	5:24	528.8	530.6	52 50.00	132 17.77	52 50.05	132 20.68
Q14	7 Aug	5:24	5:38	530.6	533.0	52 50.05	132 20.68	52 52.37	132 21.80
Q14.1	7 Aug	5:38	5:59	533.0	536.6	52 52.37	132 21.80	52 55.85	132 23.20
Q15	7 Aug	6:03	6:30	537.1	541.5	52 56.08	132 23.89	52 56.02	132 31.10
Q16	7 Aug	6:31	6:59	541.7	546.5	52 56.20	132 30.98	53 0.00	132 26.23
Q17	7 Aug	7:00	7:40	546.6	552.9	53 0.00	132 26.40	52 59.98	132 36.85
Q18	7 Aug	7:42	7:59	553.1	556.0	53 0.13	132 37.03	53 3.04	132 37.30
Q18.1	7 Aug	9:25	9:36	563.2	565.1	53 3.07	132 37.27	53 4.97	132 37.39
Q19	7 Aug	9:37	10:04	565.3	569.4	53 5.00	132 37.72	53 5.02	132 44.51
Q20	7 Aug	10:05	10:52	569.6	576.5	53 5.17	132 44.63	53 10.39	132 37.50
Q21	7 Aug	11:59	12:27	582.3	586.4	53 10.00	132 41.10	53 10.12	132 47.95
Q22	7 Aug	12:31	12:56	587.1	591.7	53 10.73	132 47.77	53 15.00	132 44.87
Q23	7 Aug	12:58	13:54	591.9	600.8	53 15.11	132 45.05	53 15.08	132 59.83
Q24	7 Aug	13:55	14:42	601.0	609.0	53 15.26	132 59.83	53 19.90	132 48.98
Q25	7 Aug	14:43	16:04	609.2	621.3	53 20.00	132 49.20	53 20.00	133 9.35
Q26	7 Aug	18:27	19:41	633.9	645.6	53 20.20	133 9.75	53 29.93	132 58.97
Q27	8 Aug	4:54	6:01	681.4	691.1	53 30.05	132 58.75	53 29.92	133 14.95
Q28	8 Aug	7:01	8:19	693.5	705.4	53 29.85	133 15.47	53 39.88	133 4.73
Q29	8 Aug	8:20	9:33	705.6	717.2	53 40.03	133 4.87	53 40.18	133 24.15
Q30	8 Aug	9:33	10:36	717.2	727.5	53 40.18	133 24.15	53 50.00	133 19.68
Q31	8 Aug	10:36	11:03	727.5	731.8	53 50.00	133 19.68	53 49.99	133 26.96
Q31.1	8 Aug	12:19	12:57	738.3	744.0	53 50.03	133 27.02	53 50.05	133 36.57
Q32	8 Aug	12:58	14:08	744.1	755.5	53 50.15	133 36.52	54 0.00	133 26.92
Q33	8 Aug	14:09	15:15	755.7	765.9	54 0.10	133 27.15	54 0.00	133 44.40
Q34	8 Aug	15:16	16:27	766.1	777.6	54 0.11	133 44.65	54 9.94	133 54.88
Q35	8 Aug	16:29	18:40	777.8	799.7	54 10.05	133 54.65	54 10.01	133 17.40
Q36	8 Aug	18:42	20:17	800.0	815.4	54 10.12	133 16.97	54 21.79	132 59.75

[a] Log (nmi) is the cumulative distance in nautical miles traveled during the survey.

Appendix Table 1b.--Transect start and end times and locations for the Alaska area for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

		Time (PDT)		Log (nmi)[a]		Start position		End position	
Transect	Date	Start	End	Start	End	Latitude	Longitude	Latitude	Longitude
Q38	9 Aug	6:41	10:06	886.2	916.8	54 21.79	133 0.77	54 21.71	133 53.00
Q39	9 Aug	10:08	10:42	917.0	922.4	54 21.90	133 53.02	54 27.07	133 51.60
Q39.1	9 Aug	12:13	12:34	929.4	932.9	54 26.35	133 51.35	54 29.77	133 50.10
Q40	9 Aug	12:35	14:11	933.1	947.4	54 29.89	133 50.30	54 30.04	134 14.80
Q41	9 Aug	15:21	16:30	951.8	963.0	54 29.93	134 8.06	54 40.12	133 59.80
Q42	9 Aug	16:31	17:21	963.2	971.2	54 40.22	133 59.97	54 40.01	134 13.65
Q43	9 Aug	17:23	18:21	971.5	981.5	54 40.30	134 13.63	54 50.05	134 9.77
Q44	9 Aug	18:22	19:01	981.6	987.4	54 50.10	134 9.92	54 50.05	134 19.91
Q45	9 Aug	19:03	20:02	987.6	997.8	54 50.20	134 19.97	54 59.96	134 15.25
Q46	9 Aug	20:08	20:59	998.8	1006.6	55 0.08	134 16.97	55 0.15	134 30.49
Q47	10 Aug	5:04	5:55	1033.8	1040.1	55 0.07	134 16.07	55 0.11	134 26.83
Q48	10 Aug	5:56	6:36	1040.2	1046.6	55 0.22	134 26.83	55 6.50	134 26.59
Q49	10 Aug	6:37	8:16	1046.7	1061.9	55 6.49	134 26.40	55 6.56	134 0.00
Q50	10 Aug	9:19	9:50	1066.5	1071.8	55 7.80	134 3.58	55 13.07	134 4.09
Q51	10 Aug	9:50	10:53	1071.8	1079.1	55 13.07	134 4.09	55 13.01	134 16.85
Q51.1	10 Aug	12:16	12:40	1085.1	1088.0	55 13.00	134 14.81	55 13.01	134 19.85
Q51.2	10 Aug	12:40	13:57	1088.0	1097.3	55 13.01	134 19.85	55 13.13	134 35.93
Q52	10 Aug	13:58	14:44	1097.4	1104.1	55 13.24	134 35.90	55 19.73	134 33.56
Q53	10 Aug	14:46	16:00	1104.4	1112.5	55 20.02	134 33.58	55 20.00	134 47.68
Q54	10 Aug	16:02	17:09	1112.7	1122.4	55 20.05	134 48.00	55 29.68	134 49.97
Q55	10 Aug	17:11	18:38	1122.7	1134.9	55 29.80	134 50.47	55 30.00	135 11.80
Q56	10 Aug	18:42	19:43	1135.5	1145.2	55 30.04	135 12.80	55 39.71	135 12.43
Q57	10 Aug	19:56	20:51	1147.1	1155.7	55 40.05	135 15.15	55 39.98	134 59.97
Q58	11 Aug	4:56	5:34	1188.4	1195.0	55 50.05	135 10.65	55 50.06	135 22.27
Q59	11 Aug	7:41	8:39	1203.3	1213.3	55 51.34	135 25.46	55 59.80	135 34.95
Q60	11 Aug	8:39	11:57	1213.4	1238.5	55 59.90	135 34.91	56 0.25	134 50.57
Q61	11 Aug	12:01	12:50	1239.0	1245.3	56 0.62	134 50.51	56 4.78	134 57.77
Q61.1	11 Aug	14:05	14:56	1250.9	1257.7	56 4.84	134 57.68	56 9.88	135 5.83
Q62	11 Aug	14:57	16:57	1257.8	1277.1	56 9.88	135 6.02	56 10.00	135 40.45
Q63	11 Aug	16:59	18:26	1277.4	1291.3	56 10.24	135 40.57	56 19.87	135 22.50
Q64	11 Aug	18:28	20:01	1291.6	1308.0	56 20.14	135 22.52	56 29.80	135 46.46
Q65	11 Aug	20:03	4:38	1308.4	1345.2	56 30.10	135 46.93	56 38.75	135 40.78
Q66	12 Aug	4:48	6:19	1346.4	1361.9	56 39.92	135 40.82	56 48.86	136 3.90
Q66.3	12 Aug	7:16	7:27	1366.4	1368.3	56 49.07	136 4.27	56 50.08	136 7.09
Q67	12 Aug	7:27	8:34	1368.4	1379.6	56 50.18	136 7.07	57 1.40	136 6.22
Q68	12 Aug	8:34	9:33	1379.7	1389.7	57 1.50	136 6.32	57 10.05	136 15.93
Q69	12 Aug	9:35	10:38	1390.2	1401.1	57 10.55	136 15.95	57 21.41	136 16.61
Q70	12 Aug	10:40	11:46	1401.3	1412.8	57 21.60	136 16.75	57 28.52	136 33.82
Q71	12 Aug	11:50	12:32	1413.5	1420.7	57 29.20	136 33.58	57 36.19	136 30.98
Q72	12 Aug	12:34	12:46	1421.1	1423.0	57 36.49	136 31.48	57 37.85	136 33.94
Q72.1	12 Aug	13:44	14:42	1428.0	1437.1	57 38.06	136 33.34	57 42.20	136 48.41
Q73	12 Aug	14:45	15:19	1437.6	1442.9	57 42.49	136 49.00	57 47.18	136 44.29
Q74	12 Aug	16:38	18:08	1447.2	1462.0	57 51.23	136 46.28	58 5.98	136 48.34
Q75	13 Aug	4:52	5:37	1530.4	1538.0	57 52.30	137 34.76	57 59.89	137 34.99
Q76	13 Aug	5:37	7:04	1538.1	1553.0	57 59.90	137 35.15	57 56.60	138 2.35
Q77	13 Aug	7:06	8:30	1553.2	1568.0	57 56.66	138 2.68	58 5.87	138 24.45
Q78	13 Aug	8:30	4:24	1568.1	1891.7	58 5.83	138 24.60	54 25.55	133 8.20

[a] Log (nmi) is the cumulative distance in nautical miles traveled during the survey.

Appendix Table 1c.--Transect start and end times and locations for the Dixon Entrance area for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

		Time (PDT)		Log (nmi)[a]		Start position		End position	
Transect	Date	Start	End	Start	End	Latitude	Longitude	Latitude	Longitude
D01	15 Aug	4:27	6:32	1892.2	1912.9	54 25.28	133 7.50	54 13.18	132 39.04
D02.1	15 Aug	6:40	7:14	1914.3	1919.9	54 12.11	132 39.07	54 17.74	132 38.81
D03	15 Aug	7:15	8:35	1920.1	1926.7	54 17.75	132 38.57	54 14.21	132 39.92
D03.1	15 Aug	8:56	10:07	1930.1	1941.4	54 16.42	132 36.38	54 9.41	132 21.55
D04	15 Aug	10:08	11:39	1941.6	1956.0	54 9.55	132 21.34	54 23.95	132 21.62
D05	15 Aug	11:41	13:07	1956.3	1969.8	54 24.11	132 21.67	54 13.84	132 6.86
D06	15 Aug	13:08	14:44	1969.9	1982.2	54 13.76	132 6.75	54 21.73	132 3.77
D07	15 Aug	14:47	16:12	1982.7	1996.5	54 21.94	132 3.22	54 11.81	131 47.70
D08	15 Aug	16:14	17:50	1996.7	2013.4	54 11.89	131 47.48	54 28.70	131 47.17
D09	15 Aug	17:52	18:46	2013.7	2023.2	54 28.90	131 46.90	54 29.35	131 30.64
D10	15 Aug	18:47	20:02	2023.5	2036.0	54 29.15	131 30.37	54 16.76	131 29.98
D11*	16 Aug	4:52	6:10	2108.6	2123.3	54 32.00	133 2.87	54 37.16	132 39.17
D12*	16 Aug	6:11	6:33	2123.4	2127.0	54 37.13	132 39.02	54 33.60	132 38.40
D13*	16 Aug	6:35	8:09	2127.3	2143.7	54 33.67	132 37.90	54 41.57	132 21.47
D14*	16 Aug	8:33	9:00	2147.9	2152.6	54 37.40	132 21.55	54 32.75	132 21.60
D15*	16 Aug	9:01	10:13	2152.8	2164.2	54 32.62	132 21.43	54 37.78	132 4.15
D16*	16 Aug	10:17	10:40	2164.8	2168.9	54 37.18	132 4.00	54 33.13	132 3.85
D17*	16 Aug	10:41	11:05	2169.0	2173.4	54 33.04	132 3.85	54 28.67	132 3.75
D19	16 Aug	16:35	17:20	2209.7	2218.2	54 21.67	131 29.60	54 22.39	131 15.08
D20	16 Aug	17:21	17:36	2218.4	2221.1	54 22.46	131 14.78	54 25.07	131 13.80
D21	16 Aug	17:38	17:59	2221.4	2224.6	54 25.20	131 13.43	54 25.12	131 8.06
D21.1	16 Aug	18:10	18:15	2225.5	2226.5	54 25.22	131 7.76	54 25.07	131 6.11
D22	16 Aug	18:16	18:47	2226.7	2232.6	54 24.88	131 6.00	54 19.09	131 4.62
D23	16 Aug	18:48	19:10	2232.8	2237.3	54 18.90	131 4.48	54 14.89	131 1.20
D24	16 Aug	19:11	19:25	2237.5	2240.1	54 14.70	131 1.33	54 12.26	131 2.62
D25	16 Aug	19:25	20:06	2240.1	2247.8	54 12.26	131 2.62	54 4.70	131 0.93

[a] Log (nmi) is the cumulative distance in nautical miles traveled during the survey.

Note: Transects with * are designated 'Disputed Zone' (see Tables 13-16; Figure 2).

Appendix Table 1d.--Transect start and end times and locations for the Hecate Strait and Queen Charlotte Sound areas for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

		Time (PDT)		Log (nmi)[a]		Start position		End position	
Transect	Date	Start	End	Start	End	Latitude	Longitude	Latitude	Longitude
H01	17 Aug	4:51	5:10	2277.0	2280.1	53 44.92	130 54.11	53 45.05	130 49.12
H01.2	17 Aug	6:19	6:38	2287.3	2290.6	53 44.95	130 49.15	53 45.05	130 43.61
H01.4	17 Aug	7:24	7:45	2294.1	2297.8	53 44.98	130 43.65	53 45.02	130 37.43
H02	17 Aug	7:46	9:30	2298.0	2314.8	53 44.89	130 37.24	53 30.00	130 49.78
H03	17 Aug	9:33	10:09	2315.2	2320.9	53 29.96	130 49.15	53 29.95	130 39.71
H04	17 Aug	10:10	12:05	2321.1	2339.4	53 29.78	130 39.83	53 15.20	130 58.20
H05	17 Aug	12:07	13:45	2339.8	2355.9	53 14.96	130 58.13	53 15.00	130 31.33
H06	17 Aug	13:49	14:13	2356.5	2360.3	53 14.77	130 30.80	53 11.48	130 33.86
H06.1	17 Aug	15:12	16:27	2365.9	2379.2	53 11.48	130 33.92	53 0.15	130 44.87
H07	17 Aug	16:29	19:05	2379.5	2406.0	53 0.02	130 44.47	53 0.00	130 0.62
H08	17 Aug	19:08	4:42	2406.5	2428.1	52 59.75	130 0.19	52 45.52	129 52.47
H09	18 Aug	4:56	6:56	2429.9	2450.1	52 44.96	129 51.04	52 44.96	130 24.25
H10	18 Aug	6:57	7:16	2450.3	2453.4	52 44.80	130 24.30	52 43.33	130 20.40
H10.1	18 Aug	7:16	7:28	2453.4	2455.4	52 43.33	130 20.40	52 41.77	130 22.37
H10.2	18 Aug	7:28	7:43	2455.4	2457.7	52 41.77	130 22.37	52 40.18	130 20.53
H10.3	18 Aug	7:43	7:52	2457.7	2459.2	52 40.18	130 20.53	52 39.26	130 22.43
H10.4	18 Aug	7:52	8:10	2459.2	2462.1	52 39.26	130 22.43	52 36.94	130 19.82
H10.5	18 Aug	8:10	8:58	2462.1	2469.8	52 36.94	130 19.82	52 30.32	130 26.08
H11	18 Aug	8:58	11:08	2469.8	2492.0	52 30.32	130 26.08	52 29.87	129 50.48
H12	18 Aug	11:29	12:49	2495.6	2508.9	52 29.77	129 44.98	52 20.20	129 59.51
H13	18 Aug	12:51	14:47	2509.2	2527.7	52 20.08	129 59.97	52 19.99	130 30.11
H14	18 Aug	14:47	5:06	2527.7	2702.7	52 19.99	130 30.11	51 51.79	130 52.33
H15	19 Aug	5:14	6:26	2703.5	2714.8	51 52.25	130 51.34	51 51.98	130 33.15
H16	19 Aug	6:30	7:15	2715.4	2723.0	51 52.45	130 32.77	51 59.89	130 30.08
H17	19 Aug	7:16	8:03	2723.3	2731.6	52 0.10	130 30.34	52 0.00	130 43.73
H17.1	19 Aug	9:54	10:32	2740.8	2747.1	51 59.92	130 44.08	52 0.02	130 54.33
H18	19 Aug	10:33	11:34	2747.2	2756.9	52 0.08	130 54.43	52 9.70	130 55.43
H19	19 Aug	11:41	12:00	2757.9	2760.8	52 10.09	130 53.93	52 10.10	130 49.24
H19.1	19 Aug	13:06	15:56	2766.1	2794.7	52 10.16	130 49.09	52 10.05	130 2.65
H20	19 Aug	15:58	17:08	2795.0	2807.4	52 9.92	130 2.36	52 0.04	130 14.23
H21	19 Aug	17:09	17:29	2807.6	2810.7	51 59.90	130 14.21	52 0.00	130 9.22
H22	19 Aug	17:31	18:49	2810.9	2824.0	51 59.85	130 9.37	51 52.00	130 23.70
H23	19 Aug	18:51	21:34	2824.3	2850.0	51 52.00	130 23.21	51 52.00	129 41.85
H24	20 Aug	4:55	6:16	2893.6	2907.4	51 40.00	128 34.90	51 39.83	128 12.85
H25	20 Aug	6:17	7:14	2907.6	2917.3	51 39.65	128 12.86	51 30.13	128 15.08
H26	20 Aug	7:16	9:02	2917.6	2934.8	51 30.04	128 15.52	51 30.00	128 42.45
H27	20 Aug	9:02	9:12	2934.9	2936.5	51 29.92	128 42.43	51 28.58	128 41.05
H27.1	20 Aug	9:54	11:38	2940.3	2957.6	51 28.57	128 40.88	51 14.87	128 24.38
H28	20 Aug	11:46	13:41	2958.9	2977.0	51 13.82	128 23.72	51 10.09	128 51.80
H29	20 Aug	13:42	14:15	2977.2	2982.5	51 10.22	128 52.03	51 14.80	128 56.27

Appendix Table 1d.--Continued.

Transect	Date	Time (PDT)		Log (nmi)[a]		Start position		End position	
		Start	End	Start	End	Latitude	Longitude	Latitude	Longitude
H29.1	20 Aug	15:15	16:34	2988.2	3001.0	51 15.02	128 56.44	51 26.23	129 6.63
H30	20 Aug	16:36	17:40	3001.2	3012.3	51 26.18	129 6.92	51 21.34	129 22.67
H31	20 Aug	17:42	20:04	3012.5	3035.5	51 21.15	129 22.60	51 0.52	129 7.39
H32	21 Aug	5:20	6:39	3112.2	3123.7	51 40.01	128 37.97	51 49.78	128 28.01
H33	21 Aug	6:40	7:53	3123.8	3134.8	51 49.87	128 28.10	51 50.02	128 45.79
H34	21 Aug	7:54	8:45	3135.0	3143.5	51 50.18	128 45.79	51 57.00	128 37.53
H34.2	21 Aug	9:37	9:54	3147.9	3150.8	51 57.60	128 36.88	51 59.92	128 34.09
H35	21 Aug	9:55	13:14	3151.0	3183.5	52 0.04	128 34.24	52 0.08	129 26.89
H36	21 Aug	13:16	13:53	3183.8	3190.4	51 59.90	129 27.07	51 53.93	129 22.73
H36.1	21 Aug	15:36	15:58	3198.2	3202.2	51 53.78	129 22.70	51 50.17	129 20.15
H37	21 Aug	15:59	16:34	3202.4	3208.2	51 50.02	129 20.32	51 49.99	129 29.65
H38	21 Aug	16:36	16:54	3208.5	3211.7	51 49.80	129 29.97	51 46.63	129 30.00
H39	21 Aug	17:31	18:48	3214.7	3228.0	51 46.43	129 29.13	51 50.00	129 49.82
H40	21 Aug	18:49	19:19	3228.2	3233.0	51 49.88	129 49.90	51 46.30	129 44.83
H40.1	21 Aug	19:19	20:17	3233.0	3242.0	51 46.30	129 44.83	51 39.65	129 35.30

[a] Log (nmi) is the cumulative distance in nautical miles traveled during the survey.

Appendix Table 2.--Summary of mid-water trawl station details for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.

Set number	1	2	3	4	5	6	7
Date (MMDDYY)	8/6/98	8/6/98	8/6/98	8/7/98	8/7/98	8/7/98	8/8/98
Time Start (PDT)	0912	1332	1430	0933	1208	1740	1238
Time End (PDT)	1040	1352	1455	0950	1238	1810	1251
Duration of Set (Minutes)	92	20	25	17	30	30	13
Major Area	9	9	9	9	9	9	9
Minor Area	34	34	34	31	31	31	31
Locality	1	5	5	8	7	14	4
Start Latitude (Deg. N)	52	52	52	53	53	53	53
Start Latitude (Minutes)	3.30	11.53	12.27	1.70	10.22	19.40	49.50
Start Longitude (Deg. W)	131	131	131	132	132	133	133
Start Longitude (Minutes)	20.00	40.76	40.84	36.80	39.29	6.90	26.10
End Latitude (Deg. N)	52	52	52	53	53	53	53
End Latitude (Minutes)	0.2	12.8	10.15	1.1	10.22	18.4	49.5
End Longitude (Deg. W)	131	131	131	132	132	133	133
End Longitude (Minutes)	12.40	40.70	40.60	35.40	43.00	6.00	26.10
Direction of Set (Deg. T)	166	000	180	140	270	133	145
Start Bottom Depth (m)	231	1851	1829	577	104	373	331
Start Target Depth (m)	145	80	250	200	5	228	260
Start Capture Depth (m)	130	89	213	192	9	290	270
Start Gear Depth (m)	130	89	213	192	9	290	270
End Bottom Depth (m)	230	1595	1995	621	563	429	332
End Target Depth (m)	170	80	250	200	3	200	277
End Capture Depth (m)	177	71	221	202	3	230	277
End Gear Depth (m)	177	71	221	202	3	230	277
Min. Bottom Depth (m)	231	1595	1829	577	104	373	331
Min. Target Depth (m)	140	1	220	160	1	200	210
Min. Capture Depth (m)	168	71	221	192	1	250	260
Min. Gear Depth (m)	168	71	221	192	1	250	260
Max. Bottom Depth (m)	310	1851	1995	621	563	429	332
Max. Target Depth (m)	170	100	260	220	1	350	320
Max. Capture Depth (m)	230	89	233	225	5	346	277
Max. Gear Depth (m)	230	89	233	225	5	346	277
Modal Bottom Depth (m)	270	1723	1912	600	334	401	332
Modal Target Depth (m)	150	50	240	190	3	275	265
Modal Capture Depth (m)	170	80	224	202	3	300	269
Modal Gear Depth (m)	170	80	227	202	3	298	269
CTD Number	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Surface Water Temp. (Deg C.)	13.3	15.2	14.6	13.3	14.1	14	14.3
Wind Direction (Deg. T)	130	195	230	225	180	160	220
Wind Speed (knots)	7	13	16	15	20	32	5
Swell (m)	0	0	0	1	1	1	1
Air Temperature (Deg. C)	16.0	15.0	14.0	14.2	13.4	14.5	18.0

Appendix Table 2.--Continued.

Set number	8	9	10	11	12	13	14
Date (MMDDYY)	8/8/98	8/9/98	8/9/98	8/10/98	8/10/98	8/11/98	8/11/98
Time Start (PDT)	0612	1225	1538	0946	1226	0658	0758
Time End (PDT)	0618	1241	1601	0956	1235	0725	0828
Duration of Set (Minutes)	6	16	23	10	9	27	30
Major Area	9	9	10	10	10	10	10
Minor Area	35	35	32	32	32	32	32
Locality	1	0	1	1	1	2	2
Start Latitude (Deg. N)	54	54	54	55	55	55	55
Start Latitude (Minutes)	13.60	27.50	30.00	6.50	13.00	50.00	50.41
Start Longitude (Deg. W)	133	133	134	134	134	135	135
Start Longitude (Minutes)	11.60	53.14	13.00	2.20	14.20	20.40	19.21
End Latitude (Deg. N)	54	54	54	55	55	55	55
End Latitude (Minutes)	13.8	26.5	30	6.6	13.3	49.9	50.48
End Longitude (Deg. W)	133	133	134	134	134	135	135
End Longitude (Minutes)	11.50	51.30	10.00	3.00	13.10	17.70	23.73
Direction of Set (Deg. T)	090	127	090	270	090	000	270
Start Bottom Depth (m)	163	399	1718	161	822	731	680
Start Target Depth (m)	50	280	300	163	200	180	0
Start Capture Depth (m)	60	271	290	163	227	217	0
Start Gear Depth (m)	60	271	290	163	227	217	2
End Bottom Depth (m)	160	363	1646	164	749	630	742
End Target Depth (m)	85	255	300	164	230	250	35
End Capture Depth (m)	85	285	293	164	240	230	35
End Gear Depth (m)	85	285	293	164	240	230	35
Min. Bottom Depth (m)	130	363	1646	150	749	630	680
Min. Target Depth (m)	50	250	270	125	190	150	0
Min. Capture Depth (m)	60	275	290	161	227	217	2
Min. Gear Depth (m)	60	275	290	161	227	217	2
Max. Bottom Depth (m)	163	399	1718	170	822	731	742
Max. Target Depth (m)	75	300	320	160	250	450	75
Max. Capture Depth (m)	85	295	390	164	257	236	35
Max. Gear Depth (m)	85	295	390	164	257	236	35
Modal Bottom Depth (m)	192	381	1682	160	786	680	710
Modal Target Depth (m)	62	275	295	145	220	235	35
Modal Capture Depth (m)	72	285	300	164	234	227	25
Modal Gear Depth (m)	72	285	300	164	234	227	25
CTD Number	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Surface Water Temp. (Deg C.)	13.4	14.1	14.3	13.5	13.7	14	14
Wind Direction (Deg. T)	169	220	225	210	200	080	080
Wind Speed (knots)	3	15	10	15	20	12	15
Swell (m)	0	1	1	2	2	0	1
Air Temperature (Deg. C)	14.2	14.5	14.7	13.0	13.5	14.5	13.4

Appendix Table 2.--Continued.

Set number	15	16	17	18	19	20	21
Date (MMDDYY)	8/11/98	8/12/98	8/12/98	8/12/98	8/13/98	8/15/98	8/16/98
Time Start (PDT)	1409	0732	1421	1634	1058	0845	1237
Time End (PDT)	1423	0740	1429	1706	1114	0920	1307
Duration of Set (Minutes)	14	8	8	32	16	35	30
Major Area	10	10	10	10	10	8	8
Minor Area	32	32	32	32	32	3	3
Locality	2	8	6	5	5	3	5
Start Latitude (Deg. N)	56	56	57	57	57	54	54
Start Latitude (Minutes)	4.00	48.46	38.80	48.00	56.69	15.67	24.80
Start Longitude (Deg. W)	134	136	136	136	138	132	132
Start Longitude (Minutes)	56.20	2.81	34.00	44.70	32.20	37.93	3.80
End Latitude (Deg. N)	56	56	57	57	57	54	54
End Latitude (Minutes)	3.43	48.35	38.2	50.4	57.42	14.06	22.3
End Longitude (Deg. W)	134	136	136	136	138	132	132
End Longitude (Minutes)	55.30	2.48	33.60	45.80	31.56	40.08	3.40
Direction of Set (Deg. T)	135	306	130	345	030	197	180
Start Bottom Depth (m)	310	460	391	156	3000	160	311
Start Target Depth (m)	200	250	190	0	180	90	0
Start Capture Depth (m)	212	240	190	3	187	93	3
Start Gear Depth (m)	212	240	190	3	187	93	3
End Bottom Depth (m)	311	290	372	146	3000	162	277
End Target Depth (m)	225	250	200	35	200	90	0
End Capture Depth (m)	219	250	214	35	183	95	3
End Gear Depth (m)	219	250	214	35	183	95	3
Min. Bottom Depth (m)	310	290	372	146	3000	160	277
Min. Target Depth (m)	160	220	150	1	160	80	0
Min. Capture Depth (m)	212	240	190	3	183	13	3
Min. Gear Depth (m)	212	240	190	3	183	93	3
Max. Bottom Depth (m)	311	460	391	156	3000	173	311
Max. Target Depth (m)	250	300	200	45	200	120	0
Max. Capture Depth (m)	219	250	214	35	187	115	3
Max. Gear Depth (m)	219	250	214	35	187	115	3
Modal Bottom Depth (m)	310	350	382	136	3000	165	301
Modal Target Depth (m)	200	250	175	30	180	100	0
Modal Capture Depth (m)	215	245	201	20	185	100	3
Modal Gear Depth (m)	215	245	201	20	185	100	3
CTD Number	N/A	N/A	N/A	30	N/A	N/A	N/A
Surface Water Temp. (Deg C.)	13.5	13.5	13.4	14.7	14.2	11.9	13.2
Wind Direction (Deg. T)	030	005	320	010	130		310
Wind Speed (knots)	25	5	5	2	20	0	10
Swell (m)	0	1	0	0	1	0	0
Air Temperature (Deg. C)	13.0	14.0	16.8	17.0	14.0	13.5	16.0

Appendix Table 2.--Continued.

Set number	22	23	24	25	26	27	28
Date (MMDDYY)	8/16/98	8/16/98	8/17/98	8/17/98	8/17/98	8/19/98	8/19/98
Time Start (PDT)	1334	1420	0642	0754	1542	0940	1320
Time End (PDT)	1351	1515	0658	0759	1549	1013	1337
Duration of Set (Minutes)	17	55	16	5	7	33	17
Major Area	8	8	8	8	7	6	7
Minor Area	3	3	5	5	6	8	2
Locality	5	5	1	1	1	6	4
Start Latitude (Deg. N)	54	54	53	53	53	51	52
Start Latitude (Minutes)	22.80	23.30	45.60	45.00	12.60	58.60	10.17
Start Longitude (Deg. W)	132	132	130	130	130	130	130
Start Longitude (Minutes)	3.50	4.30	52.60	44.00	33.10	41.50	50.60
End Latitude (Deg. N)	54	54	53	56	53	51	52
End Latitude (Minutes)	23.5	21.7	44.37	45	12.4	57.2	10.18
End Longitude (Deg. W)	132	132	130	130	130	130	130
End Longitude (Minutes)	3.50	7.70	51.40	44.90	32.60	41.20	52.13
Direction of Set (Deg. T)	005	215	152	270	125	163	269
Start Bottom Depth (m)	282	288	68	135	177	318	221
Start Target Depth (m)	90	150	45	65	110	250	165
Start Capture Depth (m)	107	160	45	68	119	194	165
Start Gear Depth (m)	107	160	45	68	119	194	165
End Bottom Depth (m)	290	282	65	135	173	309	222
End Target Depth (m)	100	175	50	65	120	250	200
End Capture Depth (m)	100	173	45	71	132	253	273
End Gear Depth (m)	100	173	45	71	132	253	273
Min. Bottom Depth (m)	282	282	65	135	125	309	221
Min. Target Depth (m)	80	150	40	75	110	250	165
Min. Capture Depth (m)	93	160	40	68	119	194	165
Min. Gear Depth (m)	93	160	40	68	119	194	165
Max. Bottom Depth (m)	290	288	68	135	173	318	222
Max. Target Depth (m)	110	200	45	90	130	300	200
Max. Capture Depth (m)	107	175	45	71	132	272	175
Max. Gear Depth (m)	107	175	45	71	132	272	175
Modal Bottom Depth (m)	286	285	66	135	151	313	221
Modal Target Depth (m)	95	175	43	75	120	372	180
Modal Capture Depth (m)	101	173	43	69	126	253	172
Modal Gear Depth (m)	101	173	43	69	126	253	172
CTD Number	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Surface Water Temp. (Deg C.)	13.1	13	14	14	14.7	15.1	14.7
Wind Direction (Deg. T)	310	270	310	310	310	330	330
Wind Speed (knots)	10	18	8	10	5	5	15
Swell (m)	0	0	0	0	0	0	0
Air Temperature (Deg. C)	16.0	16.0	14.5	14.5	18.1	18.4	19.3

Appendix Table 2.--Continued.

Set number	29	30	31	32	33
Date (MMDDYY)	9/20/98	8/20/98	8/21/98	8/21/98	8/21/98
Time Start (PDT)	1029	1544	1003	1514	1815
Time End (PDT)	1031	1548	1012	1533	1817
Duration of Set (Minutes)	2	4	9	19	2
Major Area	6	5	6	6	6
Minor Area	8	11	8	8	8
Locality	1	1	0	4	4
Start Latitude (Deg. N)	51	51	51	51	51
Start Latitude (Minutes)	28.90	13.60	56.50	54.30	50.00
Start Longitude (Deg. W)	128	128	128	129	129
Start Longitude (Minutes)	39.50	56.10	38.30	23.00	29.20
End Latitude (Deg. N)	51	51	51	51	51
End Latitude (Minutes)	29.04	13.35	55.96	55.4	46.13
End Longitude (Deg. W)	128	128	128	129	129
End Longitude (Minutes)	38.96	56.39	38.89	23.80	28.69
Direction of Set (Deg. T)	067	247	208	335	040
Start Bottom Depth (m)	174	169	152	214	152
Start Target Depth (m)	100	100	125	150	75
Start Capture Depth (m)	102	105	113	156	85
Start Gear Depth (m)	102	105	113	156	85
End Bottom Depth (m)	175	164	152	214	154
End Target Depth (m)	110	120	132	120	85
End Capture Depth (m)	111	116	118	120	96
End Gear Depth (m)	111	116	118	120	96
Min. Bottom Depth (m)	174	164	152	214	152
Min. Target Depth (m)	100	100	120	220	75
Min. Capture Depth (m)	102	105	113	120	85
Min. Gear Depth (m)	102	105	113	120	85
Max. Bottom Depth (m)	175	169	152	214	154
Max. Target Depth (m)	150	140	150	175	155
Max. Capture Depth (m)	111	116	118	150	96
Max. Gear Depth (m)	111	116	118	150	96
Modal Bottom Depth (m)	174	166	152	214	153
Modal Target Depth (m)	125	120	135	135	135
Modal Capture Depth (m)	107	110	115	130	93
Modal Gear Depth (m)	107	110	115	130	93
CTD Number	N/A	N/A	N/A	N/A	N/A
Surface Water Temp. (Deg C.)	14	14.8	14.7	15.3	15.1
Wind Direction (Deg. T)	310	310	300	330	315
Wind Speed (knots)	15	18	15	12	5
Swell (m)	0	0	0	0	0
Air Temperature (Deg. C)	18.0	14.9	14.5	16.9	16.3

Appendix Table 3. Percent weight species composition by set for the CCGS *W.E. Ricker* for the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts. (* = Visual estimate.)

Set No.	1	3	4	5	6	7	8	9
Total catch (kg)	407.3	6.7	372.8	2.6	522.8	443.8	1,159.8	283.4
Species								
Pacific hake	79	-	93	-	98	98	97	95
Walleye pollock	-	-	-	-	-	-	-	-
Pacific herring	-	-	-	-	-	-	-	-
Pacific sardine	-	-	-	-	-	-	-	-
Jack mackeral	-	-	-	-	-	-	-	-
Whitebait smelt	-	-	-	-	-	-	-	-
Eared black smelt	-	-	-	-	-	-	-	-
Eulachon	-	-	-	-	-	-	-	-
Sablefish (juv)	-	-	-	-	-	-	-	-
Pink salmon	-	-	-	-	-	-	-	-
Coho salmon	-	-	-	-	-	-	-	-
Chum salmon	-	-	6	-	-	-	<1	-
Sockeye salmon	-	-	-	-	-	-	-	-
Sebastes brevispinis	4	-	-	-	-	-	1	-
S. flavidus		-	-	-	-	-	2	
S. paucispinis	2	-	-	100	-	-	-	-
S. alutus	7	-	-	-	<1	-	-	4
S. entomelas	1	-	-	-	-	-	-	-
S. proriger	7	-	-	-	<1	-	-	-
S. aleutianus	-	-	-	-	1	-	-	-
S. elongatus	-	-	-	-	-	-	-	<1
S. ruberrimus	-	-	-	-	-	-	-	-
S. helvomaculatus	-	-	-	-	-	-	-	-
S. babcocki	-	-	-	-	-	-	-	-
S. crameri	-	-	-	-	-	-	-	-
S. reedi	-	-	-	-	-	-	-	-
Dover sole	-	-	-	-	-	-	-	-
Rex sole	-	-	-	-	-	-	-	-
Turbot	-	-	-	-	-	-	-	-
Spiny dogfish	-	-	-	-	-	-	-	-
Pacific Lamprey	-	-	-	-	<1	-	<1	<1
Myctophids	-	30	-	-	-	<1	-	<1
OTHER								
Squid	-	-	-	-	1	2	-	-
Pink shrimp	-	-	-	-	-	-	-	-
Jellyfish	-	70	1	-	-	<1	-	-
Euphausiids	-	-	-	-	-	-	-	-

Appendix Table 3.--Continued.

Set No.	10	11	12	13	14	15	16	17
Total catch (kg)	14.0	65.8	438.4	20.7	4.7	531.1	89.9	198.2
Species								
Pacific hake	-	-	100	-	-	98	93	79
Walleye pollock	-	-	-	-	-	-	3	15
Pacific herring	-	-	-	-	-	-	-	-
Pacific sardine	-	-	-	-	68	-	-	-
Jack mackeral	-	-	-	-	-	-	-	-
Whitebait smelt	-	-	-	-	-	-	-	-
Eared black smelt	-	-	-	-	-	-	-	-
Eulachon	-	-	-	-	-	-	-	-
Sablefish (juv)	-	-	-	-	-	-	-	-
Pink salmon	-	-	-	-	32	1	-	-
Coho salmon	-	-	-	-	-	<1	-	-
Chum salmon	-	-	<1	-	-	1	-	-
Sockeye salmon	-	-	-	-	-	-	-	-
Sebastes brevispinis	-	3	-	-	-	-	-	-
S. flavidus		-	-	-	-	-	-	-
S. paucispinis	-	-	-	-	-	-	-	-
S. alutus	-	-	-	-	-	-	4	6
S. entomelas	-	-	-	-	-	-	-	-
S. proriger	-	52	-	-	-	-	-	-
S. aleutianus	-	-	-	-	-	-	-	-
S. elongatus	-	-	-	-	-	-	-	-
S. ruberrimus	-	7	-	-	-	-	-	-
S. helvomaculatus	-	1	-	-	-	-	-	-
S. babcocki	-	3	-	-	-	-	-	-
S. crameri	-	-	-	-	-	<1	-	-
S. reedi	-	-	-	-	-	-	-	-
Dover sole	-	1	-	-	-	-	-	-
Rex sole	-	3	-	-	-	-	-	-
Turbot	-	28	-	-	-	-	-	-
Spiny dogfish	-	3	-	-	-	-	-	-
Pacific Lamprey	-	-	<1	-	-	-	-	<1
Myctophids	100	-	-	10	-	-	<1	-
OTHER								
Squid	-	-	-	-	-	-	-	-
Pink shrimp	-	-	-	-	-	-	-	-
Jellyfish	<1	-	-	90	-	-	<1	<1
Euphausiids	-	-	-	-	-	-	-	-

Appendix Table 3.--Continued.

Set No.	18	19	20	21	22	23	24	25
Total catch (kg)	25.1	3.4	1,403.8	17.3	514.1	159.7	95.0	1,642.5
Species								
Pacific hake	-	-	70	-	98	3	-	92
Walleye pollock	-	-	16	-	1	97	-	4
Pacific herring	-	-	-	-	-	-	95	<1
Pacific sardine	-	-	-	-	-	-	1	-
Jack mackeral	-	-	-	-	-	-	-	<1
Whitebait smelt	-	-	-	-	-	-	-	<1
Eared black smelt	-	-	-	-	-	-	-	-
Eulachon	-	-	-	-	-	-	-	-
Sablefish (juv)	<1	-	-	-	-	-	-	-
Pink salmon	56	-	-	43	-	-	1	-
Coho salmon	-	-	-	16	-	-	-	-
Chum salmon	17	-	-	28	-	-	-	-
Sockeye salmon	15	-	-	2	-	-	-	-
Sebastes brevispinis	-	-	-	-	-	-	-	-
S. flavidus	-	-	11	12	<1	-	-	1
S. paucispinis	-	-	-	-	1	-	-	-
S. alutus	-	-	-	-	-	-	-	-
S. entomelas	-	-	-	-	-	-	-	-
S. proriger	-	-	-	-	-	-	-	-
S. aleutianus	-	-	-	-	-	-	-	-
S. elongatus	-	-	-	-	-	-	-	-
S. ruberrimus	-	-	-	-	-	-	-	-
S. helvomaculatus	-	-	-	-	-	-	-	-
S. babcocki	-	-	-	-	-	-	-	-
S. crameri	-	-	-	-	-	-	-	-
S. reedi	-	-	-	-	-	-	-	-
Dover sole	-	-	-	-	-	-	-	-
Rex sole	-	-	-	-	-	-	-	-
Turbot	-	-	-	-	-	-	-	-
Spiny dogfish	-	-	-	-	-	-	-	2
Pacific Lamprey	-	-	<1	-	<1	<1	-	-
Myctophids	-	<1	-	-	-	-	-	-
OTHER								
Squid	-	<1	-	<1	-	-	-	-
Pink shrimp	-	-	-	-	-	-	-	-
Jellyfish	<1	<1	-	<1	-	-	3	-
Euphausiids	-	82	-	-	-	-	-	-

Appendix Table 3.--Continued.

Set No.	26	27	28	29	30	31	32	33
Total catch (kg)	975.0	29.1	59.2	989.7	980.7	1,295.1	*10,000	1,318.6
Species								
Pacific hake	97	86	88	98	93	99	*98	78
Walleye pollock	3	-	-	-	-	-	-	-
Pacific herring	-	-	-	-	-	<1	<1	-
Pacific sardine	-	-	-	-	-	-	-	-
Jack mackeral	-	-	-	-	-	-	-	1
Whitebait smelt	-	-	-	-	-	-	-	-
Eared black smelt	-	<1	-	-	-	-	-	-
Eulachon	-	-	-	-	-	<1	-	-
Sablefish (juv)	-	-	-	-	-	-	-	-
Pink salmon	-	-	-	-	-	-	-	-
Coho salmon	-	-	-	-	-	-	-	-
Chum salmon	-	-	-	-	-	-	-	-
Sockeye salmon	-	-	-	-	-	-	-	-
Sebastes brevispinis							<1	
S. flavidus	<1	-	-	<1	<1	<1	1	13
S. paucispinis	<1	-	-	-	-	-	-	-
S. alutus	-	-	1	1	<1	-	-	-
S. entomelas	-	-	-	-	<1	-	1	7
S. proriger	-	-	-	-	-	-	-	1
S. aleutianus	-	-	-	-	-	-	-	-
S. elongatus	-	-	-	-	-	-	-	-
S. ruberrimus	-	-	-	-	-	-	-	-
S. helvomaculatus	-	-	-	-	-	-	-	-
S. babcocki	-	-	-	-	-	-	-	-
S. crameri	-	-	-	-	-	-	-	-
S. reedi	-	-	-	-	6	-	-	-
Dover sole	-	-	-	-	-	-	-	-
Rex sole	-	-	-	-	-	-	-	-
Turbot	-	-	-	-	-	-	<1	-
Spiny dogfish	<1	-	-	-	-	-	-	-
Pacific Lamprey	<1	-	-	<1	-	-	-	<1
Myctophids	-	9	<1	-	-	-	-	-
OTHER								
Squid	-	<1	-	-	-	-	-	-
Pink shrimp	-	<1	-	-	-	-	-	-
Jellyfish	-	5	11	-	-	<1	-	-
Euphausiids	-	-	-	-	-	-	-	-

Appendix Table 4a.--Summary by transect of area, mean nautical area scattering coefficient (s_A) and estimated numbers and weights (in metric tons (t)) of Pacific hake in the Queen Charlotte Islands area from transects conducted by the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts. TSn is dB/fish derived from $TSn^a = 20logL - 68$ (see text page 6). TSw is dB/kg, derived from $w = .0047(L)^{3.0855}$ (Kieser et al. 1998), using mean fish length from trawl catch data.

Transect	Area (km^2)	s_A ($m2/nmi^2$)[b]	Area s_A	TSn (dB/nos)	Fish numbers	Mean fish len (cm)	TSw (dB/kg)	Total wgt (t)	Mean fish wgt (g)
Q01	376.5	38.0	4,171	-34.22	877,181	48.8	-33.09	675.6	770
Q02	121.4	91.0	3,221	-34.22	677,331	48.8	-33.09	521.7	770
Q03	94.3	295.5	8,124	-34.22	1,708,480	48.8	-33.09	1,315.9	770
Q04.1	170.0	156.2	7,742	-34.22	1,628,061	48.8	-33.09	1,253.9	770
Q05	200.0	82.8	4,828	-34.22	1,015,315	48.8	-33.09	782.0	770
Q06	176.3	76.7	3,942	-34.22	829,064	48.8	-33.09	638.6	770
Q07	26.4	175.4	1,350	-34.22	283,906	48.8	-33.09	218.7	770
Q08	234.5	131.0	8,956	-34.22	1,883,453	48.8	-33.09	1,450.6	770
Q09	25.0	422.7	3,081	-34.22	647,907	48.8	-33.09	499.0	770
Q10	111.5	97.8	3,179	-34.22	668,581	48.8	-33.09	514.9	770
Q11	25.6	179.3	1,338	-34.22	281,424	48.8	-33.09	216.8	770
Q12	78.5	620.8	14,208	-34.22	2,987,872	48.8	-33.09	2,301.3	770
Q13.1	22.6	204.0	1,344	-34.22	282,670	48.8	-33.09	217.7	770
Q13.2	6.3	592.4	1,088	-34.22	228,821	48.8	-33.09	176.2	770
Q14	15.0	324.4	1,419	-34.22	298,341	48.8	-33.09	229.8	770
Q14.1	38.7	760.2	8,577	-34.22	1,803,763	48.8	-33.09	1,389.3	770
Q15	34.7	85.8	868	-34.22	182,540	48.8	-33.09	140.6	770
Q16	42.5	88.1	1,092	-34.22	229,565	48.8	-33.09	176.8	770
Q17	60.7	404.1	7,151	-34.22	1,503,897	48.8	-33.09	1,158.3	770
Q18	32.4	342.1	3,232	-34.22	679,577	48.8	-33.09	523.4	770
Q18.1	30.2	17.9	158	-34.22	33,144	48.8	-33.09	25.5	770
Q19	36.6	598.3	6,384	-34.22	1,342,582	48.8	-33.09	1,034.1	770
Q20	75.6	362.9	7,999	-34.22	1,682,091	48.8	-33.09	1,295.6	770
Q21	96.7	293.7	8,280	-34.22	1,741,290	48.8	-33.09	1,341.2	770
Q22	70.1	484.6	9,904	-34.22	2,082,774	48.8	-33.09	1,604.2	770
Q23	183.1	554.9	29,622	-34.22	6,229,364	48.8	-33.09	4,797.9	770
Q24	121.8	163.8	5,817	-34.22	1,223,212	48.8	-33.09	942.1	770
Q25	300.7	214.0	18,761	-34.22	3,945,371	48.8	-33.09	3,038.7	770
Q26	277.5	585.3	47,354	-34.22	9,958,230	48.8	-33.09	7,669.9	770
Q27	145.3	546.4	23,147	-34.22	4,867,623	48.8	-33.09	3,749.1	770
Q28	197.3	708.9	40,778	-34.22	8,575,366	48.8	-33.09	6,604.8	770
Q29	246.2	547.3	39,285	-34.22	8,261,409	48.8	-33.09	6,363.0	770
Q30	186.9	521.1	28,395	-34.22	5,971,329	48.8	-33.09	4,599.1	770

Appendix Table 4a.--Continued.

Transect	Area (km^2)	s_A ($m2/nmi^2$)[b]	Area s_A	TSn (dB/nos)	Fish numbers	Mean fish len (cm)	TSw (dB/kg)	Total wgt (t)	Mean fish wgt (g)
Q31	87.8	720.5	18,444	-34.22	3,878,548	48.8	-33.09	2,987.3	770
Q32	173.7	848.7	42,981	-34.22	9,038,464	48.8	-33.09	6,961.5	770
Q33	253.4	390.5	28,850	-34.22	6,066,920	48.8	-33.09	4,672.8	770
Q34	137.6	0.0	0	-34.22	0	48.8	-33.09	0.0	770
Q35	720.2	235.4	49,429	-34.22	10,394,418	48.8	-33.09	8,005.8	770
Q36	348.6	409.9	41,660	-34.22	8,760,843	48.8	-33.09	6,747.6	770
Q38	1,188.4	69.5	24,080	-34.22	5,063,934	48.8	-33.09	3,900.3	770
Total	6,837.0				117,814,661			90,741.5	

[a] TS = Target strength
[b] nmi = nautical miles

Appendix Table 4b.--Summary by transect of area, mean nautical area scattering coefficient (s_A) and estimated numbers and weights (in metric tons (t)) of Pacific hake in the Alaska area from transects conducted by the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts. TSn is dB/fish derived from $TSn^a = 20\log L - 68$ (see text page 6). TSw is dB/kg, derived from $w = .0047(L)^{3.0855}$ (Kieser et al. 1998), using mean fish length from trawl catch data.

Transect	Area (km^2)	s_A ($m2/nmi^2$)[b]	Area s_A	TSn (dB/nos)	Fish numbers	Mean fish len (cm)	TSw (dB/kg)	Total wgt (t)	Mean fish wgt (g)
Q39	405.2	29.4	3,473	-34.22	730,394	48.8	-33.09	562.6	770
Q39.1	79.0	24.6	567	-34.22	119,152	48.8	-33.09	91.8	770
Q40	194.6	24.0	1,362	-34.22	286,348	48.8	-33.09	220.5	770
Q41	158.9	59.0	2,733	-34.22	574,800	48.8	-33.09	442.7	770
Q42	117.4	23.2	794	-34.22	166,992	48.8	-33.09	128.6	770
Q43	170.3	82.0	4,071	-34.22	856,188	48.8	-33.09	659.4	770
Q44	91.8	18.2	487	-34.22	102,436	48.8	-33.09	78.9	770
Q45	273.8	431.8	34,469	-34.22	7,248,643	48.8	-33.09	5,582.9	770
Q46	76.3	255.7	5,688	-34.22	1,196,178	48.8	-33.09	921.3	770
Q47	65.3	601.5	11,452	-34.22	2,408,183	48.8	-33.09	1,854.8	770
Q48	123.1	12.9	463	-34.22	97,362	48.8	-33.09	75.0	770
Q49	400.9	79.4	9,281	-34.22	1,951,629	48.8	-33.09	1,503.2	770
Q50	133.9	0.0	0	-34.22	0	48.8	-33.09	0.0	770
Q51	195.2	743.6	42,319	-34.22	8,899,381	48.8	-33.09	6,854.4	770
Q51.1	8.3	23.0	56	-34.22	11,704	48.8	-33.09	9.0	770
Q51.2	275.7	0.0	0	-34.22	0	48.8	-33.09	0.0	770
Q52	152.3	0.0	0	-34.22	0	48.8	-33.09	0.0	770
Q53	223.8	64.2	4,189	-34.22	880,919	48.8	-33.09	678.5	770
Q54	278.2	0.0	0	-34.22	0	48.8	-33.09	0.0	770
Q55	251.1	62.3	4,561	-34.22	959,125	48.8	-33.09	738.7	770
Q56	67.8	78.8	1,558	-34.22	327,564	48.8	-33.09	252.3	770
Q57	475.9	5.9	819	-34.22	172,151	48.8	-33.09	132.6	770
Q58	489.6	33.0	4,711	-34.22	990,595	48.8	-33.09	763.0	770
Q59	300.4	0.0	0	-34.22	0	48.8	-33.09	0.0	770
Q60	777.7	4.9	1,111	-34.22	233,641	48.8	-33.09	180.0	770
Q61	140.3	70.4	2,880	-41.28	3,078,081	21.6	-29.26	193.1	63
Q61.1	192.4	7.3	409	-41.28	437,701	21.6	-29.26	27.5	63
Q62	525.8	46.7	7,159	-41.28	7,652,216	21.6	-29.26	480.1	63
Q63	337.5	195.3	19,217	-34.22	4,041,259	48.8	-33.09	3,112.6	770
Q64	449.6	48.1	6,305	-34.22	1,325,904	48.8	-33.09	1,021.2	770
Q65	282.8	29.1	2,399	-34.22	504,560	48.8	-33.09	388.6	770
Q66	413.5	125.4	15,118	-34.22	3,179,169	48.8	-33.09	2,448.6	770
Q66.3	18.2	221.6	1,176	-34.22	247,276	48.8	-33.09	190.5	770

Appendix Table 4b.--Continued.

Transect	Area (km^2)	s_A ($m2/nmi^2$)[b]	Area s_A	TSn (dB/nos)	Fish numbers	Mean fish len (cm)	TSw (dB/kg)	Total wgt (t)	Mean fish wgt (g)
Q67	261.1	303.3	23,089	-34.22	4,855,343	48.8	-33.09	3,739.6	770
Q68	297.5	840.1	72,868	-34.22	15,323,521	48.8	-33.09	11,802.3	770
Q69	310.3	116.1	10,503	-34.22	2,208,791	48.8	-33.09	1,701.2	770
Q70	283.3	1.3	107	-34.22	22,580	48.8	-33.09	17.4	770
Q71	204.6	228.0	13,601	-34.22	2,860,099	48.8	-33.09	2,202.9	770
Q72	41.6	407.1	4,938	-34.22	1,038,329	48.8	-33.09	799.7	770
Q72.1	234.8	415.7	28,457	-34.22	5,984,374	48.8	-33.09	4,609.2	770
Q73	195.8	195.5	11,160	-34.22	2,346,930	48.8	-33.09	1,807.6	770
Q74	565.7	41.7	6,878	-34.22	1,446,315	48.8	-33.09	1,114.0	770
Q75	266.8	11.9	926	-34.22	194,659	48.8	-33.09	149.9	770
Q76	350.6	6.6	675	-34.22	141,872	48.8	-33.09	109.3	770
Q77	459.4	14.7	1,969	-34.22	414,046	48.8	-33.09	318.9	770
Total	11,618.1				85,516,410			57,964.2	

[a] TS = Target strength
[b] nmi = nautical miles

Appendix Table 4c.--Summary by transect of area, mean nautical area scattering coefficient (s_A) and estimated numbers and weights (in metric tons (t)) of Pacific hake in the Dixon Entrance area from transects conducted by the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts. TSn is dB/fish derived from TSn[a] = 20logL – 68 (see text page 6). TSw is dB/kg, derived from $w = .0047(L)^{3.0855}$ (Kieser et al. 1998), using mean fish length from trawl catch data.

Transect	Area (km^2)	s_A ($m2/nmi^2$)[b]	Area s_A	TSn (dB/nos)	Fish numbers	Mean fish len (cm)	TSw (dB/kg)	Total wgt (t)	Mean fish wgt (g)
D01	445.6	157.6	20,475	-34.22	4,305,683	48.8	-33.09	3,316.3	770
D02.1	38.3	1,364.1	15,232	-34.22	3,203,211	48.8	-33.09	2,467.1	770
D03	17.4	1,280.5	6,496	-34.22	1,366,059	48.8	-33.09	1,052.1	770
D03.1	97.9	48.2	1,376	-34.22	289,315	48.8	-33.09	222.8	770
D04	177.3	53.6	2,771	-34.22	582,659	48.8	-33.09	448.8	770
D05	185.0	31.9	1,721	-34.22	361,829	48.8	-33.09	278.7	770
D06	118.6	673.7	23,295	-34.22	4,898,824	48.8	-33.09	3,773.1	770
D07	185.4	459.0	24,811	-34.22	5,217,507	48.8	-33.09	4,018.6	770
D08	265.8	361.7	28,030	-34.22	5,894,461	48.8	-33.09	4,539.9	770
D09	58.6	3.5	60	-34.22	12,575	48.8	-33.09	9.7	770
D10	191.9	0.0	0	-34.22	0	48.8	-33.09	0.0	770
D11*	268.8	146.8	11,505	-34.22	2,419,335*	48.8	-33.09	1,863.4*	770
D12*	65.4	90.3	1,722	-34.22	362,081*	48.8	-33.09	278.9*	770
D13*	126.0	376.4	13,827	-34.22	2,907,775*	48.8	-33.09	2,239.6*	770
D14*	66.0	0.0	0	-34.22	0*	48.8	-33.09	0*	770
D15*	161.9	0.0	0	-34.22	0*	48.8	-33.09	0*	770
D16*	71.6	28.8	601	-34.22	126,429*	48.8	-33.09	97.4*	770
D17*	101.4	26.4	780	-34.22	164,128*	48.8	-33.09	126.4*	770
D19	127.6	345.2	12,842	-34.22	2,700,611	48.8	-33.09	2,080.0	770
D20	32.5	28.8	273	-34.22	57,387	48.8	-33.09	44.2	770
D21	48.5	44.6	631	-34.22	132,623	48.8	-33.09	102.1	770
D21.1	27.0	0.0	0	-34.22	0	48.8	-33.09	0.0	770
D22	7.2	0.0	0	-34.22	0	48.8	-33.09	0.0	770
D23	4.0	0.0	0	-34.22	0	48.8	-33.09	0.0	770
D24	0.0	0.0	0	-34.22	0	48.8	-33.09	0.0	770
D25	0.0	0.0	0	-34.22	0	48.8	-33.09	0.0	770
Total	2,889.7				35,002,492			26,959.1	

[a] TS = Target strength
[b] nmi = nautical miles

NOTE: Values with * are numbers and biomass of fish reported for 'Disputed Zone' (see Tables 13-16; Fig. 2).

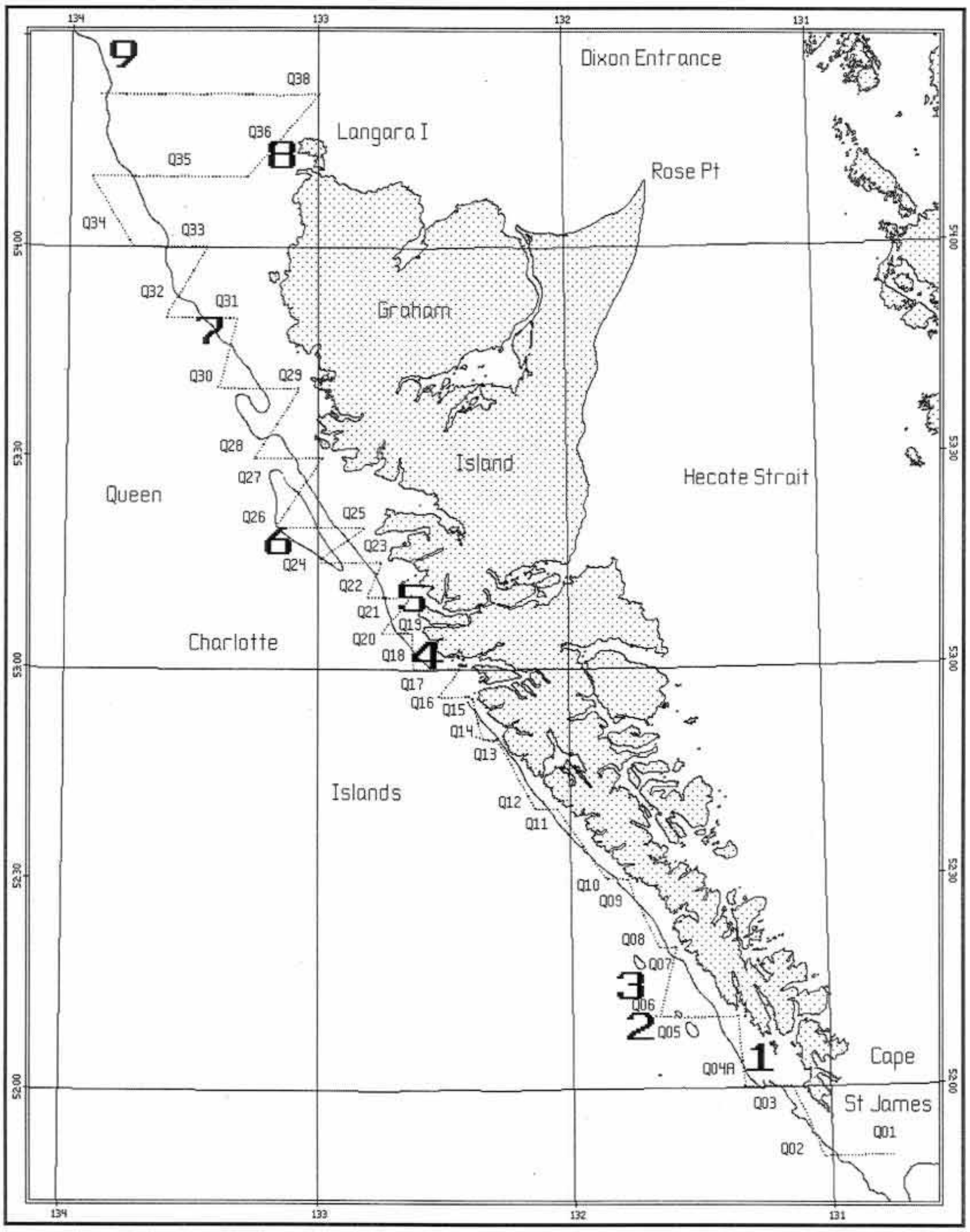
Appendix Table 4d.--Summary by transect of area, mean nautical area scattering coefficient (s_A) and estimated numbers and weights (in metric tons (t)) of Pacific hake in the Hecate Strait and Queen Charlotte Sound area from transects conducted by the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts. TSn is dB/fish derived from $TSn^a = 20logL - 68$ (see text page 6). TSw is dB/kg, derived from $w = .0047(L)^{3.0855}$ (Kieser et al. 1998), using mean fish length from trawl catch data.

Transect	Area (km^2)	s_A ($m2/nmi^2$)[b]	Area s_A	TSn (dB/nos)	Fish numbers	Mean fish len (cm)	TSw (dB/kg)	Total wgt (t)	Mean fish wgt (g)
H01	12.2	0.0	0	-34.22	0	48.8	-33.09	0.0	770
H01.2	56.1	1,232.1	20,152	-34.22	4,237,888	48.8	-33.09	3,264.0	770
H01.4	40.6	4,106.7	48,611	-34.22	10,222,559	48.8	-33.09	7,873.5	770
H02	182.3	984.3	52,316	-34.22	11,001,573	48.8	-33.09	8,473.5	770
H03	67.2	165.1	3,235	-34.22	680,232	48.8	-33.09	523.9	770
H04	349.7	109.5	11,164	-34.22	2,347,742	48.8	-33.09	1,808.2	770
H05	343.3	333.3	33,360	-34.22	7,015,356	48.8	-33.09	5,403.3	770
H06	99.8	468.5	13,632	-34.22	2,866,690	48.8	-33.09	2,207.9	770
H06.1	329.3	40.6	3,898	-34.22	819,707	48.8	-33.09	631.3	770
H07	896.8	7.2	1,883	-34.22	395,885	48.8	-33.09	304.9	770
H08	293.5	213.0	18,227	-34.22	3,832,907	48.8	-33.09	2,952.1	770
H09	1,145.5	0.0	0	-34.22	0	48.8	-33.09	0.0	770
H10	103.2	0.0	0	-34.22	0	48.8	-33.09	0.0	770
H10.1	18.8	42.5	233	-34.22	48,988	48.8	-33.09	37.7	770
H10.2	65.0	15.0	284	-34.22	59,779	48.8	-33.09	46.0	770
H10.3	27.5	1.1	9	-34.22	1,855	48.8	-33.09	1.4	770
H10.4	97.1	0.0	0	-34.22	0	48.8	-33.09	0.0	770
H10.5	265.6	0.0	0	-34.22	0	48.8	-33.09	0.0	770
H11	821.7	29.8	7,139	-34.22	1,501,309	48.8	-33.09	1,156.3	770
H12	510.0	14.9	2,216	-34.22	465,905	48.8	-33.09	358.8	770
H13	629.2	58.9	10,805	-34.22	2,272,190	48.8	-33.09	1,750.1	770
H14	143.5	0.0	0	-34.22	0	48.8	-33.09	0.0	770
H15	475.0	129.5	17,934	-34.69	4,204,659	45.5	-32.98	2,832.8	674
H16	217.8	11.8	749	-34.69	175,674	45.5	-32.98	118.4	674
H17	242.9	0.0	0	-34.69	0	45.5	-32.98	0.0	674
H17.1	185.2	73.0	3,942	-34.69	924,126	45.5	-32.98	622.6	674
H18	134.3	0.0	0	-34.69	0	45.5	-32.98	0.0	674
H19	99.6	154.7	4,492	-34.69	1,053,215	45.5	-32.98	709.6	674
H19.1	983.4	20.3	5,820	-34.69	1,364,563	45.5	-32.98	919.3	674
H20	338.1	16.4	1,617	-34.69	379,015	45.5	-32.98	255.3	674
H21	76.1	0.0	0	-34.69	0	45.5	-32.98	0.0	674
H22	298.0	21.2	1,842	-34.69	431,837	45.5	-32.98	290.9	674
H23	771.4	135.9	30,564	-34.69	7,165,831	45.5	-32.98	4,827.7	674

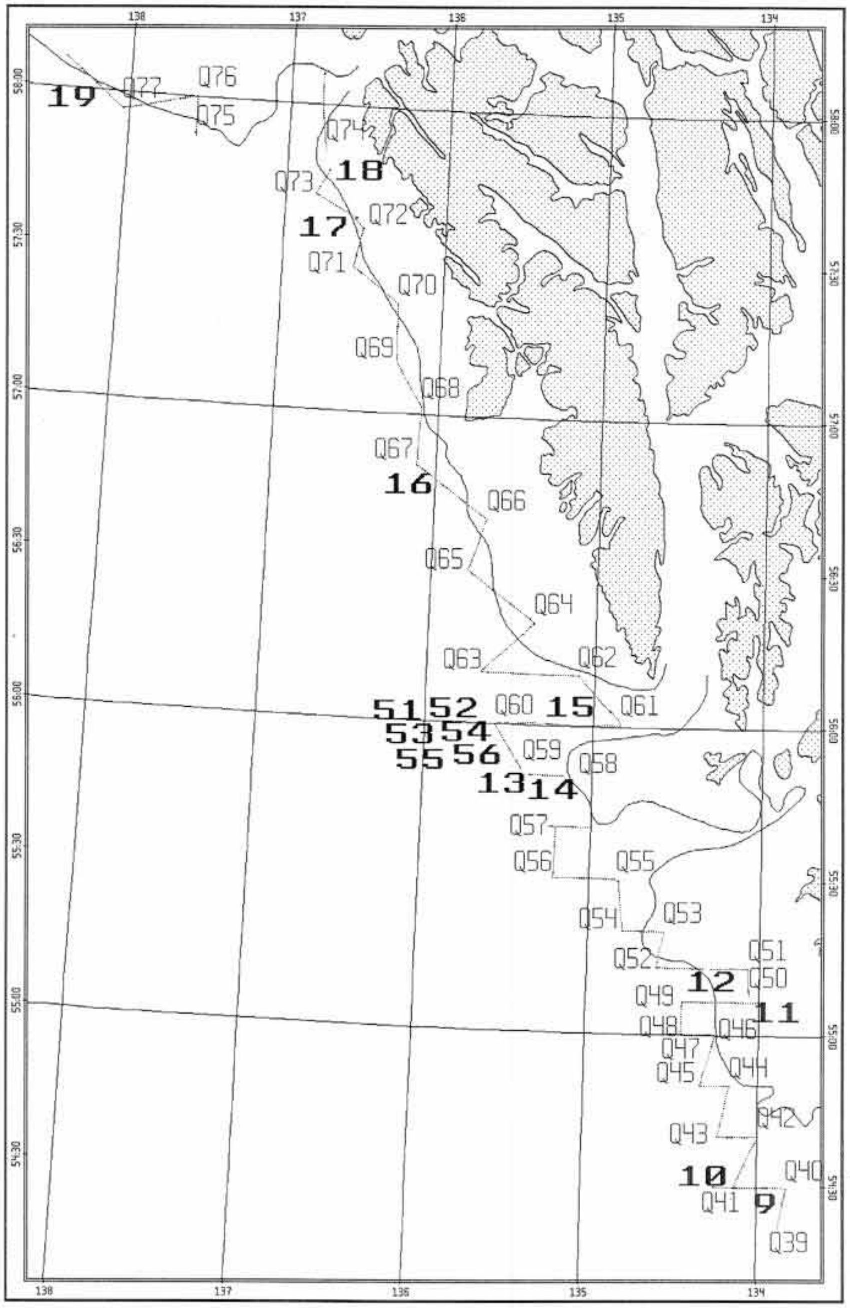
Appendix Table 4d.--Continued.

Transect	Area (km^2)	s_A ($m2/nmi^2$)[b]	Area s_A	TSn (dB/nos)	Fish numbers	Mean fish len (cm)	TSw (dB/kg)	Total wgt (t)	Mean fish wgt (g)
H24	393.8	0.0	0	-34.43	0	47.5	-32.99	0.0	718
H25	131.4	0.0	0	-34.43	0	47.5	-32.99	0.0	718
H26	444.2	302.9	39,228	-34.43	8,663,733	47.5	-32.99	6,218.4	718
H27	78.5	507.8	11,622	-34.43	2,566,786	47.5	-32.99	1,842.3	718
H27.1	531.9	364.7	56,557	-34.43	12,490,879	47.5	-32.99	8,965.4	718
H28	648.7	238.5	45,108	-34.43	9,962,298	47.5	-32.99	7,150.5	718
H29	197.4	261.1	15,027	-34.43	3,318,801	47.5	-32.99	2,382.1	718
H29.1	541.2	631.8	99,691	-34.43	22,017,330	47.5	-32.99	15,803.0	718
H30	286.1	23.8	1,985	-34.43	438,452	47.5	-32.99	314.7	718
H31	906.8	307.1	81,191	-34.43	17,931,581	47.5	-32.99	12,870.4	718
H32	217.4	212.8	13,488	-34.43	2,978,917	47.5	-32.99	2,138.1	718
H33	144.5	169.2	7,128	-34.43	1,574,329	47.5	-32.99	1,130.0	718
H34	152.3	131.6	5,844	-34.43	1,290,574	47.5	-32.99	926.3	718
H34.2	41.7	0.0	0	-34.43	0	47.5	-32.99	0.0	718
H35	1,035.8	18.0	5,436	-34.43	1,200,537	47.5	-32.99	861.7	718
H36	195.8	154.8	8,837	-39.65	6,494,934	24.9	-31.12	910.1	140
H36.1	144.4	0.0	0	-39.65	0	24.9	-31.12	0.0	140
H37	167.8	0.0	0	-34.18	0	49.0	-33.11	0.0	782
H38	39.6	31.7	366	-34.18	76,273	49.0	-33.11	59.7	782
H39	230.0	243.5	16,328	-34.18	3,402,863	49.0	-33.11	2,661.4	782
H40	115.3	6.2	208	-34.18	43,435	49.0	-33.11	34.0	782
H40.1	336.0	101.1	9,904	-34.18	2,063,993	49.0	-33.11	1,614.3	782
Total	17,300.3				159,985,200			113,252.1	

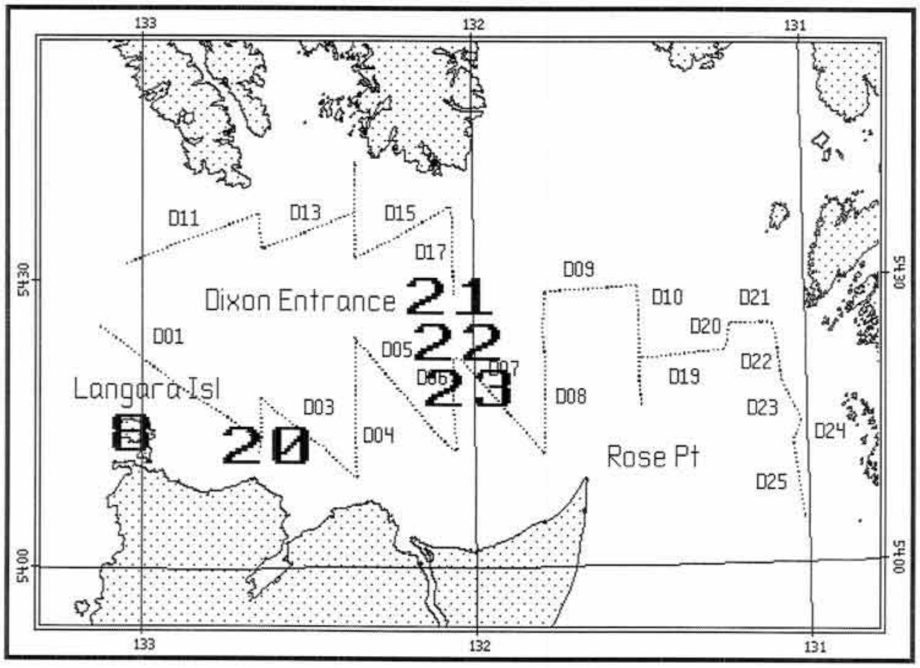
[a] TS = Target strength
[b] nmi = nautical miles



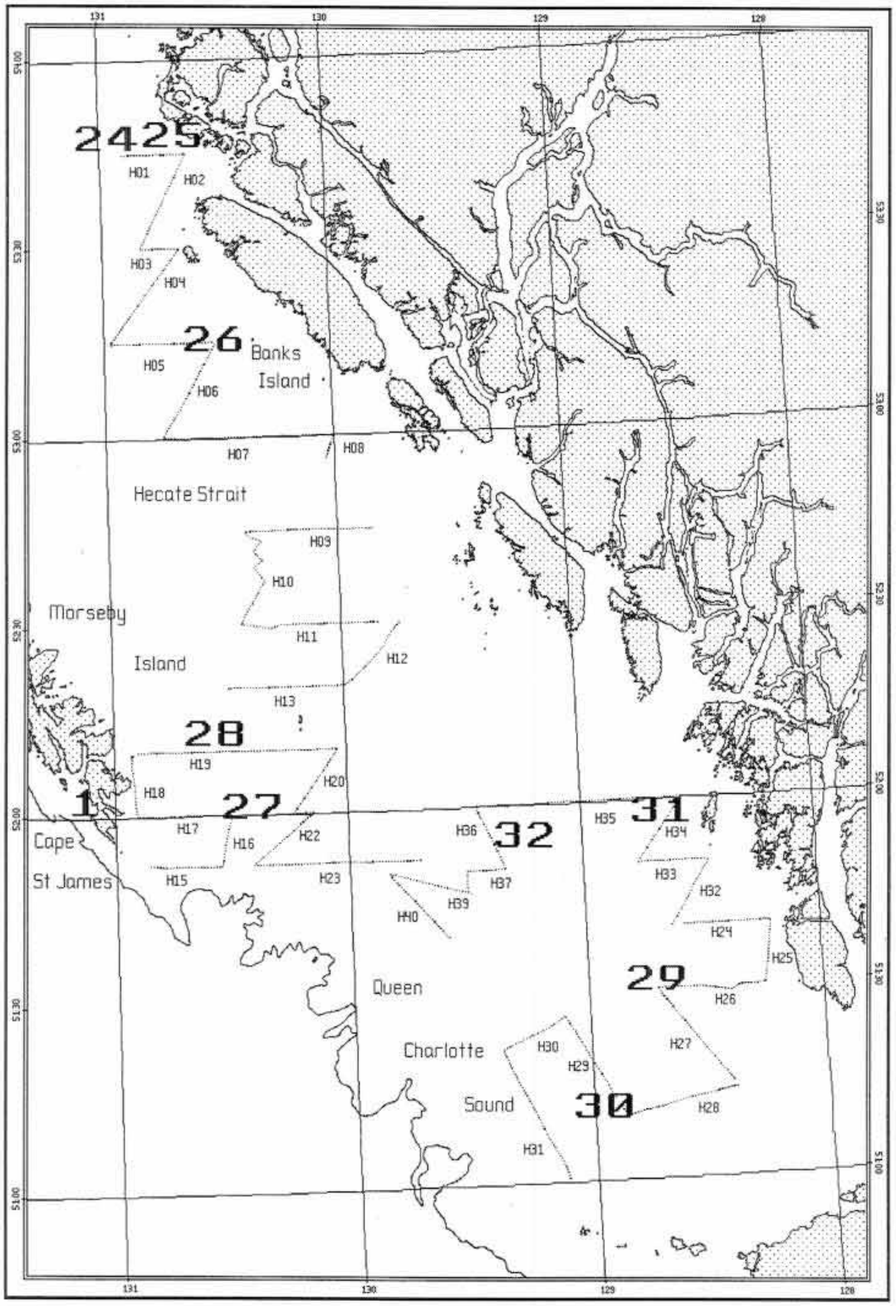
Appendix Figure 1a.--Transects and trawl locations for westcoast Queen Charlotte Islands area from the Pacific hake echo integration-trawl survey on the CCGS *W.E. Ricker,* August 4 – 24, 1998. Trawl locations are shown in **bold** numbers. The 200 m isobath is shown to indicate the continental shelf edge.



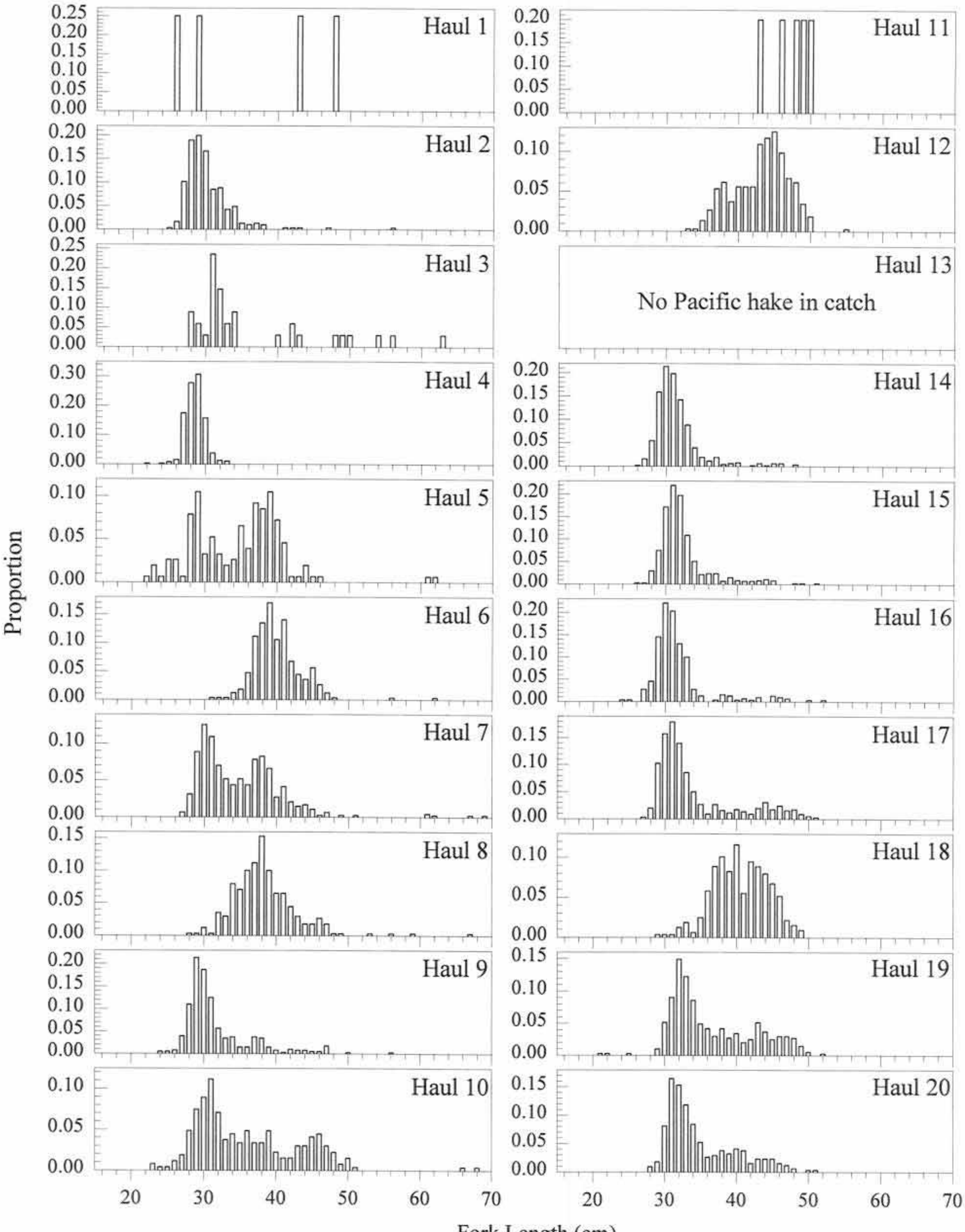
Appendix Figure 1b.--Transects and trawl locations for Alaska area from the Pacific hake echo integration-trawl survey on the CCGS *W.E. Ricker*, August 4 – 24, 1998. Trawl locations are shown in **bold** numbers; #51-56 indicate Tucker trawl locations. The 200 m isobath is shown to indicate the continental shelf edge.



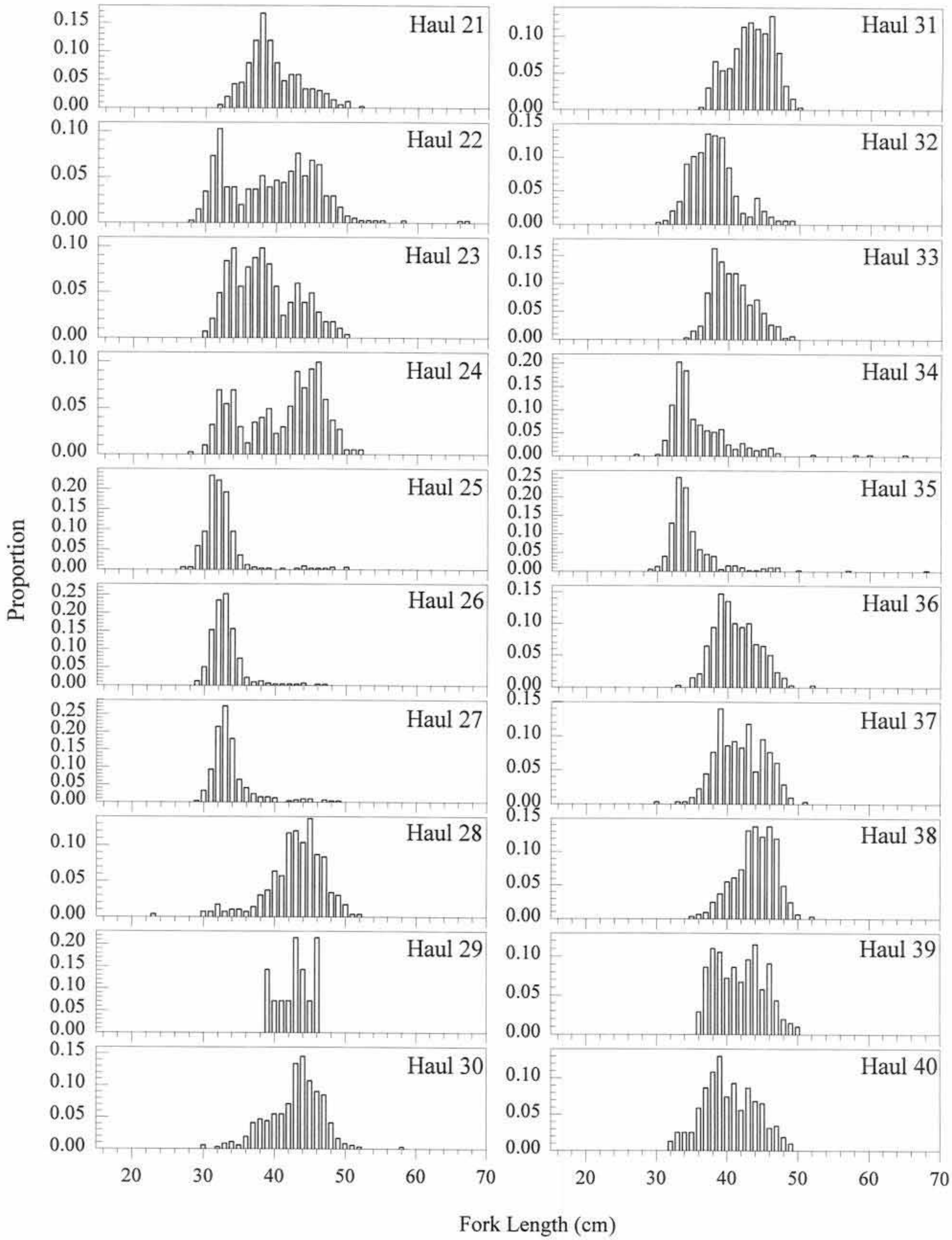
Appendix Figure 1c.--Transects and trawl locations for Dixon Entrance area from the Pacific hake echo integration-trawl survey on the CCGS *W.E. Ricker*, August 4 – 24, 1998. Trawl locations are shown in **bold** numbers.



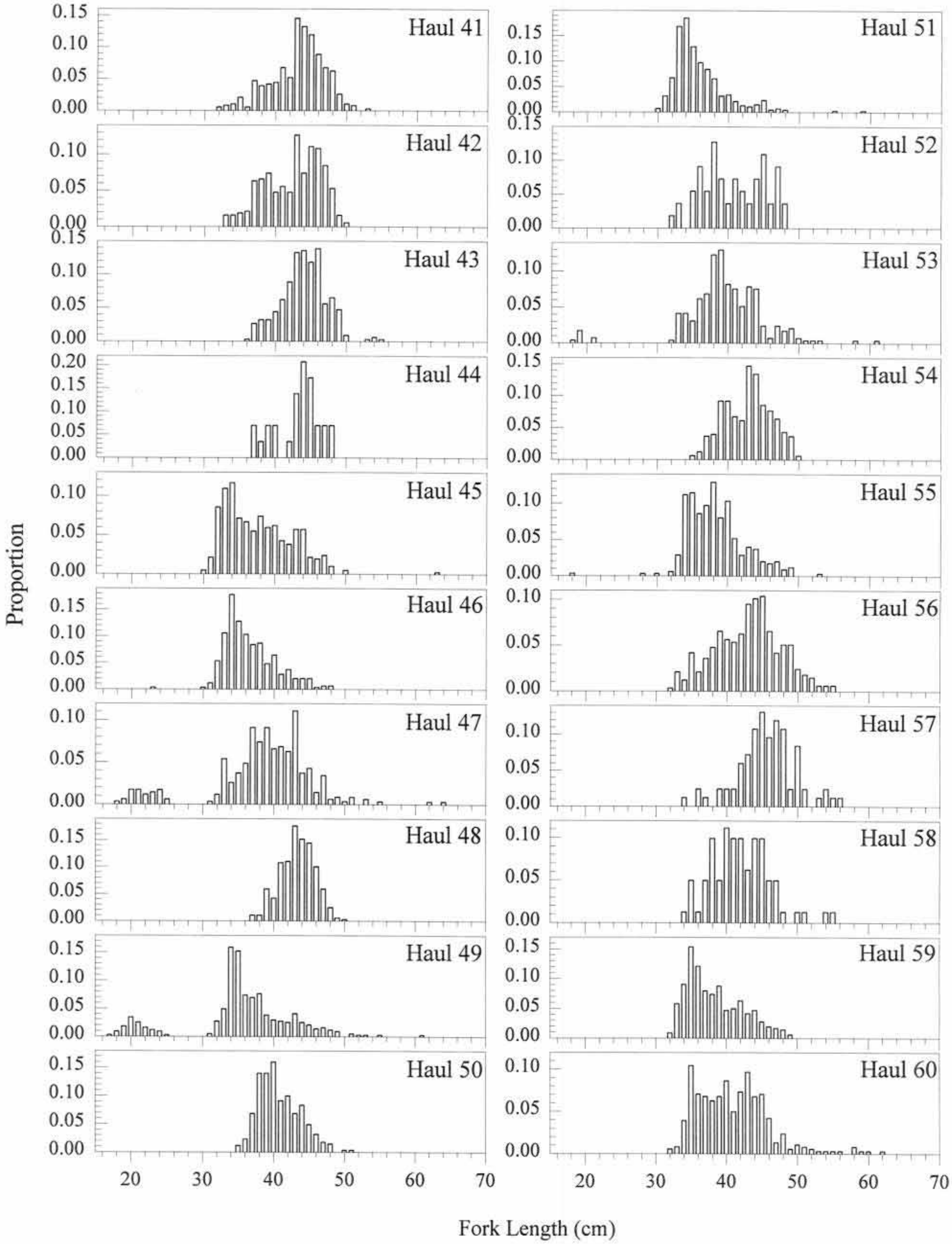
Appendix Figure 1d.--Transects and trawl locations for Hecate Strait and Queen Charlotte Sound area from the Pacific hake echo integration-trawl survey on the CCGS *W.E. Ricker*, August 4 – 24, 1998. Trawl locations are shown in **bold** numbers. The 200 m isobath is shown to indicate the continental shelf edge.



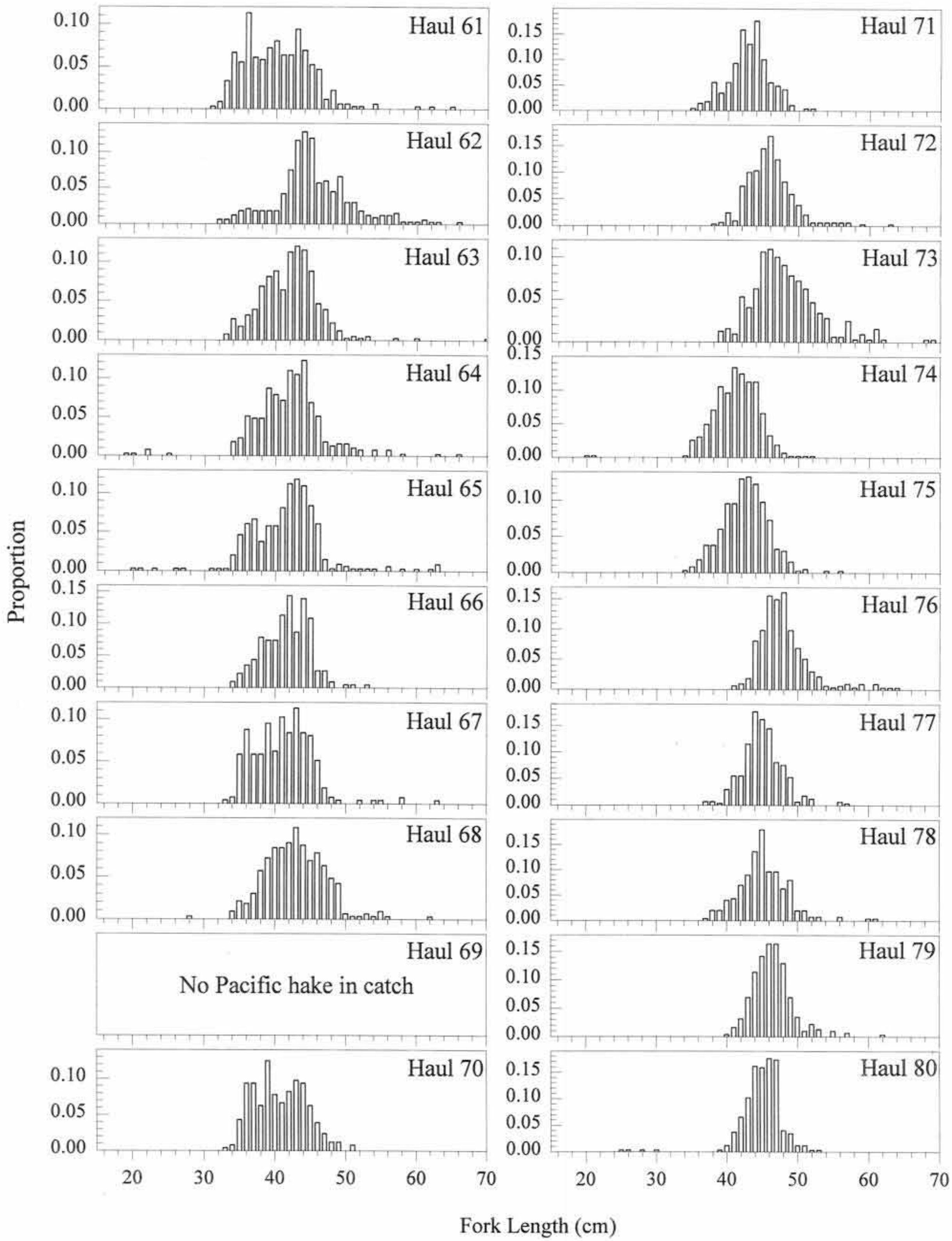
Appendix Figure 2.--Proportion at length of Pacific hake from hauls conducted by the NOAA ship *Miller Freeman* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.



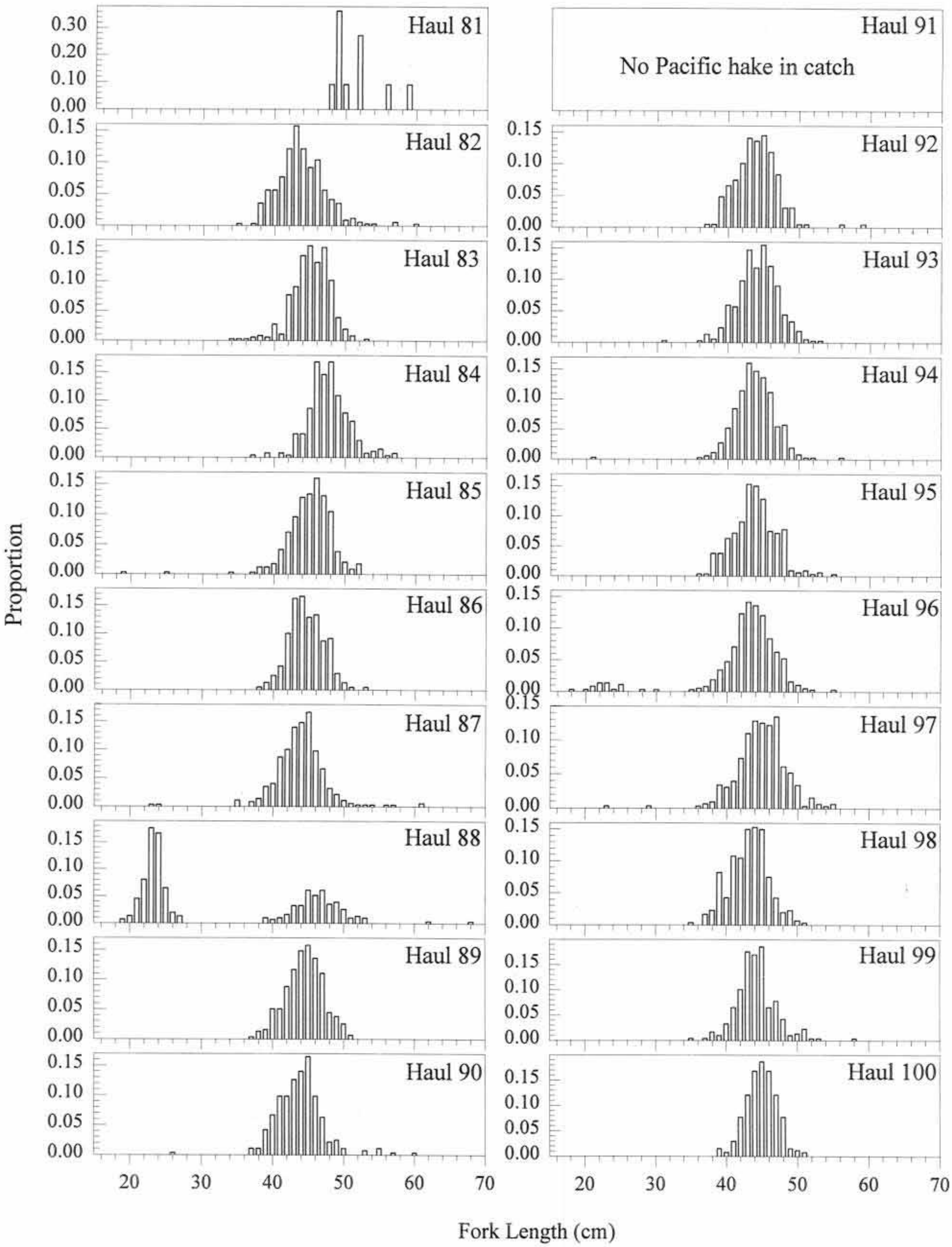
Appendix Figure 2.--Continued.



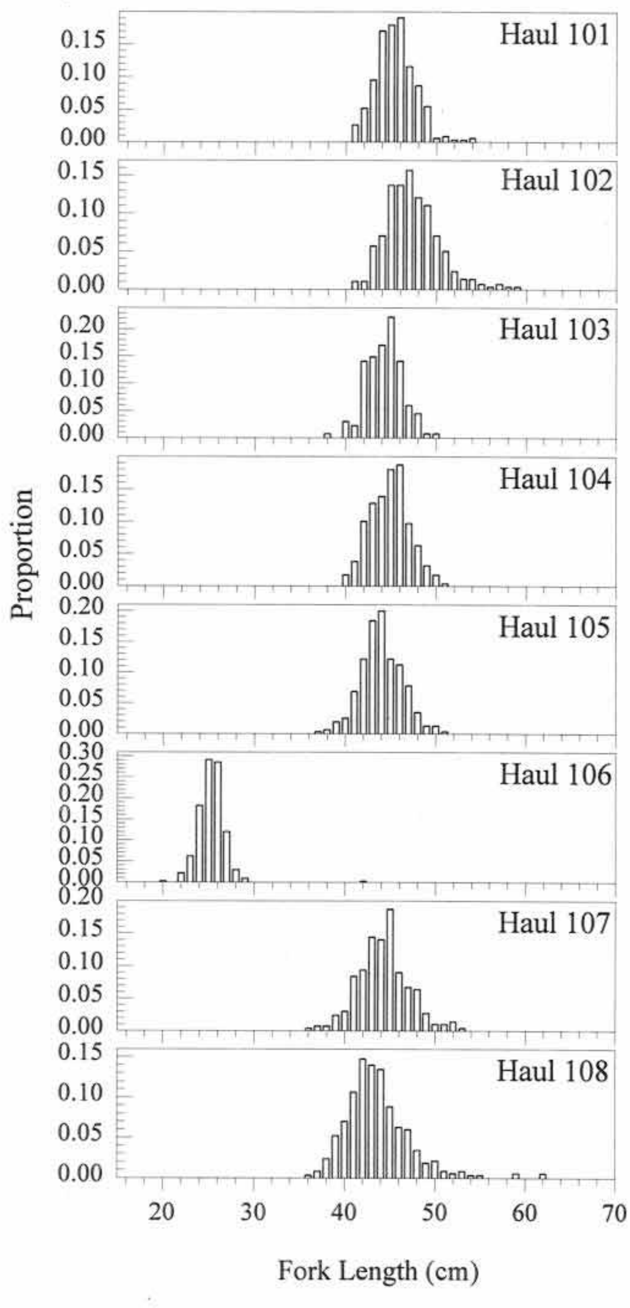
Appendix Figure 2.--Continued.



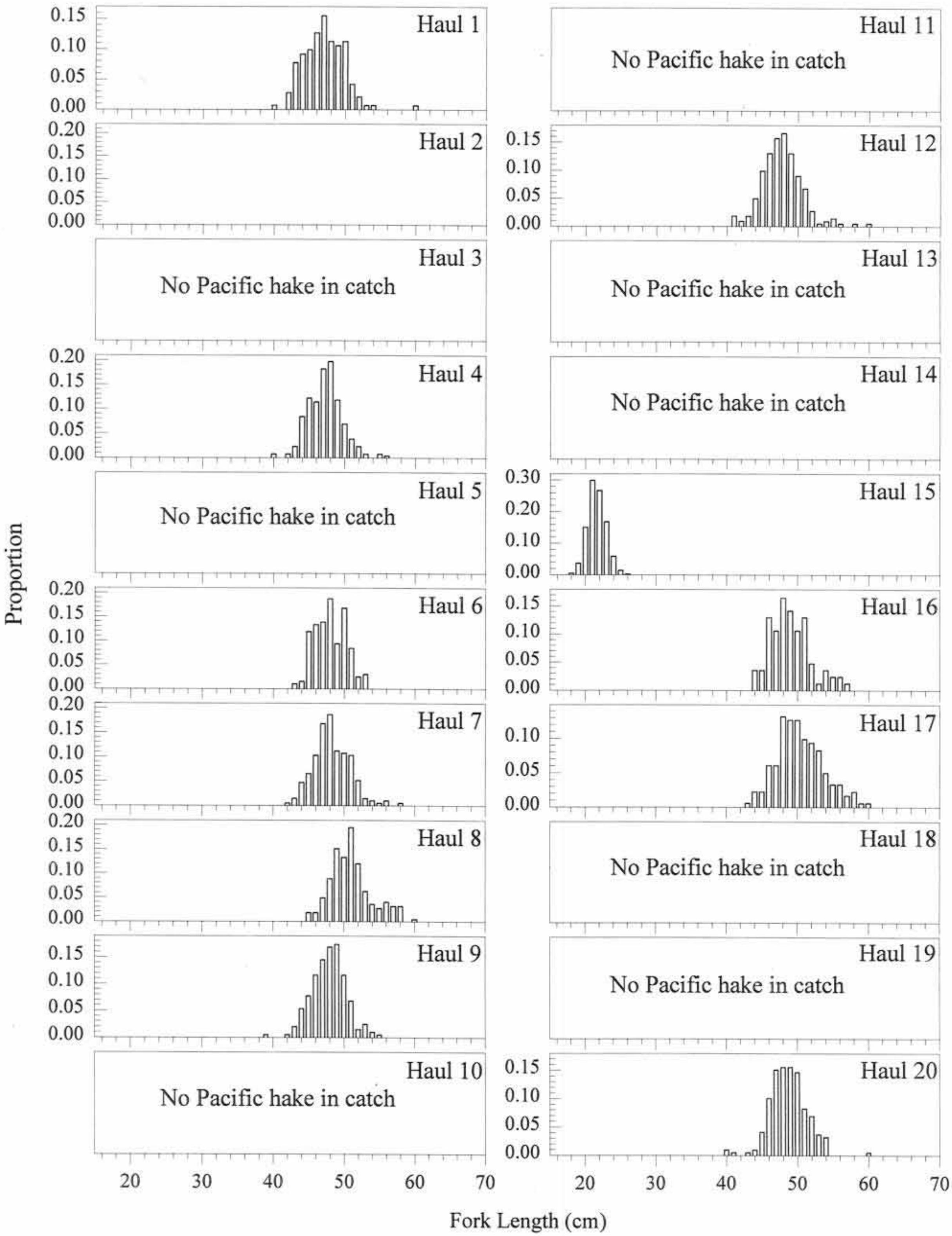
Appendix Figure 2.--Continued.



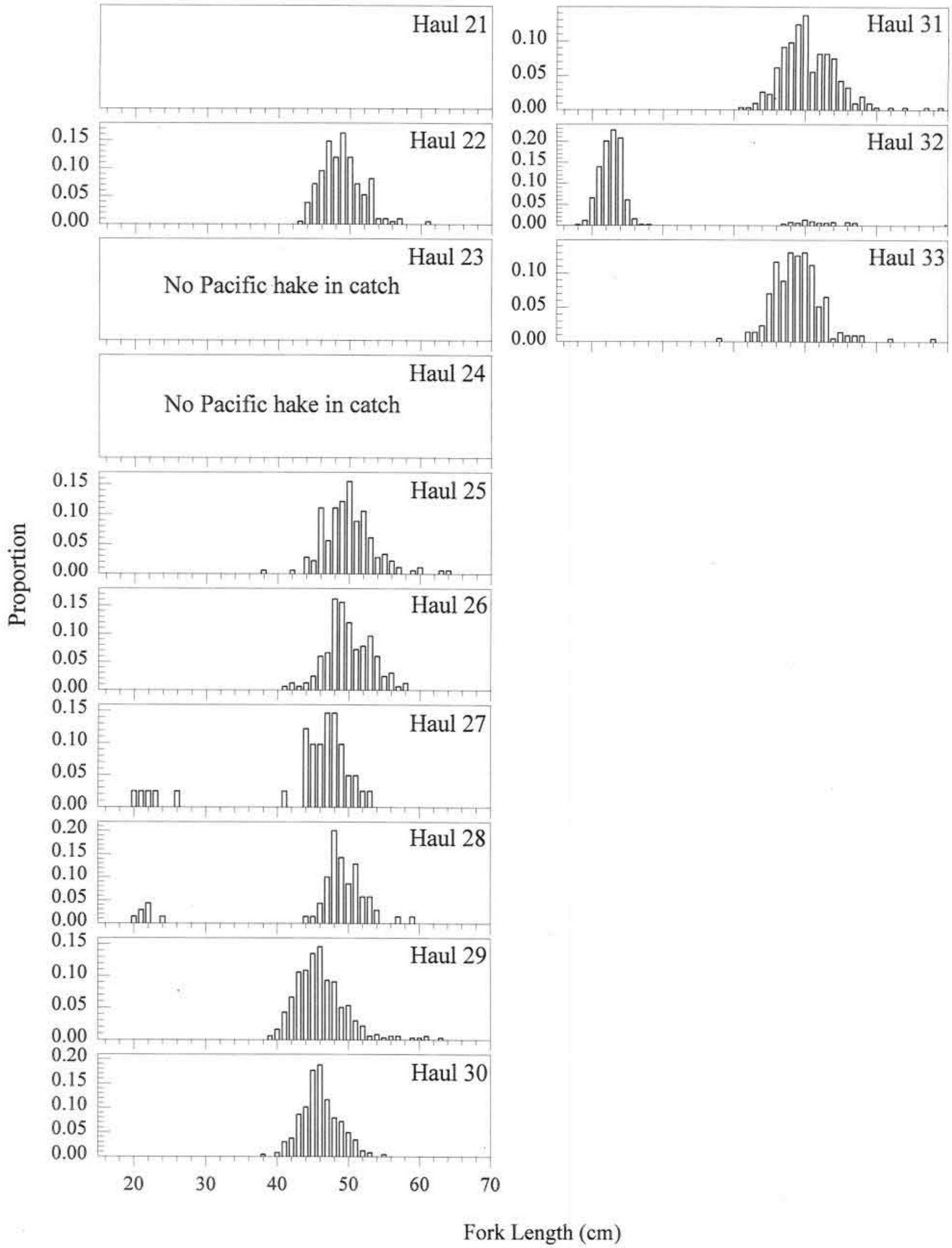
Appendix Figure 2.--Continued.



Appendix Figure 2.--Continued.



Appendix Figure 3.--Proportion at length of Pacific hake from hauls conducted by the CCGS *W.E. Ricker* during the 1998 joint U.S.-Canada Pacific hake echo integration-trawl survey of the U.S. and Canadian west coasts.



Appendix Figure 3.--Continued.

RECENT TECHNICAL MEMORANDUMS

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