Northwest
Fisheries Science
Center

National Marine
Fisheries Service

U.S. DEPARTMENT OF COMMERCE

NWFSC PROCESSED REPORT

Results of the 2007 Integrated Acoustic and Trawl Survey of Pacific Hake (*Merluccius productus*) in U.S. and Canadian Waters off the Pacific Coast

February 2009

This report does not constitute a publication and is for information only.

This document should be cited as follows:

de Blois, S. K., D. Chu, and K. D. Cooke. 2009. Results of the 2007 integrated acoustic and trawl survey of Pacific hake (*Merluccius productus*) in U.S. and Canadian waters off the Pacific Coast. NWFSC Processed Rep. 2009-xx, 70 p. Northwest Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 2725 Montlake Blvd. E., Seattle, WA 98112.

Reference in this document to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Results of the 2007 integrated acoustic and trawl survey of Pacific Hake (*Merluccius productus*) in U.S. and Canadian waters off the Pacific coast

by

Stephen K. de Blois, Dezhang Chu, and Ken D. Cooke

Northwest Fisheries Science Center

2725 Montlake Blvd. E

Seattle, WA 98112

February 2009

Table of Contents

List of Tables v

List of Figures vi

Executive Summary viii

Introduction 1

Materials and Methods 2

Data Collection 2

Acoustic Sampling 2

Equipment 2

Calibration 3

Operation 3

Biological Sampling 4

Equipment 4

Operation 5

Oceanographic Sampling 6

Equipment 6

Operation 7

Acoustic Data Processing and Biomass Estimate 7

Results and Discussion 12

Acoustic System Calibration 12

Biological Sampling 12

Oceanographic Sampling 13

Pacific Hake Distribution and Abundance Estimates 13

Acknowledgements 16

References 17

Tables and Figures 20

Appendix A 67

List of Tables

Table 1. Itinerary and scientific personnel for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……20

Table 2. Simrad ER60 38-kHz acoustic system descriptions, survey settings used, and results from acoustic system calibrations with standard targets performed during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..23

Table 3. Trawl station and catch data summary from the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……24

Table 4. Catch by species from Aleutian wing midwater trawl hauls conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……28

Table 5. Catch by species from poly Nor'eastern bottom trawl hauls conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……31

Table 6 Numbers of Pacific hake biological samples and measurements collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……33

Table 7. Summary of CTD casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……36

Table 8. Summary of XBT casts conducted successfully during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……44

Table 9. Estimated biomass of Pacific hake by age for each INPFC area and Canada for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……48

Table 10. Estimated numbers of Pacific hake by age for each INPFC area and Canada for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……49

Table A-1. Individual transect coordinates, length, corresponding area, and estimated Pacific hake population numbers and biomass for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……67

List of Figures

Figure 1. Survey track design used during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..50

Figure 2. Vertical temperature profiles taken by a conductivity-temperature-depth profiler during calibrations of the acoustic system conducted in Elliott Bay, Washington and Port Hardy, British Columbia as part of the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..51

Figure 3. Details of southern acoustic transect lines and locations and haul sequence of midwater and bottom trawls during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..52

Figure 4. Details of central acoustic transect lines and locations and haul sequence of midwater and bottom trawls during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..53

Figure 5. Details of northern acoustic transect lines and locations and haul sequence of midwater and bottom trawls during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..54

Figure 6. Details of southern acoustic transect lines with locations of XBT and CTD profile measurements taken during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..55

Figure 7. Details of central acoustic transect lines with locations of XBT and CTD profile measurements taken during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..56

Figure 8. Details of northern acoustic transect lines with locations of XBT and CTD profile measurements taken during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..57

Figure 9. Acoustic area backscattering attributed to Pacific hake along southern transects completed during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. …….58

Figure 10. Acoustic area backscattering attributed to Pacific hake along central transects completed during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. …….59

Figure 11. Acoustic area backscattering attributed to Pacific hake along northern transects completed during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. …….60

Figure 12. Coast-wide length-frequency distribution of Pacific hake from specimens collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……61

Figure 13. Box-and-whisker plot of the length frequency distributions of Pacific hake for trawl tows conducted as part of the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. …….62

Figure 14. Age-length distribution of Pacific hake from specimens collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. ……..63

Figure 15. Estimated biomass and numbers of Pacific hake by age class comparing INPFC areas and Canada for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. …….64

Figure 16. Proportion of total Pacific hake biomass and number for each INPFC area and Canada that was composed of age-2 or age-8 fish during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. …….65

Figure 17. Biomass estimates of Pacific hake, 1977-2007. ……..66

EXECUTIVE SUMMARY

The 2007 integrated acoustic and trawl survey of Pacific hake was conducted by joint U.S. and Canadian science teams aboard the NOAA ship *Miller Freeman* from 20 June to 21 August 2007. This survey covered the U.S. and Canada Pacific coast from 35.8°N (north of Point Piedras Blancas, California) to 54.9°N (north of Dixon Entrance). A total of 132 line transects, generally oriented east-west and spaced at intervals of 10 nautical miles (nmi), were completed. During the survey, aggregations of Pacific hake were found along the continental shelf break from Monterey Bay (37°N) to the Dixon Entrance area. Peak concentrations of Pacific hake were observed in the following general areas: near Tomales Bay and San Francisco Bay (ca. 37.6°N), north of Eureka along the northern California coast into southern Oregon, and near Netarts Bay (ca. 45.5°N) in northern Oregon. Associated midwater (80 Aleutian wing and 4 poly Nor'eastern trawls) and bottom (8 poly Nor'eastern trawls) trawl samples showed that the coastal stock in 2007 displayed a trimodal length-frequency distribution with modes (of increasing size) centered at 19 cm, 31 cm, and 47 cm. Pacific hake around 45 cm were prevalent north of roughly 44°N; those around 30–35 cm were abundant off California and southern Oregon, and those around 20 cm were encountered often off central Oregon and from northern Washington through northern Vancouver Island.

The coast-wide estimates of Pacific hake abundance totaled 2.022 billion fish weighing 0.880 million metric tons. Age-8 Pacific hake (1999 year class) were the largest component of the population, contributing about 43% of the total coast-wide biomass and roughly 28% of the total coast-wide number. However, age-1 and age-2 Pacific hake were also relatively common.

Age-2 Pacific hake (2005 year class) contributed 42% of the total coast-wide numbers (and roughly 19% of the total coast-wide biomass). Age-8 Pacific hake were dominant in the northern part of the survey area, whereas age-2 Pacific hake were dominant in the south.

The 2007 biomass estimate of 0.880 million metric tons represents a decrease of 0.385 million metric tons, or roughly 30% from the biomass estimate made for 2005. Although the 2007 estimate is still almost 0.142 million metric tons greater than the biomass estimate made for 2001, it is the second smallest estimate produced since coast-wide acoustic surveys started in 1977.

INTRODUCTION

Pacific hake (*Merluccius productus*) is an important commercial marine fish off the west coast of North America, with recent (2004–2006) annual harvests totaling in excess of 330,000 metric tons (Helser et al. 2008). Because of the economic and ecological value of coastal Pacific hake, integrated acoustic and trawl (IAT) surveys have been conducted to assess the distribution, abundance, and biology of coastal Pacific hake along the Pacific coasts of the United States and Canada. Scientists from the Alaska Fisheries Science Center (AFSC) conducted IAT surveys on a triennial basis since 1977 (Wilson et al. 2000). Scientists from the Department of Fisheries and Oceans Canada (DFO) have conducted annual IAT surveys for Pacific hake along the Canadian west coast since 1990 (Cooke et al. 1996). Following the 2001 survey, the Northwest Fisheries Science Center (NWFSC) assumed responsibility for the U.S. portion of the joint survey and increased the survey frequency to a biennial basis (Fleischer et al 2005).

Integrated acoustic and trawl surveys are an important data source for joint U.S.-Canada Pacific hake stock assessments (Helser et al. 2008). 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 and guidance on future harvests.

The results presented here are from the summer 2007 IAT survey of Pacific hake. This report provides a brief description of the methods used in the survey and summarizes the observed distribution, biological composition, and biomass of Pacific hake in U.S. and Canadian waters off the Pacific coast. It also summarizes results of acoustic system calibrations.

MATERIALS AND METHODS

Scientists from the Fishery Resource Analysis and Monitoring (FRAM) division at the NWFSC and the Pacific Biological Station of DFO conducted an IAT survey (science cruise number MF2007-10) between 20 June and 21 August 2007 (Table 1) from 35.8°N to 54.9°N aboard the NOAA ship *Miller Freeman*, a 66-m stern trawler equipped for fisheries and oceanographic research. The *Miller Freeman* was used for the entire survey.

The Pacific hake population was surveyed along a series of parallel line transects that were oriented generally east-west, spaced at a 10-nautical mile (nmi) interval, and traversed sequentially in alternating directions (Figure 1). The survey began just north of Point Piedras Blancas, California (35.7°N) and proceeded north toward the Dixon Entrance area (ca. 54.5°N) while targeting aggregations of Pacific hake along the continental shelf and upper slope. Two transects at the north end of Vancouver Island were spaced at a 20-nmi interval and five in Dixon Entrance were oriented north-south. Sea depth at the nearshore end of individual transects was typically 50 m; offshore extent of individual transects was typically at a depth of 1,500 m, although transects in Hecate Strait (ca. 53°N) and Dixon Entrance did not reach depths as deep as 1,500 m.

Data Collection

Acoustic Sampling

Equipment

All acoustic data were collected with a Simrad EK60 scientific echo sounder coupled with the ER60 software system (Simrad 2004). Simrad 18-kHz, 38-kHz, 120-kHz, and 200-kHz

split-beam transducers were mounted on the bottom of the *Miller Freeman*'s centerboard which, when fully extended, held the transducers at a nominal depth of 9.15 m below the water surface.

Calibration

The acoustic system was calibrated in the field before and after the survey. Calibration locations were chosen where water depths were greater than 50 m in order to avoid echo contamination from seafloor reverberation. The calibration procedure involved anchoring the vessel, suspending two metal spheres with known backscattering cross sections below the transducers, and then measuring the acoustic returns following standard procedures (Foote et al. 1987, Simmonds and MacLennan 2005, Simrad 2004). A 38.1-mm tungsten carbide sphere was used for the 38-kHz, 120-kHz, and 200-kHz transducers, and a 64-mm copper sphere was used for the 18-kHz transducer. Split-beam target strength and echo integration data were collected to calculate echo sounder gain parameters as part of the evaluation of system performance. On-axis (Simmonds and MacLennan 2005) and beam pattern (Simrad 2004) measurements were taken during both calibrations.

Operation

Acoustic data were collected from 14 m below the surface (5 m below the centerboard-mounted transducer) to a maximum depth of 750 m. Raw acoustic backscatter (ER 60) and SonarData Echolog 500 data files were logged from all four frequencies; the Echolog 500 data files were used for live viewing in Echoview v.4.20.58 software. Event log markers and other marks, including at-sea judgments of Pacific hake backscattering layers, were made on the live-viewed files. Data from the 38-kHz echo sounder (the primary frequency used for generating biomass estimates) were post-processed using SonarData Echoview software on a PC, and results presented in this document are based on these data.

Vessel speed was maintained at 5.6-6.1 m/sec (11-12 knots) during acoustic sounding along each transect, resulting in an acoustic sample volume coverage of about 100% for a fish layer at a depth of about 50 m at an average ping rate of slightly slower than 1 Hz. Acoustic operations were run only during daylight hours (i.e., from sunrise to sunset, about 15 hours per day) when Pacific hake formed distinct and identifiable midwater layers.

Noise background was recorded in passive mode each day before transects started in the morning. This was done to ensure the quality of the acoustic data and the consistency of system performance throughout the survey.

Biological Sampling

Equipment

Midwater biological sampling was performed with an Aleutian wing trawl 24/20 (AWT). This net had a vertical opening that averaged 24 m (range: 17–35 m), a headrope and footrope of 101.8 m each, and a total length of 128 m. Mesh sizes tapered from 320.0 cm in the forward section of the net to 10.0 cm in the codend; a 3.2-cm (1.25-inch) codend liner was used. The AWT was deployed with a pair of 4-m^2 "Fishbuster" trawl doors (884.5 kg), 82.3-m legs, and 226.8-kg or 113.4-kg chain ("Tom") weights on each side. Trawling on bottom (and occasionally off bottom) was performed with a poly Nor'eastern trawl 89/121 (PNE). This net had a vertical opening that averaged 8 m (range: 6–9 m), a headrope of 27.1 m, a footrope of 36.6 m, and a total length of 42.1 m. Mesh size was 12.7 cm in the intermediate section and a 3.2-cm (1.25-inch) codend liner was used. The PNE also used the 4-m^2 'Fishbuster' trawl doors. A WESMAR TCS 770 third-wire sonar system attached to the AWT headrope or a Furuno

wireless net sounder system attached to the PNE headrope was used to monitor and guide the fishing process for all tows.

An electronic, 60-kg capacity Marel M1100 motion-compensating scale was used to weigh sorted portions of the catch to the nearest 0.05 kg. Large trawl catches (e.g., >1,500 kg) were weighed to the nearest 2 kg with an Eilon Engineering RON 2150 H-05 hook type load cell. A 15-kg capacity Marel M1100 motion-compensating scale was used to determine all weights of individual fish specimens to the nearest 0.005 kg. Individual fish lengths (fork length) were determined to the nearest centimeter using a Scantrol FM100 FishMeter board.

Operation

Trawl samples were used to classify observed backscatter layers to species and size composition and to collect specimens of Pacific hake and other organisms. The number and locations of trawl sets were not pre-determined—other than an allowance for an expected total number of tows by area based on past surveys—but were dependent on the occurrence and pattern of backscattering layers observed at the time of the survey. Coverage by trawling was not systematic, but adaptive, and individual tows did not require a standardized effort. Distinct layers of intense backscatter that were indicative of high densities of Pacific hake were the highest priority for trawl sample assignments, but other types of backscattering features, both in terms of areas of low fish density and putative aggregations of species other than Pacific hake, were also sampled. Attention was given to perform tows at several locations along any single, extensive, and continuous aggregation of Pacific hake, or within the same area where vertically discrete backscattering layers appeared.

During trawl operations, trawling speed averaged about 1.5 m/s (3 knots). Fish and other organisms entering the net were observed on either the WESMAR (AWT) or Furuno (PNE) net monitoring system and were visually quantified by scientists and crew conducting the trawl operations. Haul duration lasted only as long as the scientist overseeing trawl operations deemed was necessary to ensure an adequate catch sample. Trawl catches less than roughly 1,500 kg were sorted and weighed completely; hauls greater than roughly 1,500 kg were weighed with a load cell for total weight before being subsampled. Total weights and numbers were determined for most species; gelatinous invertebrates such as jellyfish and salps often could not be counted. Pacific hake were subsampled to determine length composition by sex, to collect otoliths for subsequent age determination, and to collect individual weight measurements and gonad condition (Pacific hake were sampled completely from a trawl catch when just a small number were caught, i.e., fewer than roughly 300 to 400.). Pacific hake maturity was determined by visual inspection of gonads and classified by a 5-stage scale (ADP Code Book, 2003, RACE Division, AFSC, Seattle, Washington). Otoliths were preserved in 50% ethanol for subsequent age determination. Stomachs from Pacific hake were collected and preserved in 10% neutral-buffered formalin.

Oceanographic Sampling

Equipment

Vertical profiles of temperature and salinity data were collected using a Sea-Bird Electronics, Inc. SBE 911*plus* conductivity-temperature-depth (CTD) system. In conjunction with the CTD casts, vertical profiles of dissolved oxygen (DO) were collected using a Sea-Bird SBE 43 DO sensor that was attached to the CTD. Additional temperature and depth profile data were collected by attaching a Sea-Bird SBE 39 temperature and pressure recorder to the trawl

headrope during trawl hauls and by launching expendable bathythermographs (XBTs). Ocean current velocity profile data were obtained using a Teledyne RD Instruments Ocean Surveyor 75-kHz Acoustic Doppler Current Profiler (ADCP) system. Sea surface temperature and salinity data were collected using a Sea-Bird SBE 21 probe located approximately 5 m below the vessel's waterline and stored on the *Miller Freeman's* Scientific Computing System (SCS).

Operation

Physical oceanographic sampling was conducted at day and at night. CTD and XBT casts were made at selected locations along designated (primarily odd-numbered) acoustic transects. CTDs were performed primarily at night after collection of acoustic data had ceased; XBTs were performed primarily during daytime while the ship was moving at survey speed. CTD casts also were made during calibrations of the acoustic system (for calculation of sound speed). ADCP data were collected to provide current information at depths up to roughly 600 m. SCS sea surface data were collected continuously throughout the day and night.

Acoustic Data Processing and Biomass Estimate

The first step in analyzing acoustic data was to identify and delineate the backscatter layers that were attributed to Pacific hake. Echograms of each transect were displayed and examined for aggregations of Pacific hake using SonarData Echoview v.4.20.58 software. Display settings reflected the echo sounder calibration settings at the time of acoustic data acquisition. On each display, continuous backscattering layers were demarcated and classified as: 1) "hake," which indicated that all backscatter in the region was considered Pacific hake; 2) "hake mix," which indicated that there was a significant amount of backscatter from Pacific hake in the region plus other species that were partitioned quantitatively later; or 3) "rockfish,"

“sardine,” “herring,” “plankton,” “jellyfish,” or “unclassified,” which indicated that backscatter in the region was a non-Pacific hake species. These classifications were guided by visual interpretation of echo traces and species compositions observed in associated trawl catches. Initial scrutiny of echograms took place at sea, usually upon completion of a day’s acquisition of acoustic data. This process was followed by an exchange of assigned transects between scientists to cross-check and validate the echograms and associated documentation in an effort to ensure consistency in the decisions among scientists. A final post-survey review of echograms, conducted by several of the participating U.S. and Canadian scientists, consisted of perusal of each echogram and refinement of the extent and classification of regions. Each scientist also developed explicit documentation for these decisions.

Acoustic estimates of fish abundance were derived from application of echo integration theory where the range-compensated measure of calibrated volume backscattering is assumed to be directly proportional to fish density (Burczynski 1979, Foote 1983). Calculations of the echo integral (mean volume backscattering strength) were made over a specific volume in the vertical direction of a depth stratum in a defined region and averaged in the horizontal direction along each transect. The range of strata considered for analysis along each transect included depths from 14 m below surface (approximately 5 m below the extended transducer) to 0.5 m above the detected bottom or to a maximum depth of 500 m when sea depths exceeded this value. Integrator output was averaged for Pacific hake backscatter regions within “cells” defined by 10-m vertical depth strata along 0.5-nmi horizontal intervals. Values of mean area backscatter from the Simrad EK60 echo sounder, termed the Nautical Area Scattering Coefficient (m^2/nmi^2) and denoted here as s_A (MacLennan et al. 2002), were calculated by the SonarData Echoview

software when vertical depth strata were summed for an interval (a column of cells from 14 m below surface to 0.5 m above bottom [or 500 m when sea depths were greater than 500 m]).

Pacific hake catches were pooled into analytical groups based on geographic proximity of hauls and on similarity in size compositions as guided by paired comparisons with a Kolmogorov-Smirnov test (Campbell 1974). We assigned equal weight to each haul, taking no account of differences in the total catch. Composite length-frequency distributions were used for characterizing Pacific hake distributions along each particular transect and were the basis for predicting an expected differential backscattering cross section (σ_{bs}) for Pacific hake based on a relation proposed by Simmonds and MacLennan (2005) as:

$$\sigma_{bs} = \sum_i f_{ij} \sigma_{bs}^{ij} , \qquad (1)$$

where f_{ij} is the length-frequency weightings for length class i from composite catch sample j, and the differential backscattering cross section σ_{bs}^{ij} can be estimated by a linear regression relation against the length square in linear scale:

$$\sigma_{bs}^{ij} = C_f L_{ij}^2 , \qquad (2)$$

for a frequency f of length class i in composite catch sample j where $C_f = 1.58489 \times 10^{-7}$ for f = 38 kHz. Equation (2) is the linear form of a regression relation in logarithmic form originally suggested by Traynor (1996)

$$TS_{dB} = 10 \log_{10} \sigma_{bs} = 20 \log L - 68 , \qquad (3)$$

where TS_{dB} is target strength in decibels and L is length in centimeters. Substituting Eq. (2) into Eq. (1), we were able to calculate a final σ_{bs} for each Pacific hake analytical group. Henderson and Horne (2007) have suggested that Eq. (3) overestimates the TS_{dB} values by about 4 to 6 dB.

However, this conclusion was based on nighttime TS work, whereas the IAT survey was conducted during daytime hours. We feel that it would be premature to change the regression coefficient until further research resolves the issue of converting TS to length for Pacific hake.

Age-specific population number ($\hat{N}_a$) and biomass ($\hat{B}_a$) estimates of Pacific hake (Appendix A) were derived from the measured s_A for each cell within each echo integration interval and were derived as:

$$\hat{N}_a = \left[\sum_i \frac{s_A}{4\pi\sigma_{bs}} P_i Q_{ia} A \right], \tag{4}$$

and

$$\hat{B}_a = \left[\sum_i \frac{s_A}{4\pi\sigma_{bs}} P_i \hat{W}_i Q_{ia} A \right], \tag{5}$$

where σ_{bs} is the expected backscattering cross-section (m^2) for each particular interval, P_i is the proportion of Pacific hake at length class *i*, $\hat{W}_i$ is the mean weight for length class *i*, Q_{ia} is the proportion of age class *a* for length class *i* derived from the age-length key, and *A* is the applied linear areal interpolation (typically 0.5 nmi by 10.0 nmi, or 5 nmi^2) for each echo integration interval (Appendix A). We calculated $\hat{W}_i$ using data directly when possible, rather than using a weight-length model. This was done by averaging all weights for each length class *i* when the sample size was six or greater. Only when this sample size was fewer than six was $\hat{W}_i$ derived from the weight-length model $\hat{W} = 0.0078(length_{cm})^{2.934}$. For regions we had classified as a mixture of species, s_A attributed to Pacific hake was apportioned from total s_A based on the biomass catch proportion of acoustically detectable species (i.e., fish with swimbladders

dwelling off bottom). This direct ratio or "slider" method assumes equal trawl catchability and identical backscattering properties between Pacific hake and other species. Strictly speaking, however, such an assumption is problematic because acoustic backscattering is not necessarily proportional to the biomass due to anatomical differences among different fish species. However, we chose to apply the assumption and believed it was the best approach based on the following considerations: 1) currently we do not have sufficient knowledge of the acoustic TS of various rockfish species; 2) the size of rockfish and hake caught simultaneously by trawling was similar, suggesting their swimbladder size may be comparable, hence their TS may not differ significantly; and 3) there were only a very limited number of "hake mix" trawls—no more than a few percent of total trawls that were classified as "hake".

Estimates of age-specific biomass for individual cells were summed over each interval, transect, International North Pacific Fisheries Commission (INPFC) statistical area or subarea (Dorn 1996), and ultimately coast-wide to obtain a total estimate.

An important issue in data analysis is the determination of a threshold value of the volume backscattering strength (Sv) to exclude echoes from non-Pacific hake weak scattering targets. In the 2007 IAT survey, acoustic-based estimates were derived entirely on an application of a uniform −69-dB threshold.

RESULTS AND DISCUSSION

Acoustic System Calibration

Two calibrations of the acoustic system were conducted (Table 2), the first on 16 June in Elliott Bay, Washington, and the second on 22 August in Port Hardy, British Columbia. Calibration results were within expected levels based on factory settings and results from previous calibrations. Vertical profiles of water column temperatures from CTD casts conducted at both calibration sites are shown in Figure 2. Water temperatures at the depth corresponding to the face of the transducers (roughly 6.4 m with centerboard retracted) showed considerable variation on both days, whereas temperatures at calibration sphere depths (21.23 m and 38.70 m) were more similar.

Biological Sampling

A total of 84 midwater trawls (including 4 times the poly'Noreastern net was fished off bottom) and 8 bottom trawls were successfully conducted during the course of the survey (Table 3, Figures 3, 4, and 5). Two midwater trawls were unsuccessful. Trawl durations ranged from 0.4 to 30.7 minutes (mean = 13.9 minutes). Catch weights ranged from 0.02 to 3,800 kg (mean = 517.1 kg); over 91% of trawls were sorted completely without subsampling. By weight and numbers, Pacific hake was the dominant species caught in both midwater and bottom trawl hauls, accounting for roughly 92% and 79%, respectively, of catch composition by weight (Tables 4 and 5). During the survey, over 14,500 Pacific hake were lengthed and more than 3,150 pairs of Pacific hake otoliths were collected (Table 6). Over 650 Pacific hake stomachs were collected.

Oceanographic Sampling

A total of 277 CTD temperature and salinity profiles were collected at selected locations along the line transects and at acoustic system calibration sites (Table 7, Figures 6, 7, and 8). Additional temperature profiles were collected from 158 XBT casts (Table 8, Figures 6, 7, and 8) and from 89 SBE casts that were collected at most trawl stations. Analysis of oceanographic data is ongoing.

Pacific Hake Distribution and Abundance Estimates

Acoustic data were collected from 132 line transects that covered a distance of 8,469 km (4,573 nmi). Aggregations of Pacific hake were detected along the continental shelf break from Monterey Bay (37°N) to the Dixon Entrance area (Figures 9, 10, and 11). Higher concentrations of Pacific hake were observed in the following general areas: near Tomales Bay and San Francisco Bay (ca. 37.6°N), north of Eureka along the northern California coast into southern Oregon, and near Netarts Bay (ca. 45.5°N) in northern Oregon. Less concentrated, yet consistent aggregations of Pacific hake were observed off the Washington coast.

The overall coast-wide length-frequency distribution of Pacific hake displayed a trimodal distribution (Figure 12) with an incidental catch of young-of-the-year. The largest mode, centered at 47 cm, correlated with adult Pacific hake three years old and greater. Successively smaller modes at 31 cm and 19 cm correlated with two-year-old and one-year-old Pacific hake, respectively. Pacific hake of fork lengths around 45 cm were encountered throughout the survey range (Figure 13), although they were more prevalent north of roughly 44°N. Fish around 30–35 cm long were abundant in waters off California and southern Oregon, and fish around 20 cm

were encountered often off central Oregon and northern Washington through northern Vancouver Island. Pacific hake specimens collected in trawls ranged in age from 0 to 17 years (Figure 14). Although the 1999 year class (age 8) was the dominant age, relatively large numbers of age-1 and age-2 Pacific hake were collected.

The coast-wide estimate of Pacific hake biomass totaled 0.880 million metric tons (Table 9 and Figure 15A). Most of the observed biomass (over 25% of survey total) was in Canadian waters, followed closely by the Vancouver-North Columbia (VNC) INPFC area with roughly 22%. The remaining three areas (Monterey, Eureka, and South Columbia) contained similar biomasses of 17.6%, 18.1%, and 17.1%, respectively, of survey total. Even though most biomass was observed in northern waters, differences among the survey areas were not dramatic: the VNC area biomass was only roughly 14% less than what was observed in the Canada survey area, and the Monterey, Eureka, and South Columbia area biomasses were each roughly 80% of what was observed in the VNC area.

The coast-wide estimate of Pacific hake numbers totaled 2.022 billion fish (Table 10 and Figure 15B). Largest numbers of Pacific hake were observed in the southern survey area: Monterey INPFC area numbers were roughly twice as large as what was observed in each of the South Columbia, VNC, and Canada areas, and were roughly 58% greater than the numbers observed in the Eureka INPFC area. Pacific hake numbers in the Eureka area were themselves roughly 25% larger than what was observed in each of the areas further north.

The overall Pacific hake population was made up mostly of biomass from age-8 fish and of numbers from age-2 fish (Tables 9 and 10, Figure 15A and B), followed by age-4 fish (2003 year class). The 1999 year class contributed 43% of the total coast-wide biomass (vs. roughly 19% from the 2005 year class) while the 2005 year class contributed 42% of the total coast-wide numbers (vs. over 28% from the 1999 year class). This dichotomy was most pronounced at opposite ends of the survey area, i.e., age-2 fish dominated in the south and age-8 fish dominated in the north (Figure 16). Age-2 fish composed 85% and 46% of Monterey and Eureka INPFC area numbers, respectively, whereas age-8 fish composed only 5% and roughly 23%. At the VNC area and further north, age-8 fish became more numerous than age-2 fish (and all other age-classes as well), which declined to negligible levels. In the Monterey INPFC area, age-2 fish contributed over four times more to total biomass than age-8 fish did (65% to 14%), but from Eureka on north, age-8 fish contributed more to total biomass. Age-2 biomass, like numbers, was negligible in the two northern-most areas. Age-4 fish contributed roughly 12% and 10% to total coast-wide biomass and numbers, respectively.

The 2007 biomass estimate of 0.880 million metric tons represents a decrease of 0.385 million tons or roughly 30% from the biomass estimate made for 2005 (Figure 17). When compared to the 2003 biomass estimate (the first year the NWFSC conducted the IAT survey for Pacific hake), the 2007 estimate represents a decline of over 0.962 million metric tons. Although the 2007 estimate is still almost 0.142 million metric tons greater than the biomass estimate made for 2001, it is the second smallest estimate produced since coast-wide acoustic surveys started in 1977.

ACKNOWLEDGEMENTS

The authors would like to thank the officers and crew of the NOAA ship *Miller Freeman* for their contribution to the successful completion of this survey. We also wish to thank all others who supported and helped make this a successful survey, notably the personnel from the NOAA FRAM Division and Fisheries and Oceans Canada Stock Assessment Division.

REFERENCES

Burczynski, J. 1979. Introduction to the use of sonar systems for estimating fish biomass. FAO Fish. Tech. Paper 191.

Campbell, R. C. 1974. Statistics for Biologists, 2nd edition. Cambridge University Press.

Cooke, K., M. W. Saunders, W. T. Andrews, and R. Kieser. 1996. A hydroacoustic survey of Pacific hake on the continental shelf off British Columbia from the Canada/U.S. boundary to Queen Charlotte Sound: August 15-31, 1994. Can. Manuscript Rep. Fish. Aquat. Sci. 2363.

Dorn, M. W. 1996. Status of the coastal Pacific whiting resource in 1996. *In* Pacific Fishery Management Council, Appendix Volume I: Status of the Pacific Coast groundfish fishery through 1996 and recommended acceptable biological catches in 1997, p. A1-A77. (Available from Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201.)

Fleischer, G. W., K. D. Cooke, P. H. Ressler, R. E. Thomas, S. K. de Blois, L. C. Hufnagle, A. R. Kronlund, J. A. Holmes, and C. D. Wilson. 2005. The 2003 integrated acoustic and trawl survey of Pacific hake, *Merluccius productus*, in U.S. and Canadian waters off the Pacific coast. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-65.

Foote, K. G. 1983. Linearity of fisheries acoustics, with addition theorems. J. Acoust. Soc. Am. 73(6):1932-1940.

Foote, K. G., H. P. Knudsen, G. Vestnes, D. N. MacLennan, and E. J. Simmonds. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. ICES, Palaegade 2-4, 1261 Copenhagen, Denmark. Coop. Res. Rep. 144.

Guttormsen, M. D., C. D. Wilson, K. Cooke, M. W. Saunders, D. R. McKelvey, and R. Kieser. 2003. Echo integration-trawl survey of Pacific hake, *Merluccius productus*, off the Pacific coast of the United States and Canada during June-August 2001. AFSC Processed Rep. 2003-12. (Available from NOAA, NMFS, Alaska Fishery Science Center, 7600 Sand Point Way NE, Seattle WA 98115.)

Helser, T. E., R. D. Methot, and G. W. Fleischer. 2004. Stock assessment of Pacific hake (whiting) in U.S. and Canadian Waters in 2003. *In* Pacific Fishery Management Council, Appendix: Status of the Pacific Coast groundfish fishery through 2004 and stock assessment and fishery evaluation. (Available from Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201.)

Helser, T. E., I. J. Stewart, G. W. Fleischer, and S. Martell. 2006. Stock assessment of Pacific hake (whiting) in U.S. and Canadian waters in 2006. *In* Pacific Fishery Management Council, Appendix: Status of the Pacific Coast groundfish fishery through 2006 and stock assessment and fishery evaluation. (Available from Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201.)

Henderson, M. J., and J. K. Horne. 2007. Comparison of in situ, ex situ, and backscatter model estimates of Pacific hake (Merluccius productus) target strength. Can. J. Fish. Aquat. Sci. 64:1781-1794.

MacLennan, D. N., P. G. Fernandes, and J. Dalen. 2002. A consistent approach to definitions and symbols in fisheries acoustics. ICES J. Mar. Sci. 59:365-369.

Simmonds, J., and D. MacLennan. 2005. Fisheries acoustics: theory and practice. Blackwell Science, Oxford.

Simrad. 2004. Simrad ER60 scientific echo sounder operator manual Rev. B. (Available from Simrad Subsea A/S, Strandpromenaden 50, Box 111, N-3191 Horten, Norway.)

Traynor, J. J. 1996. Target strength measurements of walleye pollock (*Theragra chalcogramma*) and Pacific whiting (*Merluccius productus*). ICES J. Mar. Sci. 53:253-258.

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.

Table 1. Itinerary and scientific personnel for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Leg 1a

June 16	Embark portion of scientific party in Seattle. Conduct acoustic system calibration with standard targets in Elliott Bay.
June 17-19	Transit south to start of survey area.
June 20	Begin survey. Touch and go at Monterey, California to exchange personnel.
July 1	Inport Eureka, California. Exchange personnel and remove defective Acoustic Doppler Current Profiler unit.

Scientific Personnel	Position	Organization	Nation
Stephen de Blois	Chief Scientist	NWFSC	USA
Ken Cooke	Acoustician	DFO	USA (embark 6/20)
John Harms	Fishery Biologist	NWFSC	USA (embark 6/20)
Grant Law	Fishery Biologist	NWFSC	USA
Stephen Pierce	Oceanographer	OSU	USA
Suzanne Romain	Fishery Biologist	NWFSC	USA
Stan Tomich	Engineer	NWFSC	USA
Irene Watts	Graduate Student	OSU	USA (disembark 6/20)
Curt Whitmire	Fishery Biologist	NWFSC	USA (embark 6/20)

Leg 1b

July 2	Resume survey.
July 12-14	Inport Newport, Oregon. Exchange personnel and install replacement Acoustic Doppler Current Profiler unit.

Scientific Personnel	Position	Organization	Nation
Stephen de Blois	Chief Scientist	NWFSC	USA
Lisa Bonacci	Acoustician	NWFSC	USA
Julia Clemons	Fishery Biologist	NWFSC	USA
John Harms	Fishery Biologist	NWFSC	USA
Grant Law	Fishery Biologist	NWFSC	USA
Stephen Pierce	Oceanographer	OSU	USA
Suzanne Romain	Fishery Biologist	NWFSC	USA

Table 1 continued. Itinerary and scientific personnel for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Leg 2

July 15 Resume survey.
July 26-30 Inport Port Angeles, Washington. Exchange personnel.

Scientific Personnel	Position	Organization	Nation
Larry Hufnagle	Chief Scientist	NWFSC	USA
Dezhang Chu	Acoustician	WHOI	USA
George Cronkite	Acoustician	DFO	Canada
Ilan Jen-LaPlante	Student	UW	USA
Melanie Johnson	Fishery Biologist	NWFSC	USA
Grant Law	Fishery Biologist	NWFSC	USA
Suzanne Romain	Fishery Biologist	NWFSC	USA
Vanessa Tuttle	Fishery Biologist	NWFSC	USA
Irene Watts	Graduate Student	OSU	USA

Leg 3a

July 31 Resume survey.
August 3 Touch and go at Ucluelet, British Columbia to disembark personnel.
August 16 Anchor outside of Prince Rupert, British Columbia to exchange personnel

Scientific Personnel	Position	Organization	Nation
Larry Hufnagle	Chief Scientist	NWFSC	USA
Stephen de Blois	Acoustician	NWFSC	USA
Cassandra Donovan	Fishery Biologist	NWFSC	USA
Jim Miller	IT Specialist	NWFSC	USA
Stephen Pierce	Oceanographer	OSU	USA
Suzanne Romain	Fishery Biologist	NWFSC	USA
Brian West	Fishing Master	WER	Canada (disembark 8/3)

Table 1 continued. Itinerary and scientific personnel for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Leg 3b

August 17	Resume survey; transfer personnel to NOAA ship *Oscar Dyson* for inter-vessel calibration.
August 20	Personnel return from *Oscar Dyson*.
August 21	Finish survey.
August 22	Conduct acoustic system calibration with standard targets in Port Hardy, British Columbia; disembark personnel.
August 23	Transit south to Seattle.
August 24	Arrive in Seattle; end of cruise.

Scientific Personnel	Position	Organization	Nation
Larry Hufnagle	Chief Scientist	NWFSC	USA
Lisa Bonacci	Acoustician	NWFSC	USA (8/17–8/20 on *Oscar Dyson*)
Dezhang Chu	Acoustician	WHOI	USA (8/17–8/20 on *Oscar Dyson*)
Karina Cooke	Fishery Biologist	DFO	Canada (disembark 8/22)
Ken Cooke	Acoustician	DFO	Canada (disembark 8/22)
Stephen de Blois	Acoustician	NWFSC	USA
John Holmes	Acoustician	DFO	Canada (disembark 8/22)
Suzanne Romain	Fishery Biologist	NWFSC	USA
Brian West	Fishing Master	WER	Canada (disembark 8/22)

DFO – Department of Fisheries and Oceans Canada, Nanaimo, British Columbia
NWFSC – Northwest Fisheries Science Center, Seattle, Washington
OSU – Oregon State University, Corvallis, Oregon
UW – University of Washington, Seattle, Washington
WER – Canadian Coast Guard Ship *W. E. Ricker*
WHOI – Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Table 2. Simrad ER60 38-kHz acoustic system descriptions and settings used during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast, and results from acoustic system calibrations with standard targets conducted during the survey. SV denotes volume backscattering and TS denotes target strength.

		Calibrations	
	Survey system settings	16 Jun Elliott Bay, Washington	22 Aug Port Hardy, British Columbia
Transducer:	ES38B	--	--
Serial number:	30595	--	--
Transducer depth (m):	9.15	--	--
Pulse length (ms):	1.024	--	--
Transmitted power (W):	2,000	--	--
Angle sensitivity:	21.9	--	--
Two-way beam angle (dB):	-21.0	--	--
Sa correction (dB):	-0.52	-0.52	-0.59
S_v gain (dB):	26.00	26.00	25.98
TS Gain (dB):	26.53	26.53	26.58
3-dB beamwidth (deg.)			
Along:	6.8	6.8	6.8
Athwart:	6.9	6.9	6.9
Angle offset (deg.)			
Along:	0	0	0
Athwart:	0	0	0
Post-processing S_v threshold (dB):	-69	--	--
Sphere range from transducer (m):	--	14.83	32.30
Absorption coefficient (dB/m):	0.009855	0.009144	0.009266
Sound velocity (m/s):	1480.6	1494.4	1484.5
Ambient water temperature (°C):	--	10.8	9.6

Table 3. Trawl station and catch data summary from the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Haul no.[a]	INPFC area[b]	Gear type[c]	Date	Time (PDT)	Duration (min.)	Start position Latitude	Start position Longitude	Depth (m) Gear[d]	Depth (m) Bottom	Temp. (°C) Gear[e]	Temp. (°C) Surface	Catch Pacific hake (kg)	Catch Pacific hake Number	Catch Other[f] (kg)
1	Mont	AWT	21 Jun	14:13	20	36 26.03	121 59.14	313	370	7.5	11.7	716.9	669	138.5
2	Mont	AWT	22 Jun	7:22	1	36 46.22	121 52.93	107	185	9.1	12.9	853.6	4,982	10.8
3	Mont	PNE	22 Jun	8:53	20	36 46.18	121 53.96	170	361	8.5	12.4	1.3	2	1.5
4	Mont	PNE	23 Jun	7:50	10	37 16.21	122 42.98	98	98	8.8	11.8	6.5	9	47.7
5	Mont	AWT	23 Jun	12:44	10	37 16.08	122 50.56	204	235	8.4	11.3	0.0	0	0.1
6	Mont	AWT	24 Jun	8:34	18	37 36.16	122 57.21	88	106	8.8	11.2	357.1	1,842	5.9
7	Mont	PNE	24 Jun	10:29	9	37 36.52	122 55.43	94	94	8.6	11.3	502.3	2,741	45.8
8	Mont	AWT	24 Jun	15:42	6	37 45.91	123 13.54	135	148	8.7	11.2	0.0	0	3.0
9	Mont	AWT	24 Jun	17:14	9	37 46.00	123 14.32	222	329	8.0	11.1	19.2	75	42.5
10	Mont	PNE	25 Jun	8:12	13	37 56.24	123 9.67	98	98	8.2	9.4	3,206.5	1,871	35.6
11	Mont	AWT	25 Jun	13:44	8	38 6.21	123 30.10	225	308	8.1	9.7	544.7	909	16.9
12	Mont	AWT	26 Jun	7:56	3	38 25.97	123 26.47	120	135	8.1	8.7	2,830.8	9,924	369.2
13	Mont	AWT	26 Jun	15:54	2	38 46.05	123 48.53	141	144	7.7	9.9	0.0	0	0.1
14	Mont	AWT	27 Jun	9:57	20	39 15.85	123 56.35	118	177	8.1	10.3	0.0	0	0.1
15	Mont	AWT	27 Jun	17:42	31	39 36.13	124 3.13	267	802	6.7	10.4	0.0	0	0.2
16	Mont	AWT	28 Jun	7:36	13	39 46.21	124 0.95	137	160	8.0	9.7	3,586.8	17,731	13.2
17	Mont	AWT	28 Jun	12:26	5	39 56.26	124 9.85	208	363	7.4	9.6	2,095.0	8,862	5.0
18	Mont	AWT	29 Jun	9:51	25	40 16.21	124 28.40	270	407	6.4	9.3	797.8	1,351	7.5
19	Mont	AWT	29 Jun	17:41	1	40 26.00	124 36.28	145	260	7.6	13.0	3,699.8	13,660	50.2
20	Eur	PNE	30 Jun	10:19	5	40 45.91	124 26.08	100	100	7.8	13.8	0.0	0	1,006.5
21	Eur	PNE	2 Jul	9:00	1	40 56.11	124 17.22	80	80	8.0	13.9	801.2	2,850	2.3
22	Eur	PNE	2 Jul	17:52	5	41 16.18	124 16.85	93	93	--	15.7	592.6	2,022	27.1
23	Eur	AWT	3 Jul	11:32	13	41 35.92	124 22.14	87	95	7.9	13.0	62.9	113	129.9
24	Eur	AWT	3 Jul	13:04	11	41 35.99	124 26.29	135	142	7.6	14.2	1,311.0	3,116	1.9
25	Eur	AWT	4 Jul	13:14	6	42 5.68	124 36.62	198	335	7.1	11.5	386.5	695	0.6
26	Eur	AWT	5 Jul	11:39	20	42 36.04	124 53.20	315	976	6.2	12.1	6.2	13	0.4

Table 3 continued. Trawl station and catch data summary from the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Haul no.[a]	INPFC area[b]	Gear type[c]	Date	Time (PDT)	Duration (min.)	Start position Latitude	Start position Longitude	Depth (m) Gear[d]	Depth (m) Bottom	Temp. (°C) Gear[e]	Temp. (°C) Surface	Catch Pacific hake (kg)	Catch Pacific hake Number	Catch Other[f] (kg)
27	Eur	AWT	5 Jul	16:26	12	42 45.88	124 54.63	284	579	6.3	12.6	17.8	32	1.1
28	Eur	AWT	5 Jul	17:58	12	42 45.67	124 56.97	138	926	7.2	13.0	<0.1	40	<0.1
29	Eur	AWT	6 Jul	7:29	14	42 56.04	124 46.67	135	163	7.3	12.1	762.3	3,706	0.0
30	SCol	AWT	6 Jul	15:41	8	43 15.71	124 44.61	201	309	7.0	13.1	796.8	3,428	1.7
31	SCol	AWT	7 Jul	10:08	3	43 35.65	124 30.41	141	154	7.1	11.9	351.5	1,485	<0.1
32	SCol	AWT	8 Jul	7:05	20	43 56.10	124 35.09	172	176	7.0	13.3	3,800.0	14,404	0.0
33	SCol	AWT	8 Jul	11:13	30	43 56.12	125 0.80	252	898	6.6	13.7	59.7	100	3.5
34	SCol	AWT	9 Jul	7:04	11	44 15.82	124 55.30	238	279	6.7	12.8	197.3	487	14.1
35	SCol	AWT	9 Jul	17:59	1	44 35.77	124 39.23	143	295	7.6	12.9	372.1	9,468	0.0
36	SCol	AWT	10 Jul	9:10	25	44 46.13	124 45.01	281	373	6.6	16.0	10.9	20	1.9
37	SCol	AWT	10 Jul	11:50	12	44 45.73	124 39.38	263	293	8.4	16.1	0.0	0	0.1
38	SCol	AWT	10 Jul	17:51	3	44 56.11	124 23.77	179	197	7.3	16.0	1,106.4	25,289	0.0
39	SCol	AWT	15 Jul	12:36	20	44 47.68	124 33.53	184	205	6.8	18.3	3.6	6	<0.1
40	SCol	AWT	15 Jul	19:19	19	45 16.09	124 27.01	381	390	6.0	17.8	158.3	300	5.2
41	SCol	AWT	16 Jul	7:42	--	45 17.53	125 0.22	--	--	--	--	--	--	--
42	SCol	AWT	16 Jul	8:50	16	45 15.73	125 0.19	342	1,232	6.3	17.6	0.0	0	4.2
43	SCol	AWT	16 Jul	15:16	15	45 25.52	124 36.02	414	423	5.6	18.6	380.1	517	6.0
44	SCol	AWT	16 Jul	17:28	20	45 26.23	124 35.63	254	445	6.8	18.7	0.0	0	2.8
45	SCol	AWT	17 Jul	9:37	16	45 35.72	124 45.18	449	462	5.6	18.3	81.3	83	9.3
46	VanNC	AWT	17 Jul	17:40	12	45 46.63	124 24.10	141	150	7.0	17.0	575.3	10,819	0.0
47	VanNC	AWT	18 Jul	17:23	5	46 16.72	124 24.63	109	390	7.4	16.4	265.2	466	9.3
48	VanNC	AWT	18 Jul	21:12	--	46 15.79	124 55.98	--	--	--	--	--	--	--
49	VanNC	AWT	19 Jul	8:30	15	46 26.11	124 34.61	222	589	6.8	16.6	0.0	0	4.3
50	VanNC	AWT	19 Jul	15:09	19	46 36.44	124 44.89	352	910	6.1	17.0	62.5	60	8.5
51	VanNC	AWT	20 Jul	7:28	15	46 46.87	124 36.92	109	118	7.7	15.7	872.8	1,391	4.5
52	VanNC	AWT	20 Jul	9:49	<0.5	46 46.88	124 28.48	81	90	7.4	16.7	3.1	5	0.0

Table 3 continued. Trawl station and catch data summary from the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Haul no.[a]	INPFC area[b]	Gear type[c]	Date	Time (PDT)	Duration (min.)	Start position Latitude		Start position Longitude		Depth (m) Gear[d]	Depth (m) Bottom	Temp. (°C) Gear[e]	Temp. (°C) Surface	Catch Pacific hake (kg)	Catch Pacific hake Number	Catch Other[f] (kg)
53	VanNC	AWT	20 Jul	10:46	4	46	46.60	124	28.30	83	90	7.4	16.4	150.3	227	0.0
54	VanNC	AWT	20 Jul	17:59	25	47	6.99	125	6.11	257	1,398	6.7	16.9	0.0	0	12.5
55	VanNC	AWT	20 Jul	20:53	3	47	5.95	124	58.52	298	396	6.7	16.7	701.2	1,198	146.3
56	VanNC	AWT	21 Jul	11:37	18	47	16.30	125	1.54	436	574	5.9	17.0	0.0	0	8.5
57	VanNC	AWT	21 Jul	17:15	16	47	26.39	125	17.86	248	1,222	7.0	17.3	0.0	0	0.7
58	VanNC	AWT	23 Jul	14:02	21	47	45.98	125	12.70	367	659	6.2	16.1	0.0	0	32.0
59	VanNC	AWT	23 Jul	17:55	16	47	45.94	125	5.74	386	511	6.0	16.0	304.3	506	28.1
60	VanNC	AWT	24 Jul	6:44	4	47	56.96	124	48.97	51	47	9.0	16.2	0.0	0	--
61	VanNC	PNE	24 Jul	9:25	2	47	55.72	125	0.49	104	116	7.1	15.7	121.0	1,053	0.6
62	VanNC	AWT	24 Jul	14:04	16	47	56.27	125	51.41	474	1,500	5.6	16.8	0.0	0	4.7
63	VanNC	AWT	24 Jul	18:23	19	48	5.67	125	46.52	421	611	5.7	16.6	0.0	0	25.6
64	VanNC	PNE	25 Jul	8:28	1	48	6.13	124	59.06	114	134	6.8	16.1	1.9	3	1.0
65	VanNC	PNE	25 Jul	9:44	6	48	6.18	124	56.22	86	92	7.0	16.1	50.9	60	--
66	Can	AWT	1 Aug	8:39	25	48	26.17	126	10.30	385	482	5.8	14.9	43.1	76	44.4
67	Can	AWT	1 Aug	13:45	7	48	25.83	125	14.85	159	169	6.4	12.3	507.4	11,181	7.2
68	Can	AWT	1 Aug	15:49	14	48	25.98	125	26.26	149	155	6.6	13.0	0.0	0	237.1
69	Can	AWT	2 Aug	10:15	22	48	36.08	125	33.25	121	131	6.8	13.6	0.1	1	16.6
70	Can	AWT	2 Aug	13:11	16	48	36.06	125	53.95	88	95	7.7	15.7	1,106.1	6,108	28.3
71	Can	AWT	2 Aug	20:25	20	48	46.05	126	31.03	351	378	5.9	16.2	15.6	39	118.0
72	Can	AWT	3 Aug	10:01	21	48	46.18	125	32.03	121	134	7.9	14.4	0.0	0	12.8
73	Can	AWT	4 Aug	7:11	19	48	55.68	126	15.78	106	126	6.8	14.3	66.0	2,103	781.1
74	Can	AWT	4 Aug	15:37	16	49	6.16	126	26.90	76	127	7.5	16.9	0.0	0	<0.1
75	Can	AWT	5 Aug	12:10	22	49	25.92	127	15.58	424	525	7.0	14.6	9.6	59	192.3
76	Can	AWT	5 Aug	18:47	19	49	36.11	127	22.94	384	494	5.6	13.4	88.3	106	23.3
77	Can	AWT	7 Aug	7:26	18	50	26.17	128	31.54	359	634	5.6	13.2	439.2	692	113.5
78	Can	AWT	7 Aug	17:19	15	51	6.13	129	30.80	301	309	5.2	14.6	616.2	973	0.0

Table 3 continued. Trawl station and catch data summary from the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Haul no.[a]	INPFC area[b]	Gear type[c]	Date	Time (PDT)	Duration (min.)	Start position Latitude	Start position Longitude	Depth (m) Gear[d]	Depth (m) Bottom	Temp. (°C) Gear[e]	Temp. (°C) Surface	Catch Pacific hake (kg)	Catch Pacific hake Number	Catch Other[f] (kg)
79	Can	AWT	8 Aug	9:36	25	51 6.18	128 14.81	152	174	6.1	15.6	451.0	509	35.3
80	Can	AWT	9 Aug	16:01	4	51 26.17	128 24.89	157	177	6.3	16.3	401.8	656	12.0
81	Can	AWT	10 Aug	10:31	23	51 36.22	130 2.16	166	319	6.2	15.4	0.0	0	0.1
82	Can	AWT	10 Aug	17:37	25	51 46.39	130 34.96	431	530	4.8	15.9	24.8	36	5.5
83	Can	PNE	11 Aug	7:51	15	51 46.22	129 38.55	280	280	5.5	15.4	56.3	92	304.3
84	Can	AWT	11 Aug	9:39	15	51 46.22	129 34.79	152	242	6.5	15.6	9.4	14	6.2
85	Can	AWT	11 Aug	10:57	29	51 47.45	129 32.63	164	234	6.0	15.4	539.5	784	62.0
86	Can	AWT	13 Aug	13:01	14	52 46.21	129 51.62	126	236	6.5	14.9	652.4	812	48.0
87	Can	AWT	14 Aug	12:03	1	53 35.63	130 45.47	106	163	7.0	14.5	1,695.8	2,136	4.2
88	Can	AWT	14 Aug	15:41	12	53 45.85	130 43.82	94	136	8.0	14.9	741.5	903	12.1
89	Can	AWT	15 Aug	8:18	9	54 24.51	131 33.44	100	253	7.2	13.2	1,595.5	1,674	4.5
90	AK	AWT	15 Aug	13:17	25	54 37.24	131 49.52	267	339	5.5	14.7	84.8	97	33.3
91	AK	AWT	17 Aug	19:32	25	54 56.27	134 20.74	360	684	5.5	16.1	0.0	0	3.3
92	AK	AWT	18 Aug	12:12	16	54 46.11	132 58.36	197	195	6.0	12.7	43.0	53	123.1
93	Can	PNE	19 Aug	16:33	15	53 56.17	133 30.79	373	373	5.4	14.7	189.5	261	33.0
94	Can	AWT	20 Aug	13:14	25	53 15.42	132 49.23	382	489	5.2	15.5	14.4	22	31.8

[a] Haul 41 was aborted because of equipment failure; haul 48 was deployed with an open codend for sensor calibration; hauls 3, 61, 64, and 65 were PNE trawls fished off bottom.

[b] Mont = Monterey, Eur = Eureka, SCol = South Columbia, VanNC = Vancouver - North Columbia, Can = Canada, AK = Alaska

[c] AWT = Aleutian wing midwater trawl, PNE = poly Nor'eastern bottom trawl

[d] Gear depths were measured at the foot rope.

[e] Gear temperatures were measured at the head rope.

[f] Other catch in hauls 60 and 65 included unweighed salmon.

Table 4. Catch by species from Aleutian wing midwater trawl hauls conducted by the NOAA ship *Miller Freeman* during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Common name	Scientific name	Weight (kg)	(%)	Numbers
Pacific hake	*Merluccius productus*	37,445.4	92.4	167,013
yellowtail rockfish	*Sebastes flavidus*	1,242.8	3.1	881
spiny dogfish	*Squalus acanthias*	531.6	1.3	807
Humboldt squid	*Dosidicus gigas*	460.5	1.1	81
chinook salmon	*Oncorhynchus tshawytscha*	155.5	0.4	71
Pacific ocean perch	*Sebastes alutus*	129.8	0.3	109
lanternfish	Myctophidae	71.5	0.2	12,305
rougheye rockfish	*Sebastes aleutianus*	67.0	0.2	42
widow rockfish	*Sebastes entomelas*	62.2	0.2	52
arrowtooth flounder	*Atheresthes stomias*	61.1	0.2	32
yellowmouth rockfish	*Sebastes reedi*	59.1	0.1	43
chilipepper	*Sebastes goodei*	37.3	0.1	50
northern smoothtongue	*Leuroglossus schmidti*	22.1	0.1	2,275
Pacific sardine	*Sardinops sagax*	19.6	<0.1	201
walleye pollock	*Theragra chalcogramma*	18.3	<0.1	23
California headlightfish	*Diaphus theta*	15.0	<0.1	3,040
Pacific herring	*Clupea pallasi*	14.2	<0.1	253
bocaccio	*Sebastes paucispinis*	13.9	<0.1	5
northern anchovy	*Engraulis mordax*	10.9	<0.1	476
jellyfish	Scyphozoa	10.7	<0.1	--
lingcod	*Ophiodon elongatus*	10.6	<0.1	2
Pacific glass shrimp	*Pasiphaea pacifica*	9.3	<0.1	4,821
brown cat shark	*Apristurus brunneus*	8.7	<0.1	15
boreopacific armhook squid	*Gonatopsis borealis*	8.5	<0.1	16
pink salmon	*Oncorhynchus gorbuscha*	6.1	<0.1	3
Pacific electric ray	*Torpedo californica*	5.7	<0.1	1
Chrysaora jellyfish	*Chrysaora* sp.	3.9	<0.1	53
redstripe rockfish	*Sebastes proriger*	3.4	<0.1	6
fried egg jellyfish	*Phacellophora camtschatica*	3.0	<0.1	2
Pacific pomfret	*Brama japonica*	3.0	<0.1	2
salp	Thaliacea	2.5	<0.1	--
northern lampfish	*Stenobrachius leucopsarus*	2.3	<0.1	267
chum salmon	*Oncorhynchus keta*	2.2	<0.1	1
robust clubhook squid	*Moroteuthis robusta*	2.2	<0.1	1
squid	Teuthoidea	1.9	<0.1	79
lion's mane jellyfish	*Cyanea capillata*	1.6	<0.1	1
boreal clubhook squid	*Onychoteuthis borealijaponicus*	1.5	<0.1	9
lampfish	*Lampanyctus* sp.	1.5	<0.1	25

Table 4 continued. Catch by species from Aleutian wing midwater trawl hauls conducted by the NOAA ship *Miller Freeman* during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Common name	Scientific name	Weight (kg)	(%)	Numbers
viperfish	Chauliodontidae	1.4	<0.1	162
--	*Octopoteuthis deletron*	1.4	<0.1	11
lampfish	*Stenobrachius* sp.	1.1	<0.1	142
scaleless dragonfish	Melanostomiidae	0.9	<0.1	50
eulachon	*Thaleichthys pacificus*	0.8	<0.1	18
--	*Histioteuthis heteropsis*	0.6	<0.1	9
longfin dragonfish	*Tactostoma macropus*	0.6	<0.1	34
California lanternfish	*Symbolophorus californiensis*	0.6	<0.1	54
Pacific viperfish	*Chauliodus macouni*	0.6	<0.1	59
glass squid	Cranchiidae	0.5	<0.1	12
Pacific lamprey	*Lampetra tridentata*	0.5	<0.1	1
eelpout	*Lycodapus* sp.	0.5	<0.1	29
sergestid shrimp	*Sergestes* sp.	0.4	<0.1	277
cranchiid squid	*Taonius pavo*	0.4	<0.1	86
--	*Abraliopsis felis*	0.3	<0.1	69
ribbon barracudina	*Arctozenus risso*	0.3	<0.1	10
smelt	Osmeridae	0.2	<0.1	40
clawed armhook squid	*Gonatus onyx*	0.2	<0.1	38
blue lanternfish	*Tarletonbeania crenularis*	0.1	<0.1	34
shortbelly rockfish	*Sebastes jordani*	0.1	<0.1	1
shiny loosejaw	*Aristostomias scintillans*	0.1	<0.1	3
tubeshoulder	Platytroctidae	0.1	<0.1	1
northern pearleye	*Benthalbella dentata*	0.1	<0.1	5
sand sea star	*Luidia foliolata*	0.1	<0.1	1
euphausiid	Euphausiacea	0.1	<0.1	270
barracudina	Paralepididae	0.1	<0.1	1
California market squid	*Loligo opalescens*	0.1	<0.1	11
slender barracudina	*Lestidiops ringens*	0.1	<0.1	3
Gonatus squid	*Gonatus* sp.	0.1	<0.1	4
prowfish	*Zaprora silenus*	0.1	<0.1	1
helmet jellyfish	*Periphylla periphylla*	0.1	<0.1	8
crown jellyfish	*Atolla* sp.	<0.1	<0.1	6
shrimp	Decapoda	<0.1	<0.1	5
lanternfish	*Tarletonbeania* sp.	<0.1	<0.1	3
fish	Teleostei	<0.1	<0.1	2
flatfish larvae	Pleuronectiformes	<0.1	<0.1	2
hatchetfish	Sternoptychidae	<0.1	<0.1	2
pinpoint lampfish	*Nannobranchium regale*	<0.1	<0.1	2

Table 4 continued. Catch by species from Aleutian wing midwater trawl hauls conducted by the NOAA ship *Miller Freeman* during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Common name	Scientific name	Weight (kg)	(%)	Numbers
fish larvae	Teleostei	<0.1	<0.1	1
flatfish	Pleuronectiformes	<0.1	<0.1	1
longspine hatchetfish	*Sternoptyx diaphana*	<0.1	<0.1	1
northern flashlightfish	*Protomyctophum thompsoni*	<0.1	<0.1	1
ocean shrimp	*Pandalus jordani*	<0.1	<0.1	1
shining tubeshoulder	*Sagamichthys abei*	<0.1	<0.1	1
slender hatchetfish	*Argyropelecus affinis*	<0.1	<0.1	1
--	*Chiroteuthis calyx*	<0.1	<0.1	1

Table 5. Catch by species from poly Nor'eastern bottom trawl hauls conducted by the NOAA ship *Miller Freeman* during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Common name	Scientific name	Weight (kg)	(%)	Numbers
Pacific hake	*Merluccius productus*	5,529.9	78.6	10,964
canary rockfish	*Sebastes pinniger*	869.6	12.4	1,548
Pacific ocean perch	*Sebastes alutus*	275.5	3.9	412
yellowtail rockfish	*Sebastes flavidus*	126.8	1.8	225
spiny dogfish	*Squalus acanthias*	26.6	0.4	57
chilipepper	*Sebastes goodei*	24.5	0.3	39
English sole	*Parophrys vetulus*	17.8	0.3	58
Pacific halibut	*Hippoglossus stenolepis*	14.8	0.2	1
Dover sole	*Microstomus pacificus*	14.5	0.2	80
Pacific sardine	*Sardinops sagax*	13.1	0.2	90
redbanded rockfish	*Sebastes babcocki*	11.2	0.2	8
rex sole	*Glyptocephalus zachirus*	10.2	0.1	95
American shad	*Alosa sapidissima*	9.7	0.1	21
arrowtooth flounder	*Atheresthes stomias*	8.9	0.1	8
Humboldt squid	*Dosidicus gigas*	8.3	0.1	1
sablefish	*Anoplopoma fimbria*	7.9	0.1	4
Pacific sanddab	*Citharichthys sordidus*	7.4	0.1	78
salmonid	Salmonidae	7.2	0.1	4
gigantic anemone	*Metridium farcimen*	6.4	0.1	27
rougheye rockfish	*Sebastes aleutianus*	5.3	0.1	4
white croaker	*Genyonemus lineatus*	4.6	0.1	26
Chrysaora jellyfish	*Chrysaora* sp.	3.8	0.1	9
silvergray rockfish	*Sebastes brevispinus*	3.7	0.1	2
jellyfish	Scyphozoa	3.4	<0.1	24
widow rockfish	*Sebastes entomelas*	3.1	<0.1	2
shortspine thornyhead	*Sebastolobus alascanus*	3.0	<0.1	20
petrale sole	*Eopsetta jordani*	2.9	<0.1	7
copper rockfish	*Sebastes caurinus*	2.7	<0.1	2
lingcod	*Ophiodon elongatus*	2.1	<0.1	1
salp	Thaliacea	2.0	<0.1	46
magistrate armhook squid	*Berryteuthis magister*	1.6	<0.1	2
slender sole	*Lyopsetta exilis*	1.2	<0.1	18
splitnose rockfish	*Sebastes diploproa*	1.2	<0.1	4
yellowmouth rockfish	*Sebastes reedi*	1.0	<0.1	1
darkblotched rockfish	*Sebastes crameri*	0.7	<0.1	1
redstripe rockfish	*Sebastes proriger*	0.6	<0.1	1
orange-pink sea urchin	*Allocentrotus fragilis*	0.4	<0.1	10
greenstriped rockfish	*Sebastes elongatus*	0.4	<0.1	2

Table 5 continued. Catch by species from poly Nor'eastern bottom trawl hauls conducted by the NOAA ship *Miller Freeman* during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Common name	Scientific name	Weight (kg)	(%)	Numbers
pink seaperch	*Zalembius rosaceus*	0.3	<0.1	7
sharpchin rockfish	*Sebastes zacentrus*	0.3	<0.1	2
halfbanded rockfish	*Sebastes semicinctus*	0.3	<0.1	3
plainfin midshipman	*Porichthys notatus*	0.3	<0.1	4
sand sea star	*Luidia foliolata*	0.3	<0.1	3
California market squid	*Loligo opalescens*	0.2	<0.1	12
hermit crab	Paguridae	0.2	<0.1	1
Pacific herring	*Clupea pallasi*	0.1	<0.1	4
sandy sea cucumber	*Pseudostichopus mollis*	0.1	<0.1	2
sidestripe shrimp	*Pandalopsis dispar*	0.1	<0.1	6
shrimp	Decapoda	0.1	<0.1	17
snail	Gastropoda	0.1	<0.1	2
red rock crab	*Cancer productus*	0.1	<0.1	1
roughstem seawhip	*Stylatula gracile*	0.1	<0.1	4
brittlestarfish	Ophiurida	<0.1	<0.1	1
northern anchovy	*Engraulis mordax*	<0.1	<0.1	1
sevenspine bay shrimp	*Crangon septemspinosa*	<0.1	<0.1	1
chinook salmon	*Oncorhynchus tshawytscha*	--	--	2
coho salmon	*Oncorhynchus kisutch*	--	--	1

Table 6. Numbers of Pacific hake biological samples and measurements collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Haul *	Length	Maturity	Otoliths	Fish Weight	Stomachs
1	223	62	62	62	10
2	473	81	81	81	16
3	2	2	2	2	2
4	9	9	9	9	6
5	0	0	0	0	0
6	312	51	51	51	10
7	290	52	50	52	10
8	0	0	0	0	0
9	75	75	75	75	14
10	284	53	53	53	11
11	297	51	51	51	10
12	491	79	79	79	16
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	328	66	66	66	12
17	349	53	53	53	10
18	352	53	53	53	15
19	314	54	52	54	12
20	0	0	0	0	2
21	344	50	46	50	5
22	322	52	52	52	10
23	113	54	54	54	10
24	321	51	51	51	10
25	342	55	55	55	11
26	13	10	13	13	5
27	32	29	32	32	9
28	40	0	0	0	0
29	571	55	55	55	12
30	395	48	48	48	10
31	301	50	50	50	9
32	322	43	43	43	11
33	100	44	44	44	8
34	334	50	51	51	16
35	369	52	52	52	10
36	20	20	20	20	9
37	0	0	0	0	0
38	200	42	23	42	10

Table 6 continued. Numbers of Pacific hake biological samples and measurements collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Haul *	Length	Maturity	Otoliths	Fish Weight	Stomachs
39	6	6	6	6	2
40	252	47	49	49	8
42	0	0	0	0	0
43	287	0	56	56	9
44	0	0	0	0	0
45	83	0	51	51	10
46	363	50	49	50	10
47	293	42	43	43	10
49	0	0	0	0	0
50	60	41	45	45	10
51	348	0	42	43	10
52	5	5	5	5	1
53	180	43	43	43	11
54	0	0	0	0	0
55	279	50	50	50	10
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	287	48	48	48	10
60	0	0	0	0	0
61	475	65	65	65	10
62	0	0	0	0	0
63	0	0	0	0	0
64	3	3	3	3	0
65	60	50	50	50	10
66	76	55	55	55	10
67	227	36	36	36	10
68	0	0	0	0	0
69	1	1	1	1	1
70	592	56	56	56	12
71	39	39	39	39	8
72	0	0	0	0	0
73	94	46	46	46	16
74	0	0	0	0	0
75	59	45	45	45	8
76	106	50	50	50	9
77	291	67	67	67	14
78	430	83	83	83	16

Table 6 continued. Numbers of Pacific hake biological samples and measurements collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Haul *	Length	Maturity	Otoliths	Fish Weight	Stomachs
79	448	61	61	61	13
80	526	105	105	105	21
81	0	0	0	0	0
82	36	36	36	36	7
83	92	36	35	36	6
84	14	14	14	14	8
85	303	77	77	77	14
86	274	73	73	73	12
87	305	77	77	77	14
88	281	71	71	71	15
89	289	83	84	84	15
90	97	61	61	61	13
91	0	0	0	0	0
92	53	53	53	53	10
93	182	79	79	79	16
94	22	22	22	22	10
Totals	14,582	3,014	3,168	3,179	666

* Haul 41 was aborted; haul 48 had an open cod end.

Table 7. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
1	16 Jun	20:35	47	35.29	122	22.22	Elliott Bay cal.
2	17 Jun	4:06	47	35.29	122	22.23	Elliott Bay cal.
3	21 Jun	5:55	35	56.15	121	30.04	2
4	21 Jun	6:24	35	56.15	121	30.75	2
5	21 Jun	6:58	35	56.43	121	31.56	2
6	21 Jun	7:34	35	56.36	121	32.38	2
7	21 Jun	8:28	35	56.26	121	35.51	2
8	21 Jun	10:03	35	56.29	121	47.83	2
9	22 Jun	6:37	36	16.47	122	5.01	4
10	22 Jun	7:20	36	16.31	122	2.21	4
11	22 Jun	7:56	36	16.16	122	1.88	4
12	22 Jun	10:22	36	36.24	122	1.80	6
13	22 Jun	10:58	36	36.15	122	1.00	6
14	22 Jun	11:22	36	36.18	122	0.39	6
15	23 Jun	2:53	36	56.24	122	7.04	8
16	23 Jun	3:25	36	56.17	122	10.92	8
17	23 Jun	4:30	36	56.27	122	19.50	8
18	23 Jun	5:11	36	56.28	122	22.30	8
19	23 Jun	5:58	36	56.32	122	26.64	8
20	23 Jun	8:23	36	36.27	122	12.75	6
21	24 Jun	3:32	37	16.33	122	28.67	10
22	24 Jun	3:58	37	16.28	122	31.20	10
23	24 Jun	4:52	37	16.41	122	39.37	10
24	24 Jun	5:48	37	16.16	122	47.54	10
25	24 Jun	6:39	37	16.30	122	52.79	10
26	24 Jun	10:03	37	36.14	123	2.89	12
27	24 Jun	10:38	37	36.30	123	1.99	12
28	24 Jun	11:45	37	36.11	122	50.19	12
29	25 Jun	4:27	37	56.61	122	52.85	14
30	25 Jun	5:37	37	56.16	123	3.51	14
31	25 Jun	6:59	37	56.16	123	14.53	14
32	25 Jun	8:13	37	56.10	123	25.50	14
33	25 Jun	8:57	37	56.16	123	27.71	14
34	25 Jun	9:46	37	56.13	123	30.15	14
35	26 Jun	4:08	38	16.12	123	40.39	16
36	26 Jun	5:21	38	16.04	123	33.55	16
37	26 Jun	7:09	38	16.27	123	21.89	16
38	26 Jun	8:03	38	16.25	123	13.96	16

Table 7 continued. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
39	26 Jun	9:48	38	16.20	123	29.40	16
40	27 Jun	6:04	38	36.17	123	30.70	18
41	27 Jun	6:53	38	36.19	123	36.73	18
42	27 Jun	7:39	38	36.17	123	41.96	18
43	27 Jun	8:20	38	36.25	123	43.83	18
44	28 Jun	6:46	38	56.30	124	1.46	20
45	28 Jun	7:35	38	56.14	123	55.44	20
46	28 Jun	9:35	39	16.15	123	55.72	22
47	29 Jun	5:09	39	56.18	124	8.78	26
48	29 Jun	7:36	39	36.24	123	49.33	24
49	29 Jun	8:21	39	36.16	123	56.01	24
50	29 Jun	9:13	39	36.27	124	0.89	24
51	30 Jun	3:49	40	16.34	124	23.31	28
52	30 Jun	4:11	40	16.30	124	24.20	28
53	30 Jun	4:48	40	16.17	124	25.65	28
54	30 Jun	5:41	40	16.17	124	33.20	28
55	30 Jun	6:18	40	16.19	124	36.27	28
56	30 Jun	7:19	40	16.11	124	42.98	28
57	30 Jun	9:43	40	36.35	124	45.58	30
58	30 Jun	10:40	40	36.21	124	36.85	30
59	30 Jun	11:36	40	36.08	124	28.26	30
60	30 Jun	12:01	40	36.14	124	27.62	30
61	30 Jun	12:21	40	36.09	124	25.98	30
62	3 Jul	6:28	40	56.29	124	26.51	32
63	3 Jul	7:11	40	56.31	124	22.47	32
64	3 Jul	7:58	40	55.97	124	16.45	32
65	3 Jul	8:27	40	56.19	124	12.86	32
66	4 Jul	5:30	41	16.19	124	25.53	34
67	4 Jul	6:05	41	16.16	124	21.79	34
68	4 Jul	6:51	41	16.22	124	13.73	34
69	4 Jul	7:19	41	16.26	124	9.98	34
70	4 Jul	9:11	41	36.13	124	15.12	36
71	4 Jul	9:43	41	36.09	124	19.95	36
72	4 Jul	10:27	41	36.10	124	26.97	36
73	5 Jul	5:52	42	16.01	124	38.56	40
74	6 Jul	4:05	42	36.37	124	27.39	42
75	6 Jul	4:35	42	36.17	124	30.70	42
76	6 Jul	5:31	42	36.10	124	40.10	42

Table 7 continued. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
77	6 Jul	6:07	42	36.19	124	42.95	42
78	6 Jul	9:09	42	55.98	124	54.23	44
79	6 Jul	9:46	42	56.09	124	51.31	44
80	6 Jul	11:19	42	56.11	124	35.35	44
81	6 Jul	11:43	42	56.17	124	32.99	44
82	7 Jul	5:04	43	16.28	124	42.83	46
83	7 Jul	5:49	43	16.02	124	38.05	46
84	7 Jul	6:47	43	16.10	124	29.62	46
85	7 Jul	7:11	43	16.10	124	27.10	46
86	7 Jul	9:38	43	36.34	124	15.50	48
87	7 Jul	10:04	43	36.24	124	17.89	48
88	7 Jul	11:05	43	36.04	124	29.74	48
89	8 Jul	6:21	43	56.13	124	12.21	50
90	8 Jul	6:48	43	56.12	124	14.70	50
91	8 Jul	7:33	43	56.09	124	22.78	50
92	8 Jul	8:30	43	56.18	124	33.21	50
93	8 Jul	9:20	43	56.20	124	41.03	50
94	8 Jul	10:11	43	56.19	124	49.08	50
95	8 Jul	10:54	43	56.29	124	54.91	50
96	8 Jul	11:21	43	56.24	124	55.88	50
97	9 Jul	7:23	44	16.10	124	11.21	52
98	9 Jul	8:00	44	16.08	124	16.96	52
99	9 Jul	8:50	44	16.07	124	25.88	52
100	9 Jul	9:41	44	16.10	124	34.64	52
101	9 Jul	10:34	44	16.09	124	43.44	52
102	9 Jul	11:26	44	16.08	124	52.53	52
103	9 Jul	12:04	44	16.17	124	55.53	52
104	9 Jul	12:49	44	16.11	124	58.16	52
105	10 Jul	7:48	44	39.08	124	10.39	--
106	10 Jul	8:30	44	39.03	124	17.69	--
107	10 Jul	9:11	44	39.07	124	24.71	--
108	10 Jul	9:54	44	38.96	124	31.75	--
109	11 Jul	6:34	44	39.05	125	7.11	--
110	11 Jul	7:56	44	39.13	124	53.31	--
111	11 Jul	9:09	44	38.94	124	38.92	--
112	16 Jul	6:19	44	56.07	124	28.38	56
113	16 Jul	7:30	44	56.12	124	16.42	56
114	16 Jul	8:25	44	56.16	124	8.11	56

Table 7 continued. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
115	16 Jul	8:55	44	56.13	124	4.98	56
116	16 Jul	10:55	45	16.12	124	12.39	58
117	17 Jul	4:28	45	16.03	124	1.94	58
118	17 Jul	4:58	45	16.07	124	4.65	58
119	17 Jul	6:22	45	16.29	124	21.94	58
120	17 Jul	7:18	45	16.06	124	29.92	58
121	17 Jul	8:21	45	16.33	124	38.28	58
122	17 Jul	10:55	45	36.08	124	14.48	60
123	17 Jul	11:48	45	36.23	124	4.34	60
124	17 Jul	12:21	45	36.26	124	1.00	60
125	18 Jul	4:37	45	36.14	124	24.77	60
126	18 Jul	5:47	45	36.06	124	34.95	60
127	18 Jul	7:03	45	36.05	124	45.34	60
128	18 Jul	9:17	45	56.09	124	33.91	62
129	18 Jul	11:00	45	56.16	124	14.86	62
130	18 Jul	11:53	45	56.14	124	4.93	62
131	18 Jul	12:19	45	56.14	124	2.19	62
132	19 Jul	7:41	46	16.07	124	12.31	64
133	19 Jul	8:07	46	16.24	124	16.31	64
134	19 Jul	8:38	46	16.21	124	20.28	64
135	19 Jul	9:11	46	16.33	124	22.92	64
136	19 Jul	10:01	46	16.25	124	29.87	64
137	19 Jul	10:43	46	15.97	124	35.29	64
138	20 Jul	5:23	46	36.22	124	37.98	66
139	20 Jul	6:09	46	36.23	124	32.64	66
140	20 Jul	7:09	46	36.16	124	20.78	66
141	20 Jul	7:50	46	36.33	124	13.36	66
142	20 Jul	9:35	46	56.12	124	21.05	68
143	20 Jul	10:15	46	56.05	124	28.76	68
144	20 Jul	10:59	46	56.17	124	37.64	68
145	20 Jul	11:45	46	56.23	124	46.46	68
146	21 Jul	6:18	47	16.25	124	52.65	70
147	21 Jul	7:00	47	16.03	124	47.36	70
148	21 Jul	7:40	47	16.15	124	41.10	70
149	21 Jul	8:20	47	16.29	124	35.19	70
150	21 Jul	8:55	47	16.23	124	29.05	70
151	21 Jul	11:18	46	56.23	124	48.93	68
152	22 Jul	5:09	47	36.49	124	37.73	72

Table 7 continued. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
153	22 Jul	5:52	47	36.27	124	43.64	72
154	22 Jul	6:37	47	36.17	124	50.20	72
155	23 Jul	4:17	47	35.76	124	56.68	72
156	23 Jul	5:18	47	35.88	125	4.90	72
157	23 Jul	6:10	47	36.09	125	8.20	72
158	23 Jul	8:45	47	56.24	124	59.65	74
159	23 Jul	9:28	47	56.24	124	52.11	74
160	23 Jul	10:03	47	56.36	124	47.90	74
161	24 Jul	5:16	47	56.11	125	7.43	74
162	24 Jul	6:16	47	56.29	125	15.52	74
163	24 Jul	7:33	47	56.30	125	25.96	74
164	24 Jul	8:43	47	56.27	125	36.45	74
165	24 Jul	9:23	47	56.21	125	38.09	74
166	25 Jul	6:09	48	16.20	124	51.00	76
167	25 Jul	6:36	48	16.20	124	53.02	76
168	25 Jul	7:02	48	16.26	124	54.87	76
169	25 Jul	8:17	48	16.29	125	4.89	76
170	25 Jul	9:03	48	16.31	125	11.86	76
171	25 Jul	10:03	48	16.14	125	21.53	76
172	25 Jul	10:55	48	16.19	125	31.21	76
173	1 Aug	5:10	48	16.26	126	10.51	76
174	1 Aug	6:28	48	16.09	125	58.40	76
175	1 Aug	7:25	48	16.13	125	49.84	76
176	1 Aug	8:20	48	16.16	125	40.37	76
177	1 Aug	9:11	48	16.24	125	31.09	76
178	2 Aug	5:54	48	36.18	124	50.14	78
179	2 Aug	7:02	48	36.22	125	2.84	78
180	2 Aug	7:57	48	36.09	125	15.39	78
181	2 Aug	9:00	48	36.19	125	28.28	78
182	3 Aug	7:40	48	36.09	125	59.95	78
183	3 Aug	8:23	48	36.32	126	6.67	78
184	3 Aug	9:07	48	36.29	126	10.22	78
185	3 Aug	10:21	48	37.34	126	20.30	78
186	3 Aug	12:06	48	39.13	126	39.68	78
187	4 Aug	7:15	48	56.25	125	37.55	80
188	4 Aug	8:55	48	56.27	126	0.23	80
189	4 Aug	10:43	48	56.17	126	22.72	80
190	4 Aug	11:37	48	56.15	126	29.48	80

Table 7 continued. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
191	5 Aug	5:51	49	16.15	126	22.89	82
192	5 Aug	6:46	49	16.13	126	33.35	82
193	5 Aug	7:41	49	16.08	126	43.65	82
194	5 Aug	8:35	49	16.12	126	53.61	82
195	5 Aug	9:28	49	16.00	127	2.99	82
196	5 Aug	10:22	49	16.09	127	8.46	82
197	6 Aug	6:25	49	36.20	126	55.49	84
198	6 Aug	7:15	49	36.23	127	1.58	84
199	6 Aug	8:06	49	36.16	127	9.67	84
200	6 Aug	9:03	49	36.10	127	19.09	84
201	6 Aug	9:53	49	35.97	127	22.68	84
202	7 Aug	5:30	50	26.15	128	31.82	89
203	7 Aug	6:23	50	26.19	128	23.94	89
204	7 Aug	7:02	50	26.07	128	20.30	89
205	7 Aug	7:48	50	26.28	128	11.93	89
206	7 Aug	10:02	50	6.21	127	57.29	87
207	7 Aug	10:52	50	6.48	128	4.20	87
208	8 Aug	5:01	51	6.28	128	47.15	93
209	8 Aug	6:00	51	6.13	128	35.19	93
210	8 Aug	7:02	51	6.09	128	23.25	93
211	8 Aug	8:03	51	6.20	128	11.26	93
212	8 Aug	9:04	51	6.12	127	59.11	93
213	9 Aug	6:39	51	26.01	129	51.72	95
214	9 Aug	7:32	51	26.29	129	43.19	95
215	9 Aug	8:35	51	26.14	129	31.31	95
216	9 Aug	9:36	51	26.21	129	19.02	95
217	10 Aug	5:57	51	46.21	129	25.14	97
218	10 Aug	7:11	51	46.08	129	36.90	97
219	10 Aug	8:30	51	46.07	129	48.89	97
220	11 Aug	5:09	51	46.44	130	0.17	97
221	11 Aug	6:09	51	46.11	130	11.17	97
222	11 Aug	7:10	51	46.34	130	21.97	97
223	11 Aug	9:18	52	6.25	130	18.45	99
224	11 Aug	10:24	52	6.21	130	5.84	99
225	11 Aug	11:24	52	6.14	129	54.14	99
226	12 Aug	7:38	52	26.31	129	49.15	101
227	12 Aug	8:46	52	26.28	130	1.98	101
228	12 Aug	9:51	52	26.16	130	14.19	101

Table 7 continued. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
229	13 Aug	4:19	52	26.12	129	36.77	101
230	13 Aug	8:01	52	46.11	130	37.20	103
231	13 Aug	9:03	52	46.22	130	24.31	103
232	13 Aug	10:06	52	46.08	130	11.29	103
233	13 Aug	11:13	52	46.11	129	57.76	103
234	13 Aug	12:11	52	46.21	129	45.07	103
235	14 Aug	4:33	53	6.23	130	2.76	105
236	14 Aug	5:32	53	6.25	130	15.56	105
237	14 Aug	6:29	53	6.38	130	28.06	105
238	14 Aug	7:29	53	6.34	130	40.64	105
239	14 Aug	8:23	53	6.20	130	53.05	105
240	14 Aug	10:20	53	26.19	130	59.79	107
241	14 Aug	11:12	53	26.09	130	48.33	107
242	14 Aug	11:56	53	26.04	130	37.83	107
243	15 Aug	4:19	54	6.27	130	51.90	111
244	15 Aug	5:09	54	6.18	131	3.53	111
245	15 Aug	7:03	53	46.15	130	58.33	109
246	15 Aug	8:21	53	46.21	130	37.10	109
247	17 Aug	2:04	54	45.75	131	50.29	113
248	17 Aug	3:22	54	36.81	131	50.11	113
249	17 Aug	4:51	54	27.87	131	49.36	113
250	17 Aug	6:01	54	19.00	131	49.86	113
251	17 Aug	7:04	54	10.04	131	49.78	113
252	17 Aug	9:16	54	7.52	132	24.02	115
253	17 Aug	10:17	54	16.26	132	23.73	115
254	17 Aug	11:29	54	24.99	132	24.06	115
255	17 Aug	13:20	54	42.62	132	24.11	115
256	18 Aug	6:50	54	46.17	134	17.96	118
257	18 Aug	7:55	54	46.30	134	4.74	118
258	18 Aug	8:56	54	46.41	133	51.62	118
259	18 Aug	9:57	54	46.04	133	37.76	118
260	19 Aug	5:00	54	26.40	132	58.49	126
261	19 Aug	6:50	54	46.25	132	57.47	118
262	19 Aug	7:46	54	46.31	133	11.00	118
263	19 Aug	10:06	54	26.29	133	26.73	126
264	19 Aug	11:22	54	26.27	133	12.29	126
265	20 Aug	4:09	53	46.17	133	9.85	130
266	20 Aug	5:07	53	46.25	133	21.09	130

Table 7 continued. Summary of conductivity-temperature-depth (CTD) casts conducted during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
267	20 Aug	7:09	54	6.42	133	12.47	128
268	20 Aug	8:04	54	6.20	133	23.67	128
269	20 Aug	9:10	54	6.08	133	35.82	128
270	20 Aug	11:27	53	46.36	133	32.54	130
271	21 Aug	7:04	53	6.30	132	58.93	134
272	21 Aug	8:16	53	6.21	132	47.59	134
273	21 Aug	9:17	53	6.22	132	36.45	134
274	21 Aug	11:44	52	46.19	132	25.65	136
275	21 Aug	13:15	52	46.20	132	40.25	136
276	22 Aug	15:07	50	44.35	127	28.50	Port Hardy cal.
277	22 Aug	21:38	50	44.34	127	28.52	Port Hardy cal.

Table 8. Summary of expendable bathythermograph (XBT) casts conducted successfully during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

XBT Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
1	21 Jun	17:03	36	16.19	122	12.76	4
2	21 Jun	17:47	36	16.19	122	23.47	4
3	22 Jun	19:13	36	56.19	122	26.82	8
4	22 Jun	19:51	36	56.18	122	36.01	8
5	22 Jun	20:32	36	56.19	122	45.89	8
7	23 Jun	21:12	37	16.24	122	58.97	10
8	23 Jun	21:43	37	16.17	123	5.82	10
9	23 Jun	22:16	37	16.20	123	13.11	10
10	24 Jun	18:39	37	36.17	123	3.10	12
11	24 Jun	19:34	37	36.19	123	14.00	12
12	25 Jun	17:59	37	56.19	123	30.27	14
13	26 Jun	2:53	38	16.17	123	33.53	16
14	26 Jun	3:00	38	16.19	123	34.91	16
15	26 Jun	3:24	38	16.25	123	40.33	16
16	26 Jun	20:13	38	36.20	123	49.75	18
17	27 Jun	3:02	38	56.19	124	4.83	20
18	27 Jun	19:04	39	16.22	124	16.85	22
19	28 Jun	20:53	39	56.22	124	18.06	26
20	28 Jun	21:37	39	56.19	124	30.01	26
21	28 Jun	22:21	39	56.14	124	42.02	26
22	28 Jun	23:07	39	56.18	124	54.06	26
23	28 Jun	23:10	39	56.17	124	54.65	26
24	29 Jun	19:34	40	16.21	124	51.20	28
25	29 Jun	20:21	40	16.19	125	3.04	28
26	29 Jun	21:10	40	16.19	125	15.01	28
27	2 Jul	17:14	40	56.19	124	31.73	32
28	2 Jul	17:30	40	56.21	124	36.05	32
29	2 Jul	18:15	40	56.18	124	48.53	32
30	3 Jul	1:56	41	16.20	124	27.31	34
31	3 Jul	2:10	41	16.19	124	31.01	34
32	3 Jul	2:55	41	16.17	124	43.02	34
33	3 Jul	3:40	41	16.18	124	55.04	34
34	3 Jul	21:13	41	36.20	124	31.90	36
35	3 Jul	21:39	41	36.20	124	39.01	36
36	3 Jul	22:23	41	36.18	124	51.01	36
37	4 Jul	13:49	41	56.20	124	36.72	38
38	4 Jul	14:26	41	56.19	124	46.57	38
39	4 Jul	15:04	41	56.19	124	56.31	38
40	4 Jul	15:43	41	56.19	125	6.05	38

Table 8 continued. Summary of expendable bathythermograph (XBT) casts conducted successfully during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

XBT Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
43	5 Jul	17:06	42	36.22	124	45.87	42
44	5 Jul	17:41	42	36.20	124	54.94	42
45	5 Jul	20:21	42	36.19	125	4.02	42
46	6 Jul	15:48	42	56.19	124	55.82	44
47	6 Jul	16:17	42	56.20	125	3.71	44
48	6 Jul	23:59	43	16.21	124	52.12	46
49	7 Jul	0:29	43	16.21	125	0.82	46
50	7 Jul	0:59	43	16.20	125	9.53	46
51	7 Jul	18:11	43	36.20	124	37.42	48
52	7 Jul	18:29	43	36.21	124	42.24	48
53	7 Jul	18:33	43	36.22	124	43.27	48
54	7 Jul	19:15	43	36.19	124	54.63	48
55	7 Jul	20:03	43	36.20	125	7.13	48
56	8 Jul	16:47	43	56.19	124	57.94	50
57	8 Jul	16:51	43	56.20	124	59.16	50
58	8 Jul	19:58	43	56.17	125	6.81	50
59	9 Jul	3:59	44	16.20	124	58.11	52
60	9 Jul	15:36	44	16.22	125	8.72	52
61	10 Jul	3:30	44	36.20	125	11.05	54
62	11 Jul	2:31	44	56.18	124	40.27	56
63	11 Jul	3:12	44	56.22	124	52.06	56
64	11 Jul	3:53	44	56.20	125	3.83	56
65	11 Jul	4:35	44	56.20	125	15.64	56
66	16 Jul	13:00	45	16.03	124	42.77	58
67	16 Jul	13:37	45	16.02	124	52.17	58
68	16 Jul	17:17	45	16.18	125	1.57	58
69	16 Jul	17:52	45	16.18	125	11.00	58
70	17 Jul	15:20	45	36.19	124	45.47	60
71	17 Jul	18:28	45	36.19	124	54.92	60
72	17 Jul	19:00	45	36.20	125	4.63	60
73	17 Jul	19:37	45	36.17	125	14.05	60
74	18 Jul	15:17	45	56.21	124	46.12	62
75	18 Jul	15:56	45	56.16	124	58.02	62
76	18 Jul	16:36	45	56.21	125	10.01	62
77	19 Jul	1:45	46	16.20	124	37.85	64
78	19 Jul	2:27	46	16.15	124	49.86	64
79	19 Jul	3:11	46	16.19	125	2.03	64
80	19 Jul	20:07	46	36.19	124	39.12	66
81	19 Jul	20:43	46	36.16	124	48.77	66

Table 8 continued. Summary of expendable bathythermograph (XBT) casts conducted successfully during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

XBT Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
82	20 Jul	0:12	46	36.20	124	59.30	66
83	20 Jul	0:43	46	36.20	125	8.17	66
84	20 Jul	21:56	46	56.17	124	59.91	68
85	20 Jul	22:22	46	56.20	125	7.51	68
86	20 Jul	22:25	46	56.19	125	8.46	68
87	20 Jul	22:48	46	56.18	125	15.06	68
88	21 Jul	16:53	47	16.23	124	54.71	70
89	21 Jul	17:30	47	16.22	125	5.91	70
90	21 Jul	20:30	47	16.19	125	17.01	70
91	23 Jul	14:31	47	36.20	125	7.96	72
92	23 Jul	15:10	47	36.21	125	18.42	72
93	23 Jul	15:52	47	36.17	125	29.11	72
94	23 Jul	16:31	47	36.22	125	39.96	72
95	23 Jul	17:06	47	36.17	125	50.05	72
96	24 Jul	19:09	47	56.17	125	40.01	74
97	24 Jul	19:49	47	56.20	125	52.00	74
98	1 Aug	1:12	48	16.20	125	40.62	76
99	1 Aug	1:46	48	16.19	125	49.91	76
100	1 Aug	2:19	48	16.20	125	58.92	76
101	1 Aug	3:02	48	16.20	126	10.87	76
102	1 Aug	3:45	48	16.19	126	23.08	76
103	2 Aug	14:30	48	36.20	125	15.41	78
104	2 Aug	15:56	48	36.18	125	40.82	78
105	2 Aug	21:55	48	36.18	126	12.58	78
106	2 Aug	22:37	48	36.49	126	24.66	78
107	2 Aug	23:19	48	36.17	126	36.87	78
108	3 Aug	0:01	48	36.27	126	49.09	78
109	4 Aug	1:18	48	56.19	125	48.93	80
110	4 Aug	2:46	48	56.17	126	11.76	80
111	4 Aug	16:32	48	56.19	126	44.51	80
112	4 Aug	17:07	48	56.20	126	53.81	80
113	4 Aug	17:46	48	56.22	127	3.05	80
114	5 Aug	3:26	49	16.17	126	43.74	82
115	5 Aug	14:33	49	16.21	127	17.43	82
116	5 Aug	15:04	49	16.18	127	26.07	82
117	6 Aug	0:43	49	36.19	127	23.09	84
118	6 Aug	3:33	49	36.19	127	33.06	84
119	6 Aug	3:36	49	36.17	127	33.70	84
120	6 Aug	13:33	49	36.21	127	43.04	84

Table 8 continued. Summary of expendable bathythermograph (XBT) casts conducted successfully during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

XBT Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Transect
121	6 Aug	14:14	49	36.19	127	53.02	84
122	6 Aug	20:22	49	56.20	127	51.75	86
123	6 Aug	20:44	49	56.18	127	57.93	86
124	6 Aug	21:40	49	56.20	128	14.02	86
125	7 Aug	4:37	50	26.20	128	39.03	89
126	7 Aug	17:12	50	46.17	128	49.11	91
127	7 Aug	17:52	50	46.18	129	1.23	91
128	7 Aug	18:29	50	46.19	129	13.11	91
129	7 Aug	19:06	50	46.22	129	25.04	91
130	7 Aug	21:44	51	6.22	129	58.95	93
131	7 Aug	22:21	51	6.20	129	46.99	93
132	7 Aug	22:57	51	6.21	129	34.96	93
133	8 Aug	1:47	51	6.17	129	22.24	93
134	8 Aug	2:21	51	6.18	129	10.92	93
135	8 Aug	2:57	51	6.21	128	58.97	93
136	8 Aug	19:14	51	6.16	127	48.94	93
137	8 Aug	19:32	51	6.18	127	43.13	93
138	9 Aug	15:00	51	26.22	130	31.96	95
139	9 Aug	15:39	51	26.18	130	18.95	95
140	9 Aug	16:15	51	26.18	130	6.92	95
141	9 Aug	16:34	51	26.18	130	0.37	95
142	9 Aug	20:06	51	26.19	129	6.95	95
143	9 Aug	20:44	51	26.22	128	54.96	95
144	9 Aug	21:21	51	26.18	128	42.94	95
145	9 Aug	21:58	51	26.15	128	30.88	95
146	10 Aug	0:06	51	26.19	128	18.08	95
147	10 Aug	0:38	51	26.20	128	7.37	95
148	10 Aug	22:09	51	46.19	130	56.85	97
149	10 Aug	22:44	51	46.17	130	44.92	97
150	10 Aug	23:21	51	46.17	130	32.95	97
151	12 Aug	13:24	52	6.19	130	53.95	99
152	12 Aug	14:53	52	6.20	130	41.97	99
153	12 Aug	15:31	52	6.23	130	29.96	99
154	12 Aug	17:57	52	6.16	129	41.88	99
155	12 Aug	18:28	52	6.16	129	30.95	99
156	12 Aug	18:59	52	6.19	129	20.95	99
157	13 Aug	0:57	52	26.18	130	38.95	101
158	13 Aug	1:34	52	26.18	130	27.01	101

Table 9. Estimated biomass (metric tons) of Pacific hake by age for each INPFC area and Canada for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

	Geographic Area					
Age class	Monterey	Eureka	South Columbia	Vancouver-North Columbia	Canada	Total
0	0.4	2.61	2.82	5.18	1.8	12.9
1	332.9	1,165.7	154.6	235.0	75.9	1,964.1
2	101,065.7	41,645.3	25,348.0	947.1	378.0	169,383.9
3	4,460.5	4,869.3	4,138.0	4,498.5	1,984.3	19,950.6
4	12,070.4	21,747.7	21,459.5	30,083.2	17,280.8	102,641.5
5	948.6	2,486.4	2,646.4	4,018.9	2,713.3	12,813.6
6	2,892.9	8,641.9	9,550.0	15,078.8	14,421.0	50,584.7
7	2,134.4	5,311.9	5,912.5	9,381.9	11,291.4	34,032.1
8	21,537.8	59,182.9	65,621.4	103,891.6	128,175.3	378,409.0
9	3,270.7	5,945.2	6,608.6	10,506.9	15,655.3	41,986.7
10	1,808.4	2,488.2	2,713.2	4,263.2	9,602.2	20,875.3
11	1,048.3	2,507.2	2,777.2	4,390.9	8,209.4	18,933.0
12	1,646.4	1,305.5	1,441.5	2,290.0	5,019.8	11,703.2
13	1,104.1	1,062.4	1,140.3	1,722.3	5,230.2	10,259.3
14	244.1	506.0	554.6	875.5	1,932.6	4,112.7
15	58.0	92.3	98.6	155.3	516.2	920.3
16	14.5	35.4	39.6	63.4	155.0	307.8
17	39.2	62.0	65.2	102.4	350.6	619.4
Total	154,677.1	159,058.0	150,271.9	192,509.9	222,993.0	879,509.9

Table 10. Estimated numbers of Pacific hake by age for each INPFC area and Canada for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

	Geographic Area					
Age class	Monterey	Eureka	South Columbia	Vancouver-North Columbia	Canada	Total
0	228,191	1,220,401	1,430,230	2,364,687	909,021	6,152,529
1	4,693,998	21,902,446	3,591,072	6,129,285	1,957,865	38,274,665
2	543,584,549	186,819,229	113,730,285	3,552,147	1,412,877	849,099,087
3	12,129,323	12,357,642	9,990,851	9,644,878	4,212,706	48,335,399
4	27,364,421	44,531,212	42,390,109	56,516,653	31,234,689	202,037,085
5	1,877,616	4,549,719	4,750,569	7,060,733	4,619,765	22,858,402
6	4,877,250	14,250,452	15,719,164	24,764,280	22,140,479	81,751,624
7	3,030,760	8,373,450	9,304,354	14,743,680	16,200,004	51,652,246
8	32,191,983	93,009,159	103,127,144	163,243,672	183,439,273	575,011,232
9	3,946,333	9,009,978	10,022,469	15,922,040	21,052,146	59,952,965
10	1,863,784	3,449,704	3,790,308	5,981,690	11,632,049	26,717,534
11	1,401,928	3,594,890	3,993,452	6,328,574	10,845,561	26,164,404
12	1,343,435	1,754,568	1,939,016	3,080,897	6,136,651	14,254,566
13	1,122,898	1,354,521	1,472,314	2,268,914	5,854,409	12,073,057
14	313,468	702,968	773,243	1,223,011	2,495,087	5,507,777
15	69,872	113,723	121,963	192,284	627,075	1,124,917
16	18,974	46,311	51,806	82,962	202,975	403,026
17	46,479	76,012	80,331	126,503	420,868	750,193
Total	640,105,263	407,116,384	326,278,678	323,226,887	325,393,497	2,022,120,708

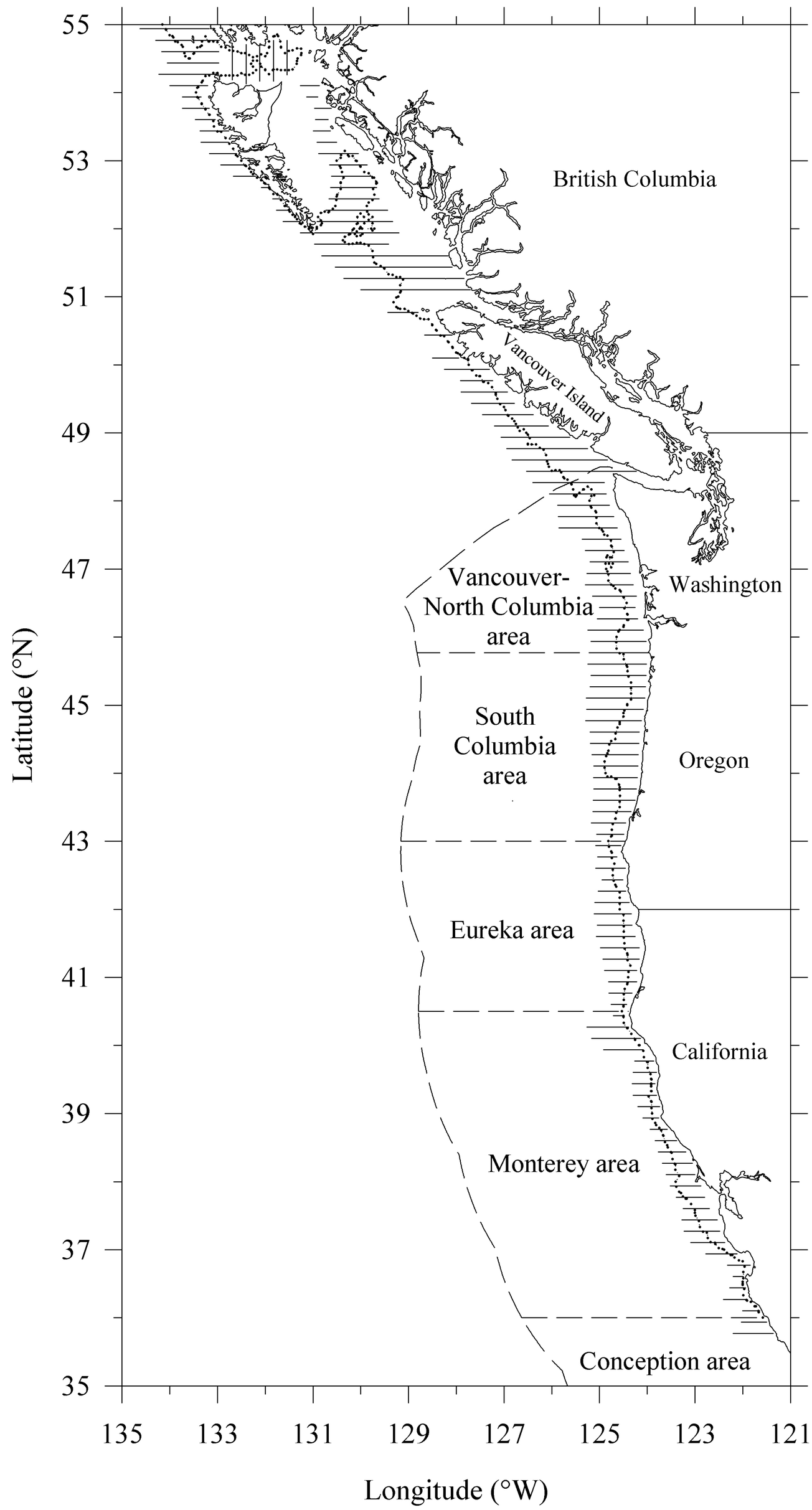

Figure 1. Survey track design used during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. International North Pacific Fisheries Commission (INPFC) statistical areas as defined by Dorn (1996) are outlined for reference. 200-m depth contour is designated by a dotted line.

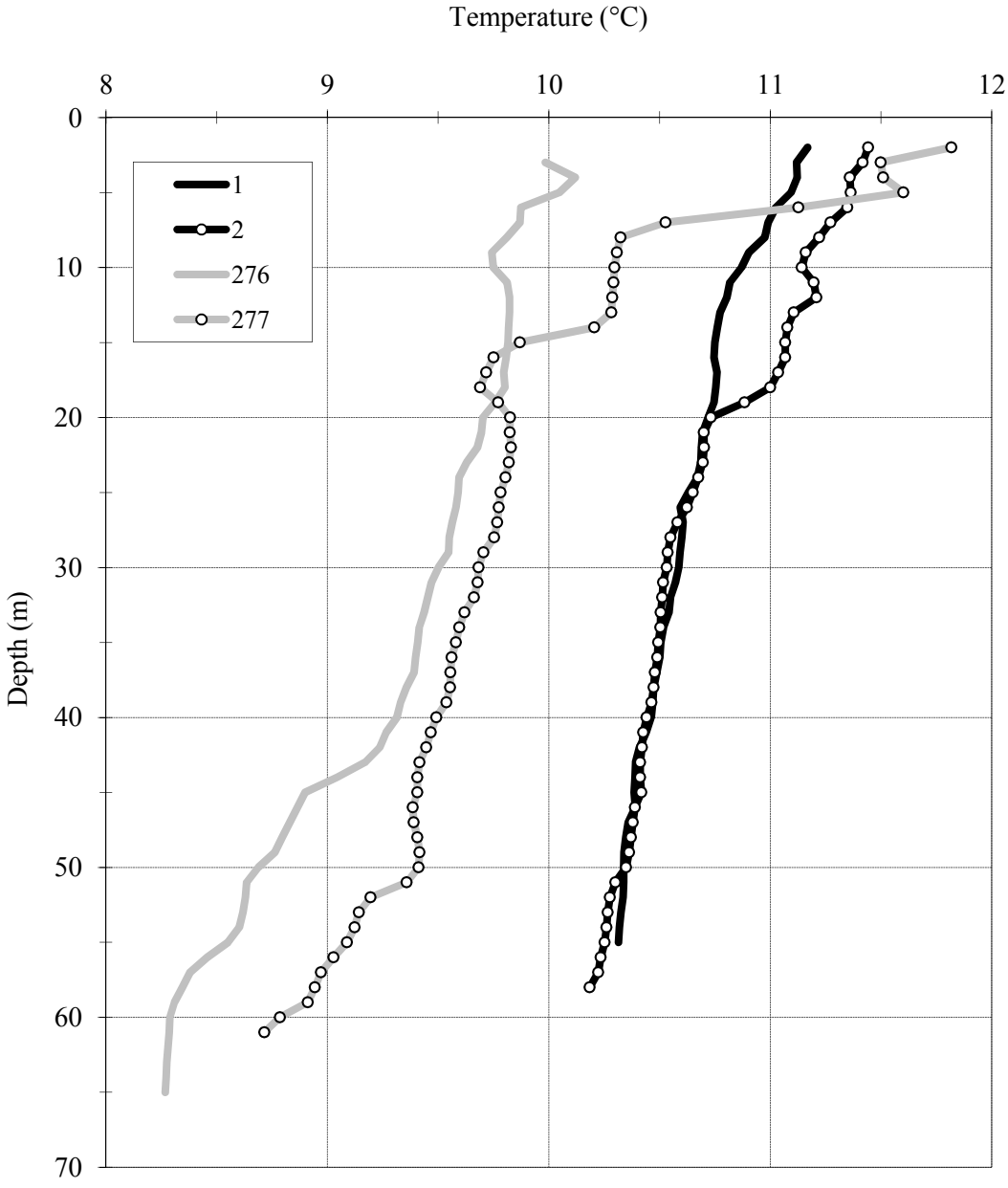

Figure 2. Vertical temperature profiles taken by a conductivity-temperature-depth (CTD) profiler during calibrations of the acoustic system conducted in Elliott Bay, Washington (casts 1 and 2, 16 June) and Port Hardy, British Columbia (casts 276 and 277, 22 August) as part of the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

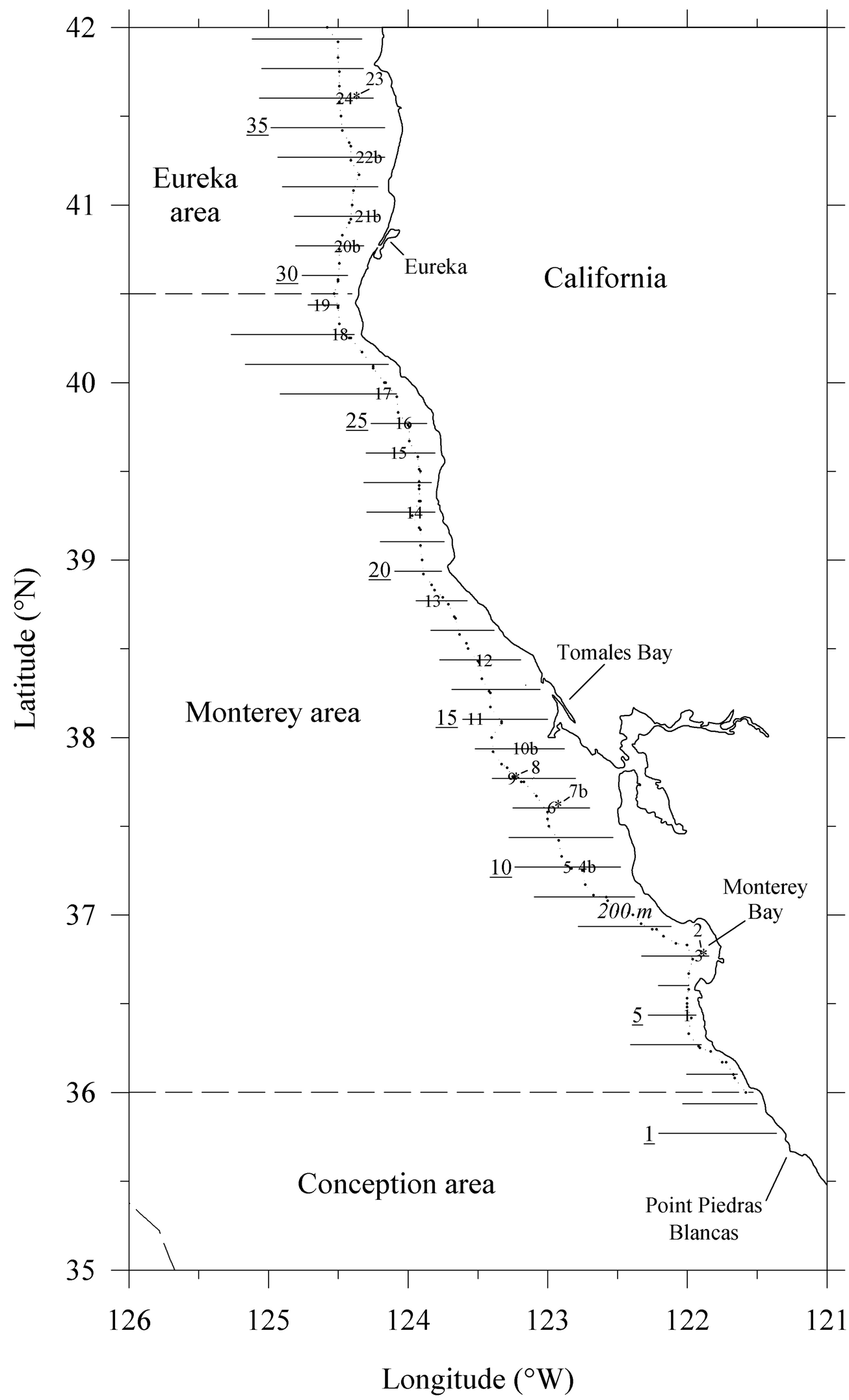

Figure 3. Details of southern acoustic transect lines and locations and haul sequence of midwater and bottom trawls (latter denoted with "b" suffix) during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Underscored numbers indicate transect sequence.

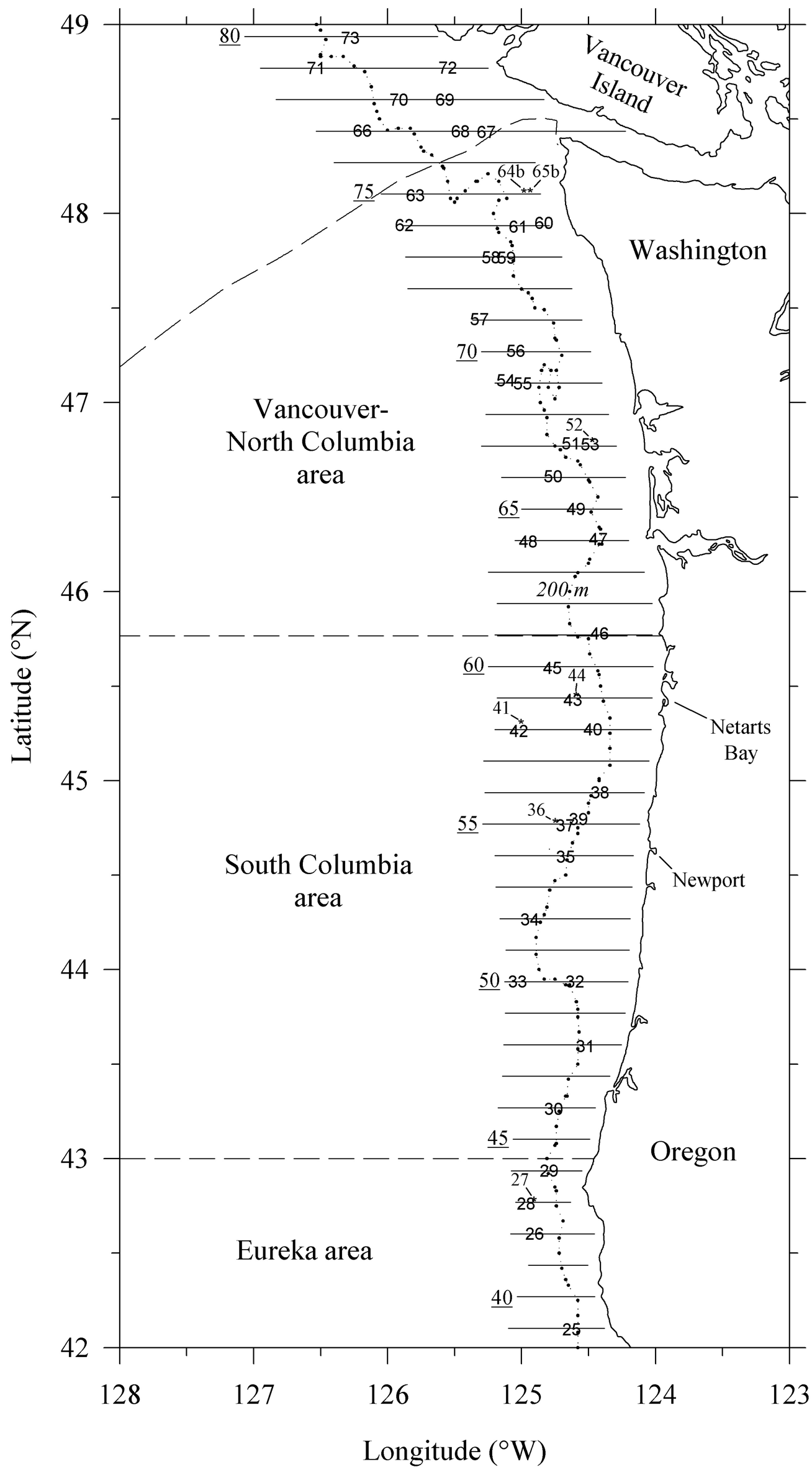

Figure 4. Details of central acoustic transect lines and locations and haul sequence of midwater and bottom trawls (latter denoted with "b" suffix) during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Underscored numbers indicate transect sequence.

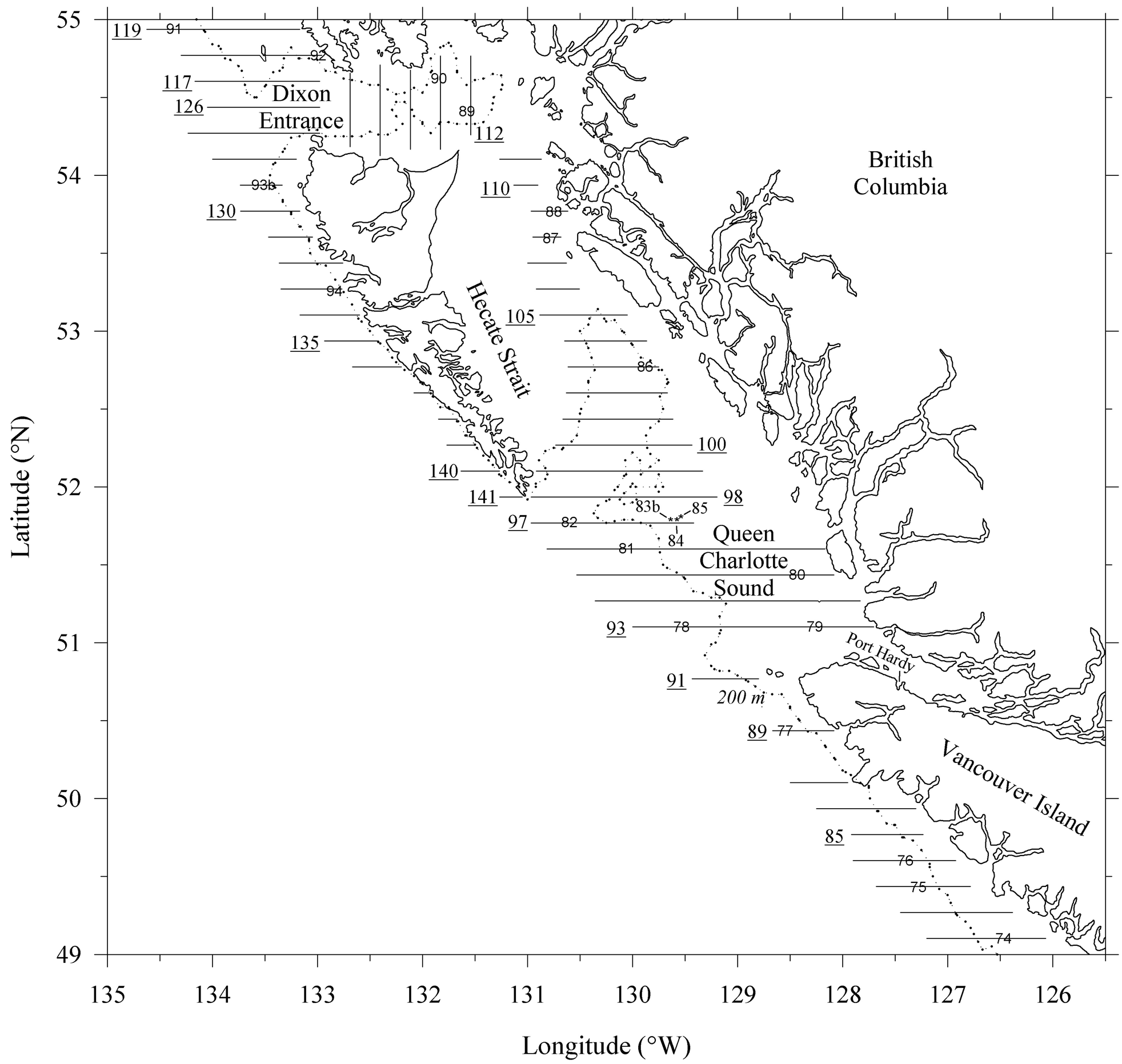

Figure 5. Details of northern acoustic transect lines and locations and haul sequence of midwater and bottom trawls (latter denoted with "b" suffix) during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Underscored numbers indicate transect sequence.

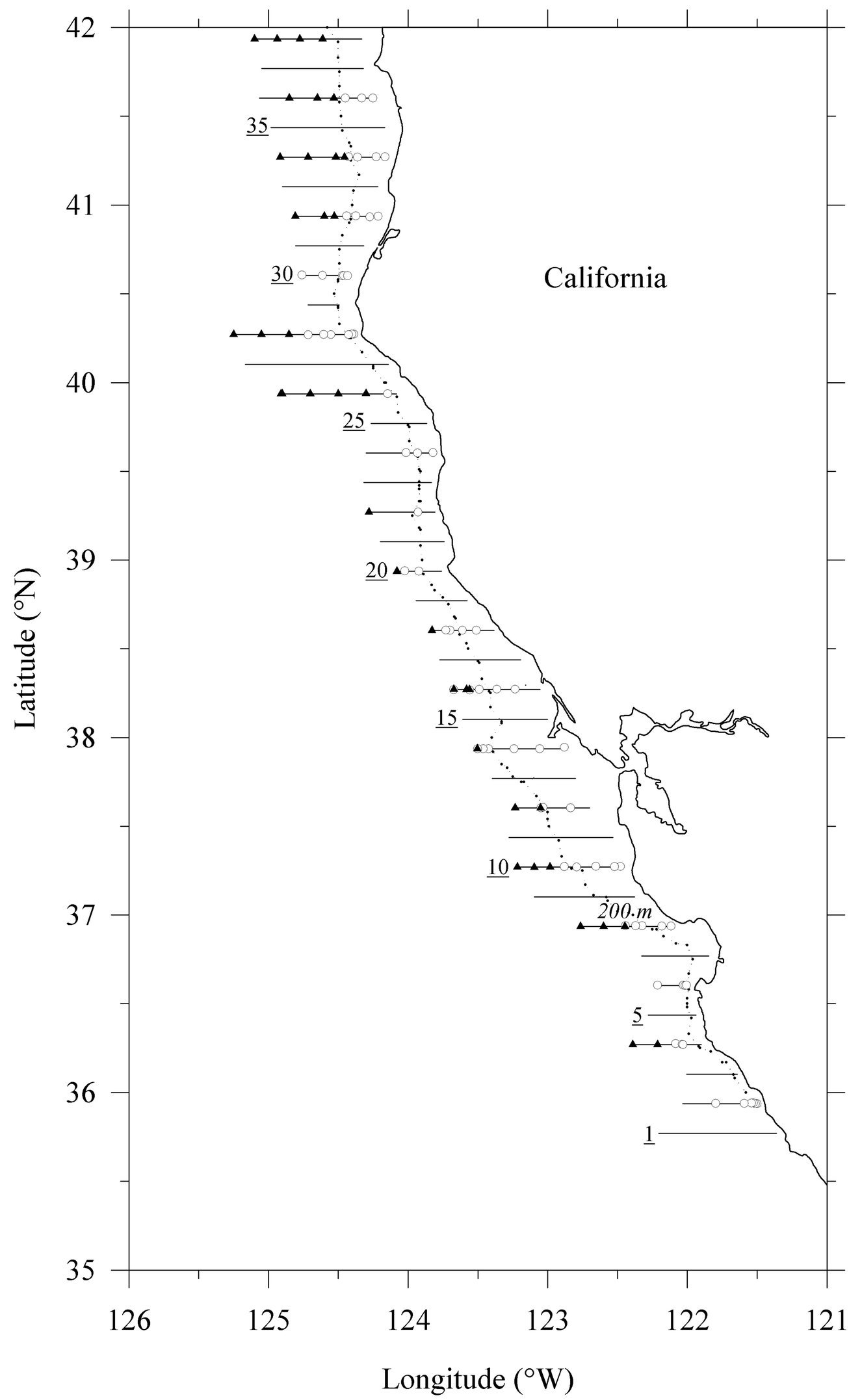

Figure 6. Details of southern acoustic transect lines with locations of expendable bathythermograph (▲) and conductivity-temperature-depth (o) profile measurements taken during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Underscored numbers indicate transect sequence.

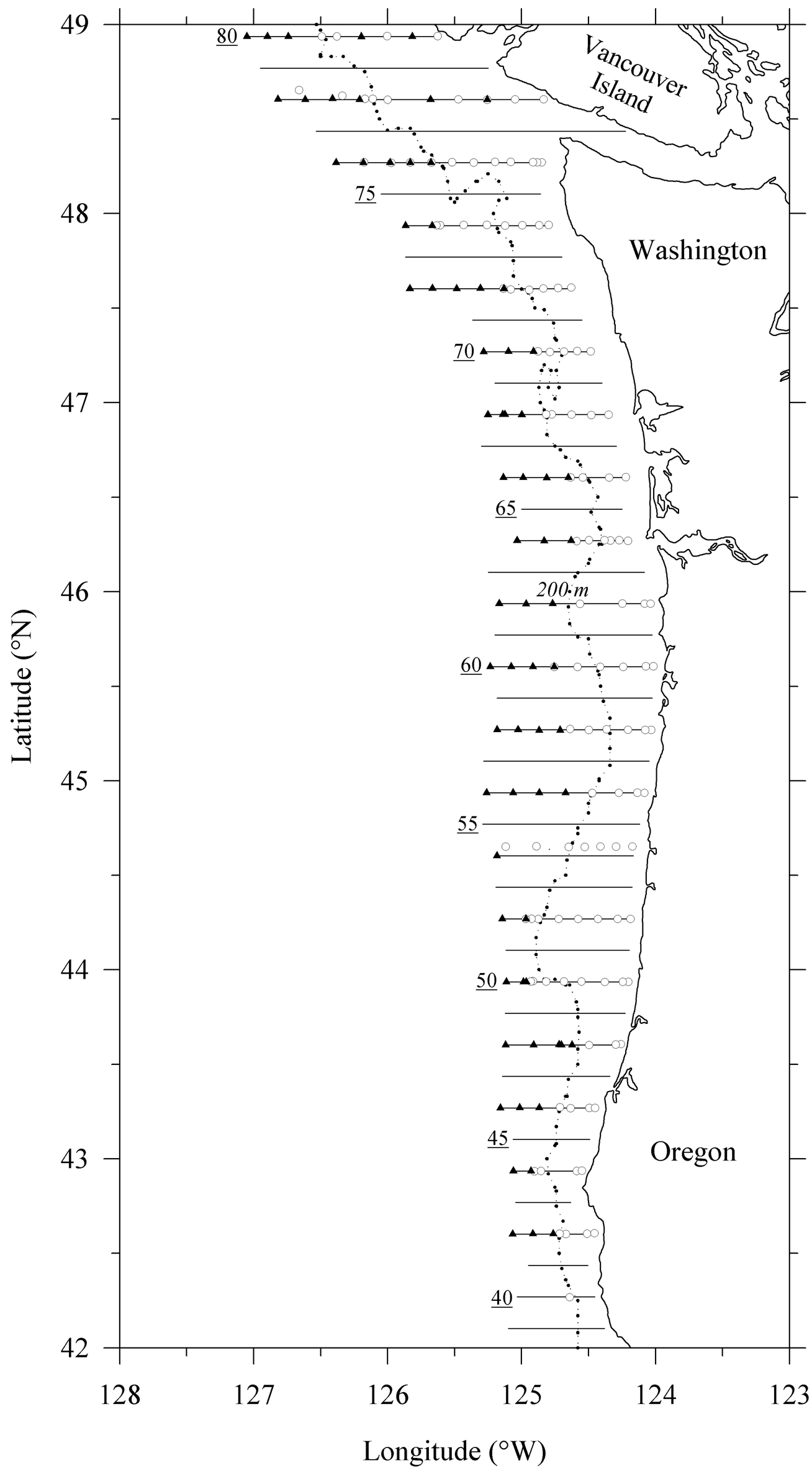

Figure 7. Details of central acoustic transect lines with locations of expendable bathythermograph (▲) and conductivity-temperature-depth (o) profile measurements taken during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Underscored numbers indicate transect sequence.

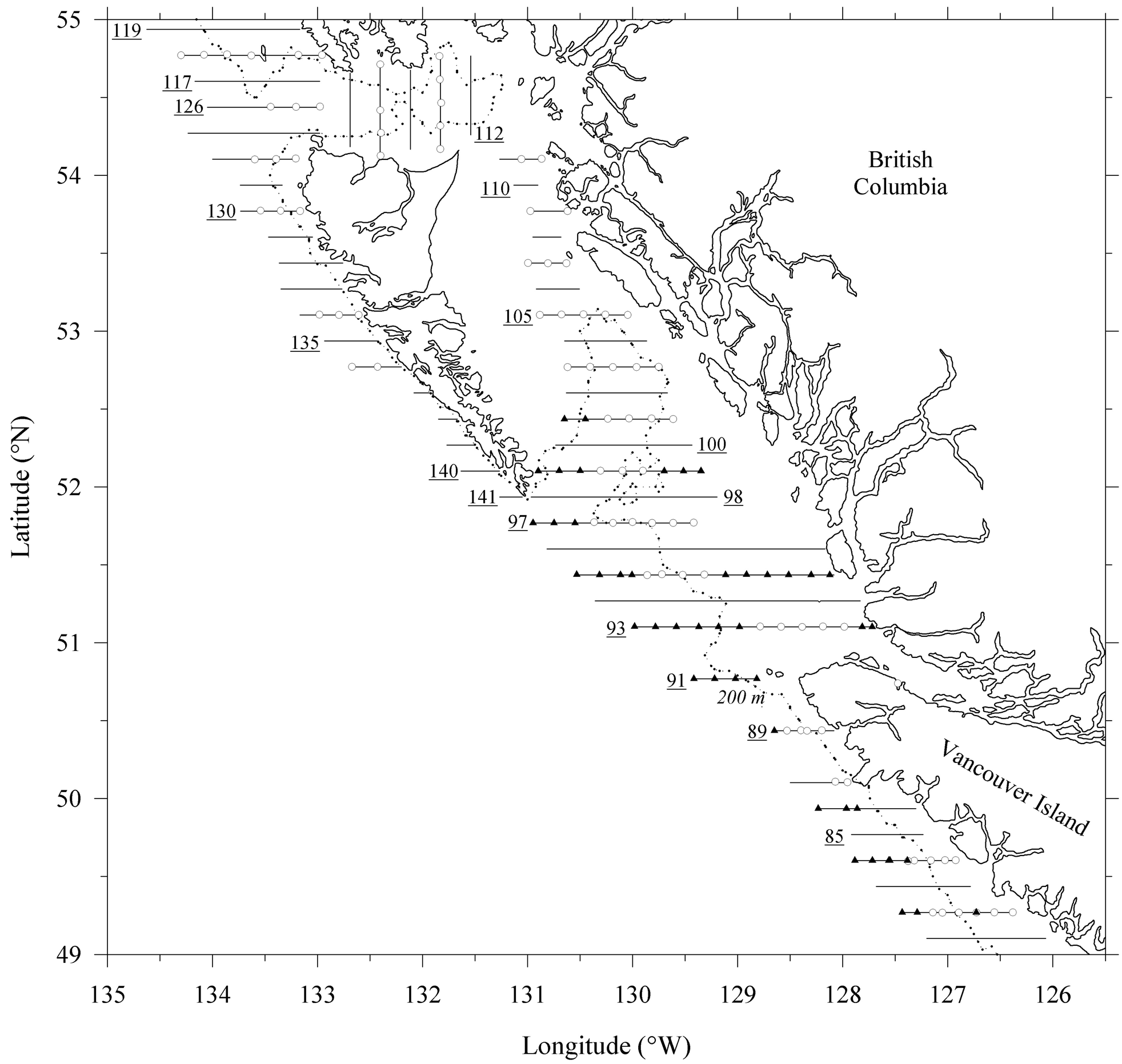

Figure 8. Details of northern acoustic transect lines with locations of expendable bathythermograph (▲) and conductivity-temperature-depth (o) profile measurements taken during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Underscored numbers indicate transect sequence.

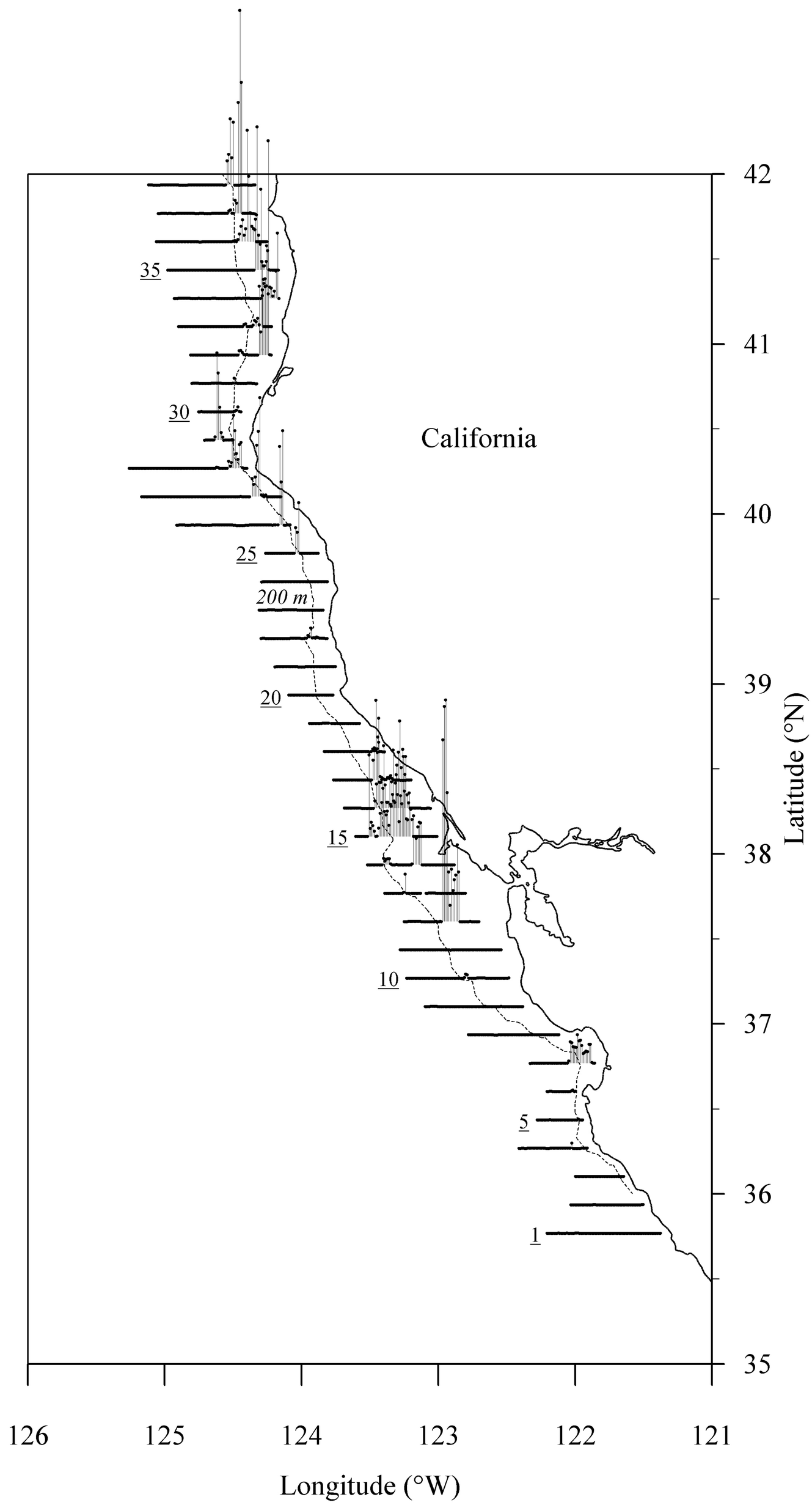

Figure 9. Acoustic area backscattering (s_A) attributed to Pacific hake along southern transects completed during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Height of lines is proportional to measured values of backscatter. Underscored numbers indicate transect sequence.

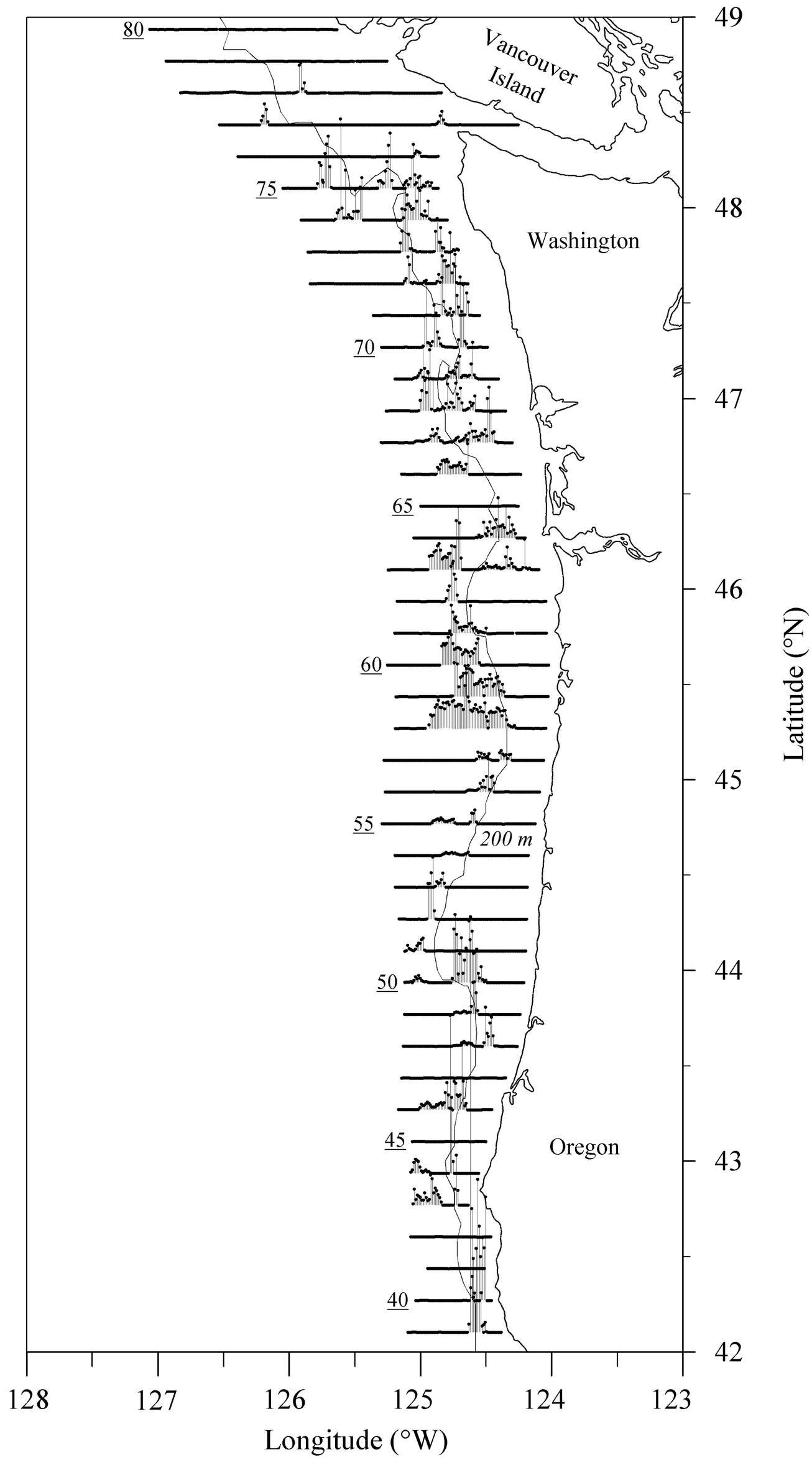

Figure 10. Acoustic area backscattering (s_A) attributed to Pacific hake along central transects completed during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Height of lines is proportional to measured values of backscatter. Underscored numbers indicate transect sequence.

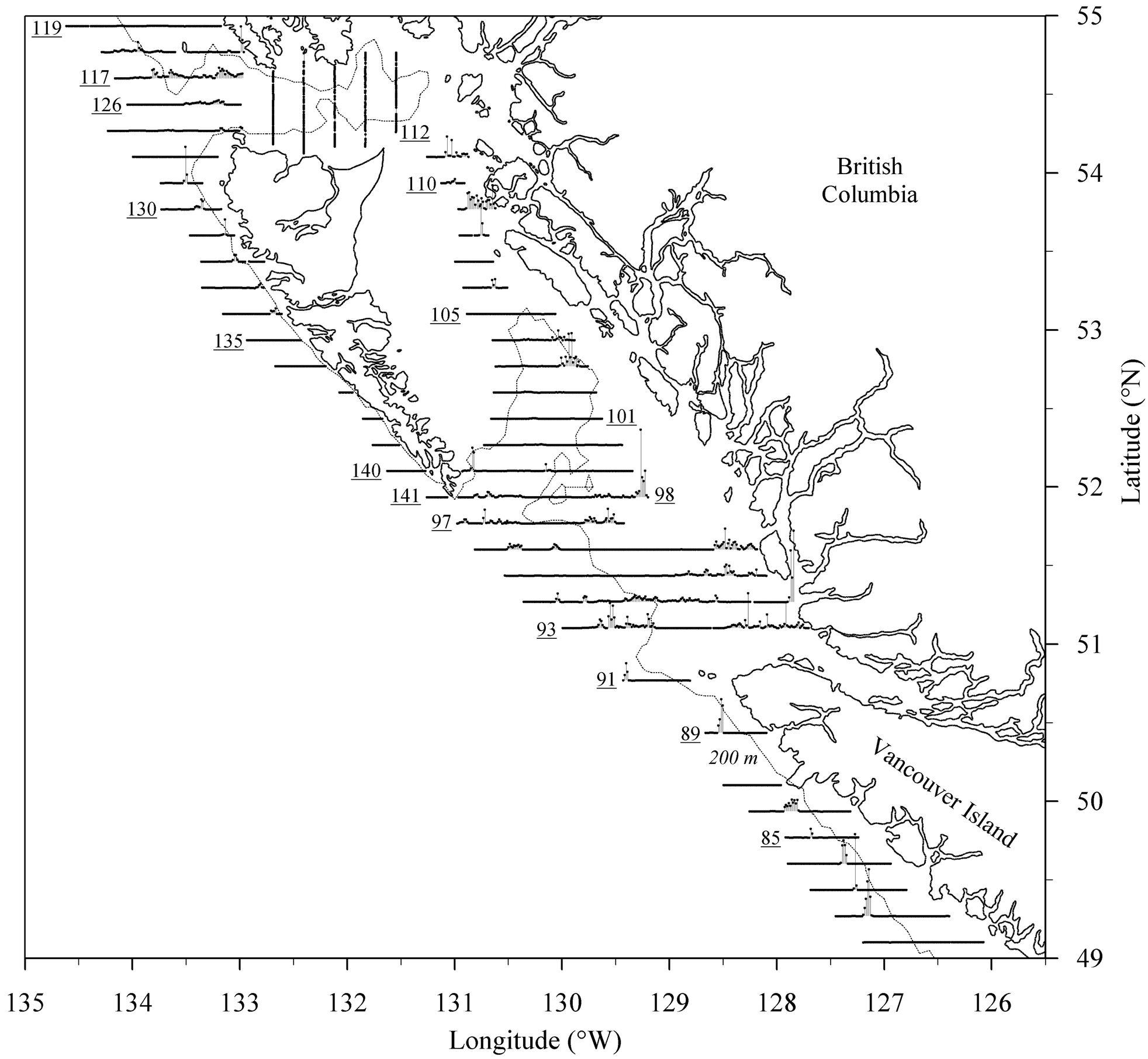

Figure 11. Acoustic area backscattering (s_A) attributed to Pacific hake along northern transects completed during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Height of lines is proportional to measured values of backscatter. Underscored numbers indicate transect sequence.

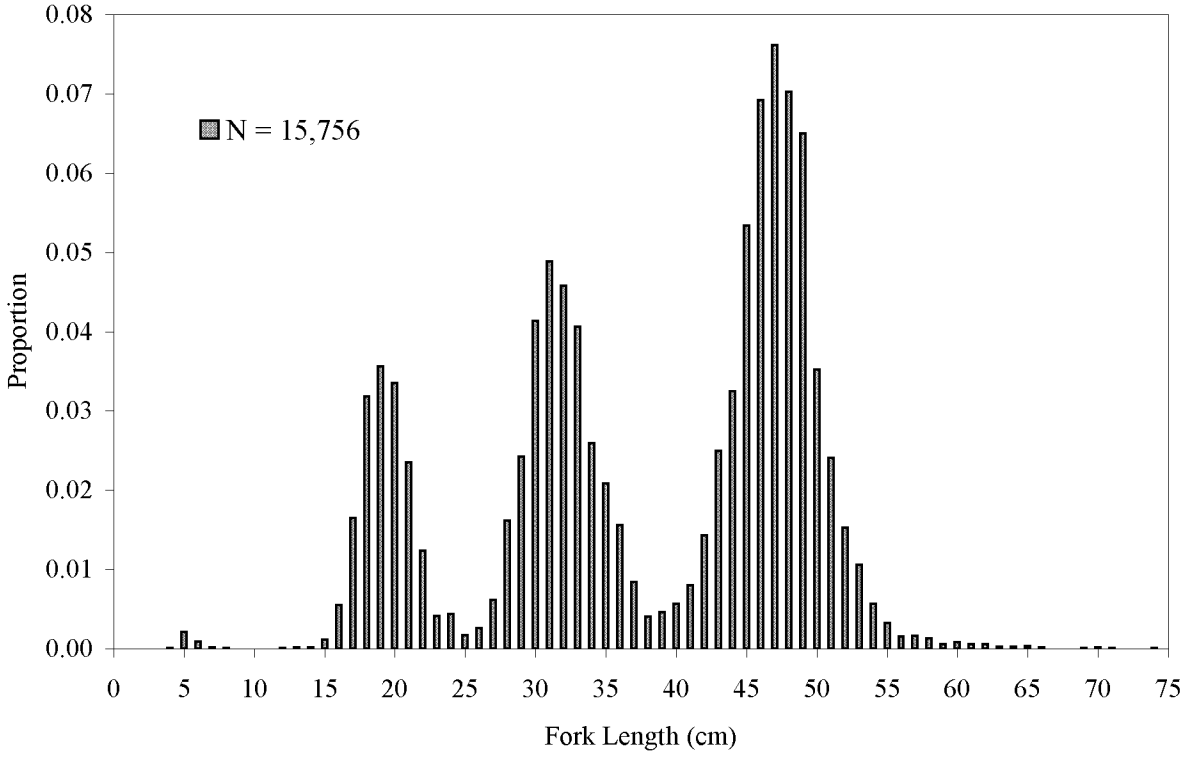

Figure 12. Coast-wide length-frequency distribution of Pacific hake from specimens collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

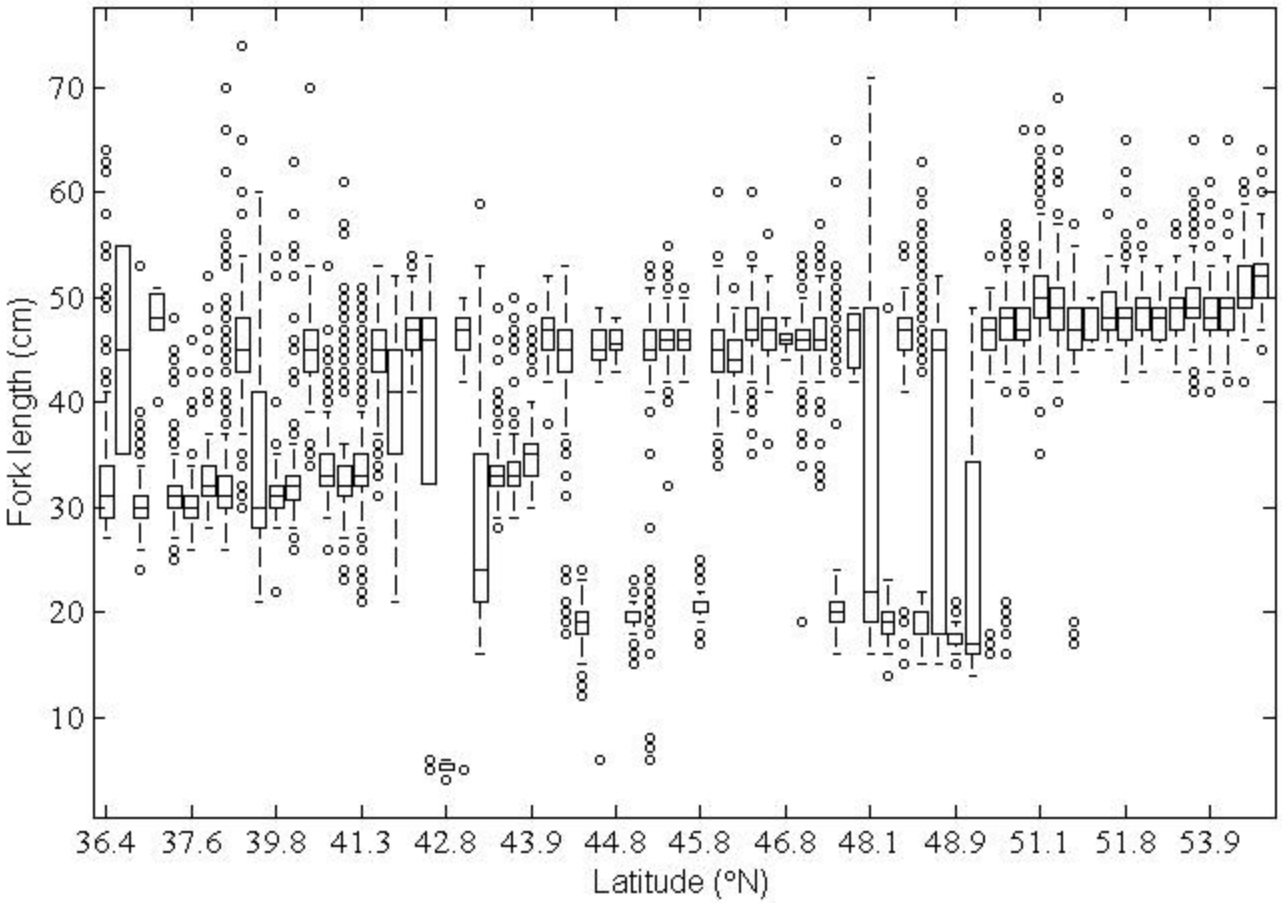

Figure 13. Box-and-whisker plot of the length frequency distributions of Pacific hake for trawl tows conducted as part of the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. The central box indicates the range of fish lengths in the upper and lower quartiles, with the median represented by the horizontal line in the box. The whiskers extend to 1.5 times the interquartile range, or approximately the 1 and 99 percentiles, and outliers are shown as open circles for each haul.

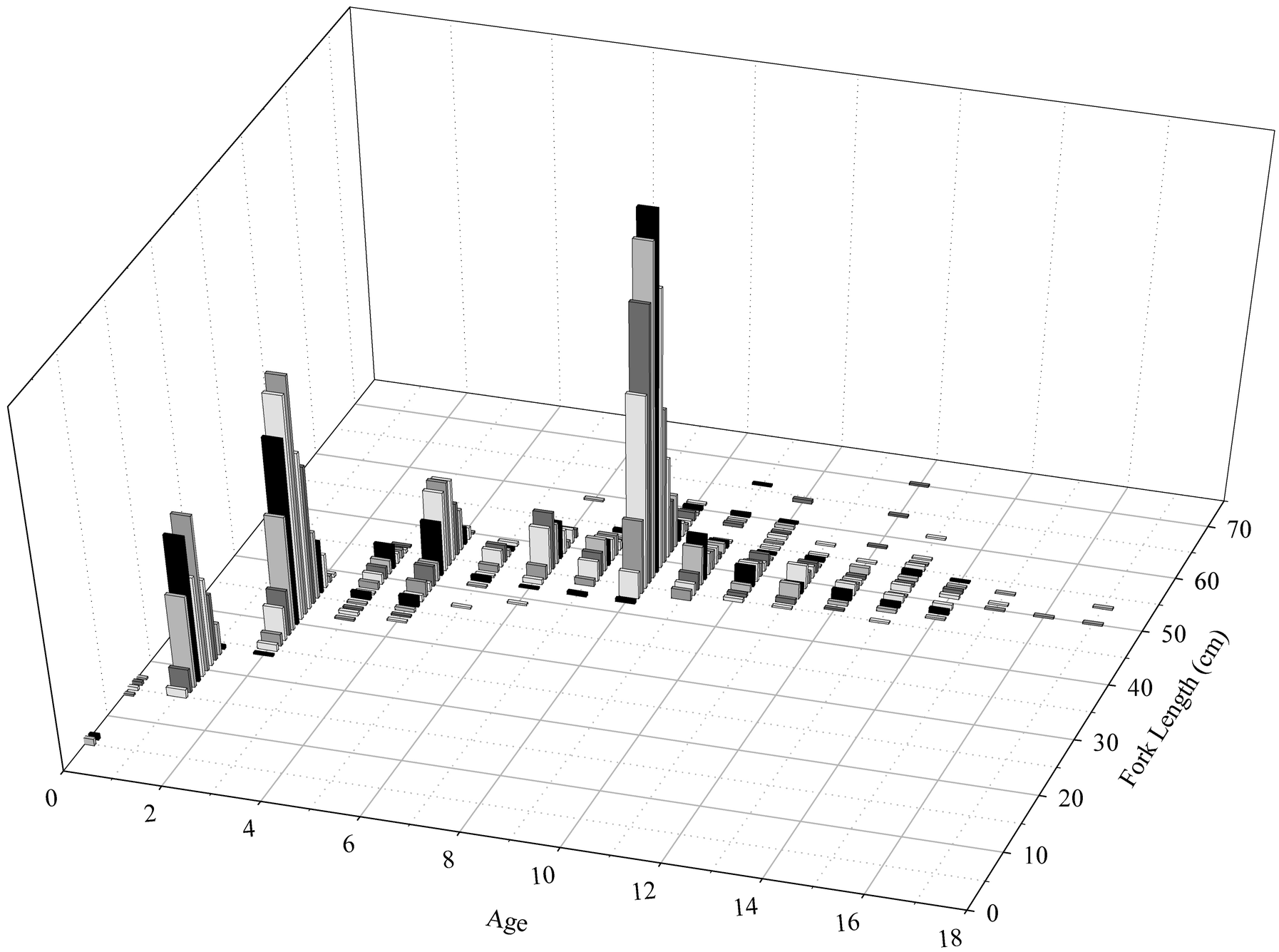

Figure 14. Age-length distributions of Pacific hake from specimens collected during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast. Ages are based on interpretation of otoliths.

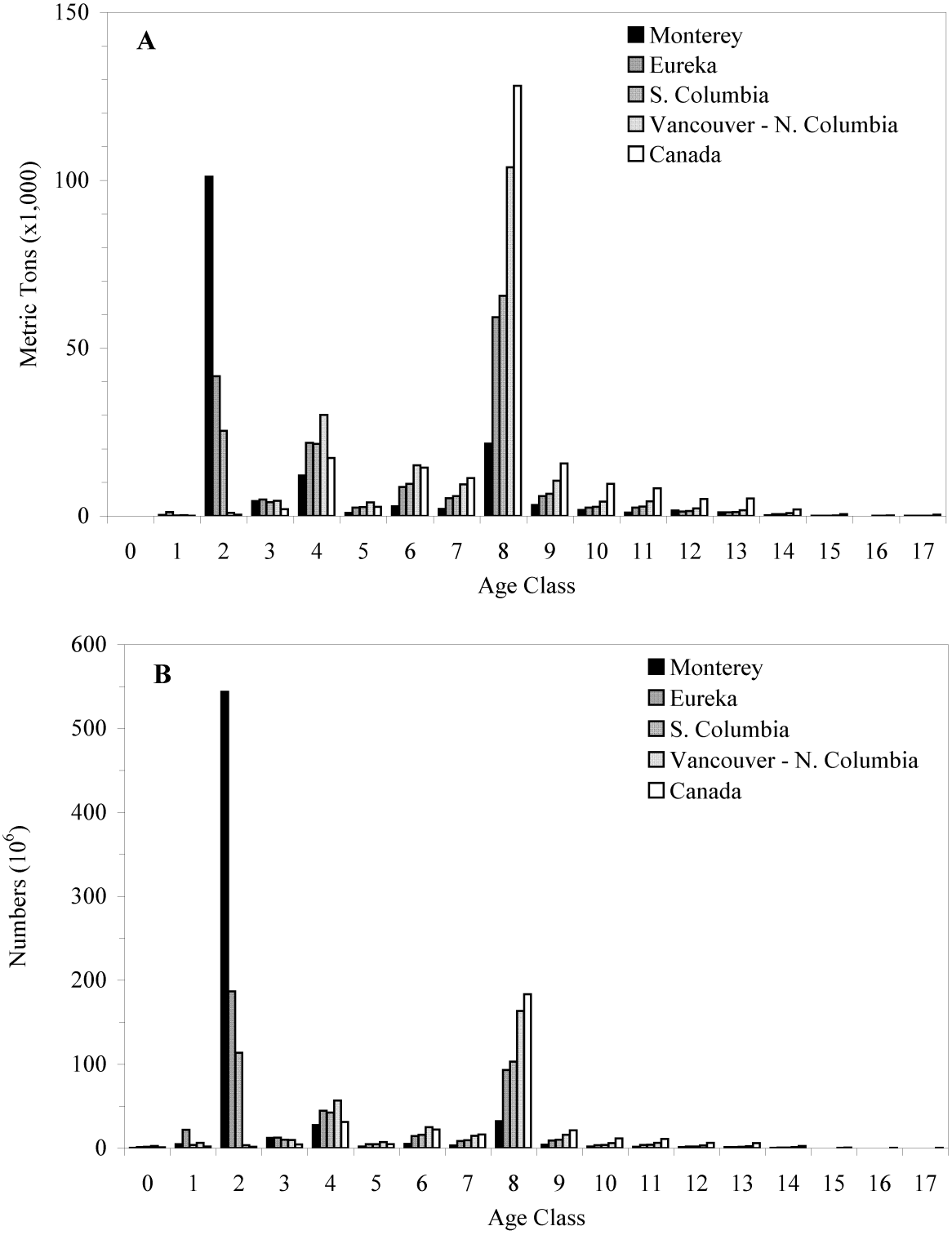

Figure 15. Estimated biomass (metric tons) and numbers (10^6) of Pacific hake by age class comparing INPFC areas and Canada for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

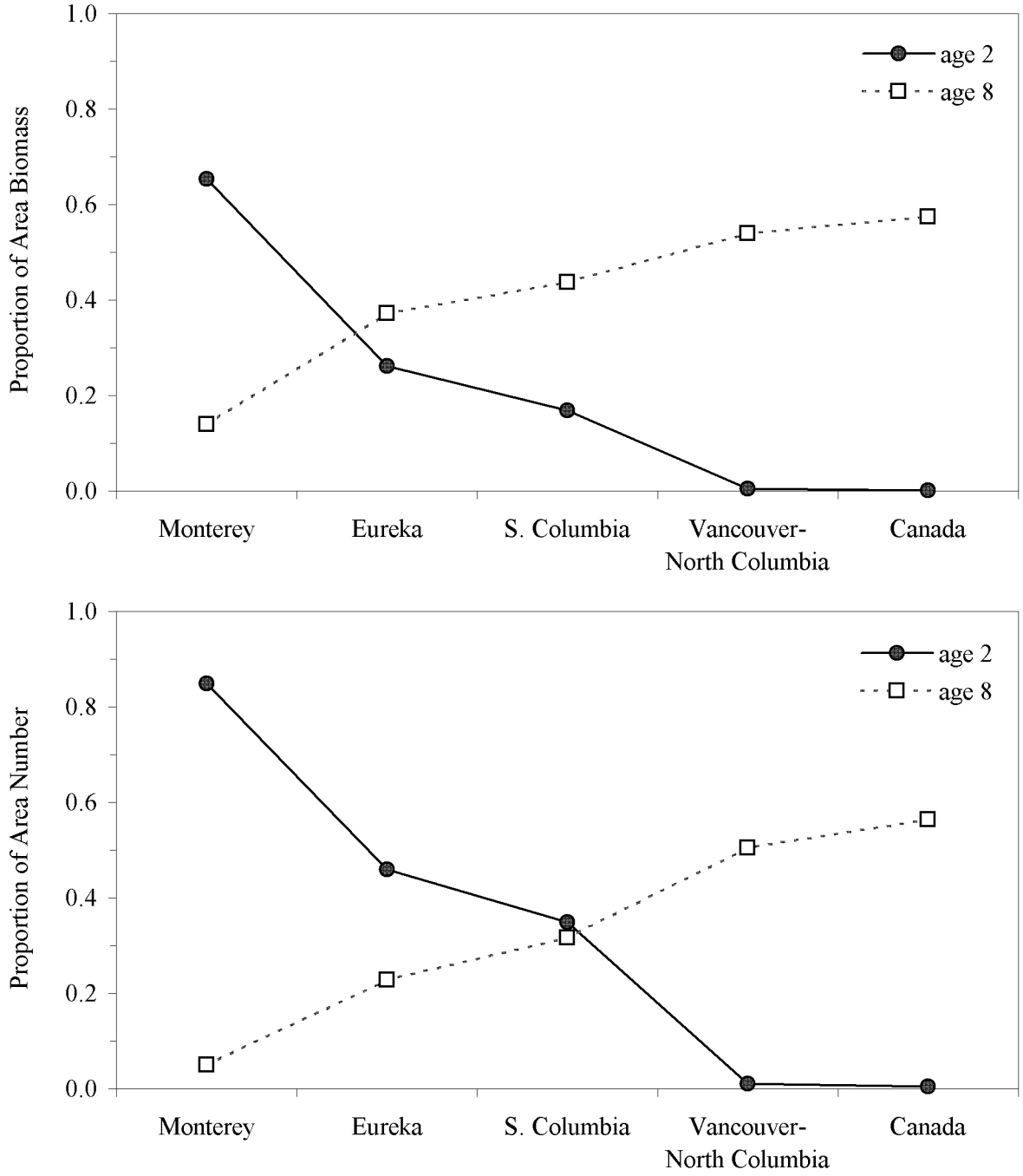

Figure 16. Proportion of total Pacific hake biomass and number for each INPFC area and Canada that was composed of age-2 or age-8 fish during the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

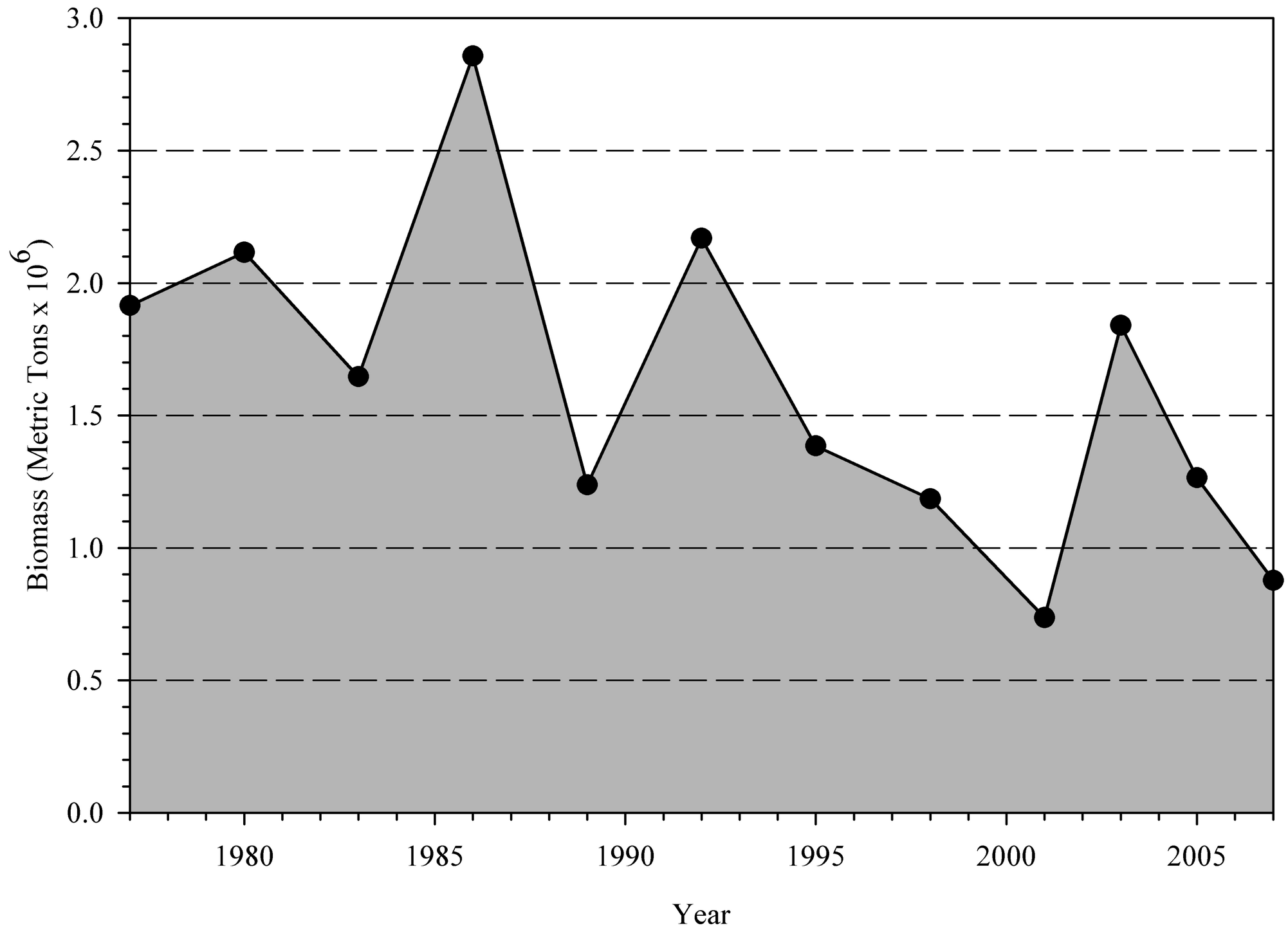

Figure 17. Biomass estimates (millions of metric tons) of Pacific hake, 1977-2007. Estimates for 1977-1989 are adjusted as described in Dorn (1996) and updated in Helser et al. (2004) to account for changes in target strength model, depth, and geographic coverage. Biomass estimates since 1992 are based on a target strength relation of 20 log L-68 used by Wilson and Guttormsen (1997). For consistency, biomass shown is for fish age 2 and older across time series.

Appendix A

Table A-1. Individual transect coordinates (decimal degrees), length, corresponding area, and estimated Pacific hake population numbers (N) and biomass (B) in metric tons for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Transect	Start latitude	Start longitude	End latitude	End longitude	Length (nmi)	Area (nmi^2)	N	B (mt)
1	35.7698	122.2050	35.7698	121.3617	41.1	410.6	0	0.00
2	35.9365	121.5000	35.9365	122.0333	25.9	259.1	0	0.00
3	36.1032	122.0050	36.1032	121.6417	17.6	176.1	0	0.00
4	36.2698	121.9000	36.2698	122.4083	24.6	245.9	744,171	158.92
5	36.4365	122.2800	36.4365	121.9383	16.5	164.9	92,998	19.86
6	36.6032	121.9900	36.6032	122.2083	10.5	105.2	292,906	62.55
7	36.7698	122.3267	36.7698	121.8450	23.2	231.5	39,373,502	8,408.39
8	36.9365	122.1167	36.9365	122.7817	31.9	318.9	0	0.00
9	37.1032	123.0967	37.1032	122.3767	34.5	344.5	0	0.00
10	37.2698	122.4783	37.2698	123.2350	36.1	361.3	1,142,067	243.89
11	37.4365	123.2767	37.4365	122.5333	35.4	354.1	0	0.00
12	37.6032	122.7000	37.6032	123.2500	26.1	261.4	164,734,056	35,179.72
13	37.7698	123.3967	37.7698	122.8000	28.3	283.0	1,417,175	846.55
14	37.9365	122.8800	37.9365	123.5200	30.3	302.9	37,948,982	8,104.18
15	38.1032	123.6083	38.1032	123.0000	28.7	287.2	119,093,633	35,138.58
16	38.2698	123.0550	38.2698	123.6883	29.8	298.3	101,489,492	24,520.90
17	38.4365	123.7733	38.4365	123.1917	27.3	273.4	26,822,325	7,534.87
18	38.6032	123.3833	38.6032	123.8383	21.3	213.3	5,194,647	1,459.27
19	38.7698	123.9450	38.7698	123.5767	17.2	172.3	0	0.00
20	38.9365	123.7617	38.9365	124.0967	15.6	156.3	0	0.00
21	39.1032	124.2000	39.1032	123.7417	21.3	213.4	0	0.00
22	39.2698	123.8067	39.2698	124.2967	22.8	227.6	2,634,731	562.66
23	39.4365	124.3167	39.4365	123.8333	22.4	224.0	0	0.00
24	39.6032	123.8083	39.6032	124.3000	22.7	227.3	0	0.00
25	39.7698	124.2667	39.7698	123.8667	18.4	184.5	14,449,316	3,085.72
26	39.9365	124.0833	39.9365	124.9167	38.3	383.4	31,916,906	6,816.00
27	40.1032	125.1667	40.1032	124.1417	47.0	470.4	39,723,768	8,565.62
28	40.2698	124.3867	40.2698	125.2667	40.3	402.9	27,436,155	7,207.68
29	40.4365	124.7167	40.4365	124.4950	10.1	101.2	25,598,431	6,761.72
30	40.6032	124.4333	40.6032	124.7583	14.8	148.1	858,497	218.18
31	40.7698	124.8067	40.7698	124.3167	22.3	222.7	801,005	203.57
32	40.9365	124.2167	40.9365	124.8167	27.2	272.0	80,908,884	20,868.29
33	41.1032	124.9000	41.1032	124.2167	30.9	308.9	31,141,973	8,032.74

Table A-1 continued. Individual transect coordinates, length, corresponding area, and estimated Pacific hake population numbers and biomass in metric tons for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Transect	Start latitude	Start longitude	End latitude	End longitude	Length (nmi)	Area (nmi^2)	*N*	*B* (mt)
34	41.2698	124.1667	41.2698	124.9333	34.6	345.7	23,282,653	5,917.01
35	41.4365	124.9833	41.4365	124.1667	36.7	367.3	39,142,056	9,947.50
36	41.6032	124.2500	41.6032	125.0667	36.6	366.4	35,114,098	11,420.57
37	41.7698	125.0500	41.7698	124.3200	32.7	326.7	34,260,211	20,465.27
38	41.9365	124.3333	41.9365	125.1167	35.0	349.6	15,244,402	9,106.21
39	42.1032	125.1000	42.1032	124.3803	32.0	320.4	69,466,133	41,495.46
40	42.2698	124.4533	42.2698	125.0333	25.8	257.5	17,186,801	10,266.50
41	42.4365	124.9500	42.4365	124.5050	19.7	197.1	0	0.00
42	42.6032	124.4567	42.6032	125.0833	27.7	276.8	0	0.00
43	42.7698	125.0450	42.7698	124.6333	18.1	181.3	18,721,802	11,183.43
44	42.9365	124.5500	42.9365	125.0783	23.2	232.1	40,987,868	9,933.24
45	43.1032	125.0633	43.1032	124.4900	25.1	251.2	0	0.00
46	43.2698	124.4500	43.2698	125.1750	31.7	316.7	33,242,206	11,714.61
47	43.4365	125.1433	43.4365	124.3400	35.0	350.0	0	0.00
48	43.6032	124.2550	43.6032	125.1350	38.2	382.3	16,668,730	4,861.66
49	43.7698	125.1217	43.7698	124.2267	38.8	387.8	14,222,554	3,614.50
50	43.9365	124.2050	43.9365	125.1283	39.9	398.9	79,365,375	20,897.99
51	44.1032	125.1183	44.1032	124.1950	39.8	397.8	3,704,453	2,212.85
52	44.2698	124.1883	44.2698	125.1617	41.8	418.2	12,079,916	7,215.91
53	44.4365	125.1933	44.4365	124.1750	43.6	436.3	2,609,616	1,558.85
54	44.6032	124.1667	44.6032	125.2000	44.1	441.4	2,177,838	1,300.93
55	44.7698	125.2917	44.7698	124.1200	49.9	499.1	6,042,833	3,609.67
56	44.9365	124.0833	44.9365	125.2750	50.6	506.1	8,903,091	5,318.24
57	45.1032	125.2833	45.1032	124.0500	52.2	522.3	5,755,527	3,438.05
58	45.2698	124.0333	45.2698	125.2000	49.3	492.6	69,824,824	41,709.72
59	45.4365	125.1833	45.4365	124.0250	48.8	487.7	43,232,512	25,824.86
60	45.6032	124.0167	45.6032	125.2500	51.8	517.7	28,449,203	16,994.08
61	45.7698	125.2000	45.7698	124.0250	49.2	491.8	12,693,429	7,582.40
62	45.9365	124.0250	45.9365	125.1833	48.3	483.3	10,249,854	6,122.73
63	46.1032	125.2500	46.1032	124.0833	48.5	485.4	38,400,861	22,938.68
64	46.2698	124.2000	46.2698	125.0500	35.3	352.5	17,846,343	10,660.48
65	46.4365	125.0000	46.4365	124.2500	31.0	310.1	0	0.00
66	46.6032	124.2250	46.6032	125.1500	38.1	381.3	13,682,565	8,173.25
67	46.7698	125.3000	46.7698	124.2917	41.4	414.4	24,175,858	14,441.40
68	46.9365	124.3500	46.9365	125.2667	37.6	375.5	28,526,073	17,040.00
69	47.1032	125.2000	47.1032	124.4000	32.7	326.7	15,306,015	9,143.02

Table A-1 continued. Individual transect coordinates, length, corresponding area, and estimated Pacific hake population numbers and biomass in metric tons for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Transect	Start latitude	Start longitude	End latitude	End longitude	Length (nmi)	Area (nmi^2)	*N*	*B* (mt)
70	47.2698	124.4833	47.2698	125.3000	33.2	332.5	26,103,329	15,592.77
71	47.4365	125.3667	47.4365	124.5500	33.1	331.4	17,906,182	10,696.22
72	47.6032	124.6250	47.6032	125.8500	49.6	495.6	17,757,207	10,607.23
73	47.7698	125.8667	47.7698	124.7000	47.0	470.5	22,975,554	13,724.40
74	47.9365	124.7917	47.9365	125.8833	43.9	438.8	37,385,580	22,332.20
75	48.1032	126.0500	48.1032	124.8583	47.7	477.5	37,075,588	21,612.51
76	48.2698	124.8990	48.2698	126.4000	59.9	599.5	1,044,631	624.01
77	48.4365	126.5333	48.4365	124.2250	91.9	918.9	5,473,661	3,269.68
78	48.6032	124.8333	48.6032	126.8333	79.4	793.5	4,881,685	2,916.07
79	48.7698	126.9500	48.7698	125.2500	67.2	672.3	0	0.00
80	48.9365	125.6250	48.9365	127.0667	56.8	568.2	0	0.00
81	49.1032	127.2000	49.1032	126.0667	44.5	445.2	0	0.00
82	49.2698	126.3833	49.2698	127.4500	41.8	417.6	11,640,625	6,953.50
83	49.4365	127.6833	49.4365	126.7833	35.1	351.2	5,607,756	3,349.78
84	49.6032	126.9250	49.6032	127.9000	37.9	379.1	6,414,949	3,831.96
85	49.7698	127.9167	49.7698	127.2333	26.5	264.8	1,153,643	689.13
86	49.9365	127.3033	49.9365	128.2500	36.6	365.6	7,479,430	4,467.82
87	50.1032	128.5000	50.1032	127.9500	21.2	317.5	0	0.00
89	50.4365	128.6667	50.4365	128.0833	22.3	445.9	14,914,595	8,909.20
91	50.7698	129.4333	50.7698	128.8000	24.0	480.7	5,645,564	3,372.37
93	51.1032	130.0000	51.1032	127.7033	86.5	1,297.9	45,936,392	31,751.30
94	51.2698	127.8333	51.2698	130.3583	94.8	947.9	26,893,957	18,338.76
95	51.4365	130.5333	51.4365	128.0833	91.6	916.4	8,358,681	6,185.18
96	51.6032	128.1700	51.6032	130.8167	98.6	986.3	15,146,718	10,517.41
97	51.7698	130.9667	51.7698	129.4167	57.6	575.5	12,284,472	7,967.80
98	51.9365	129.1960	51.9365	130.9667	65.5	655.0	19,016,327	11,574.78
99	52.1032	130.9167	52.1032	129.3333	58.4	583.5	5,728,731	3,469.56
100	52.2698	129.4333	52.2698	130.7333	47.7	477.3	569,165	339.99
101	52.4365	130.6667	52.4365	129.6167	38.4	384.1	203,364	121.48
102	52.6032	129.6667	52.6032	130.6333	35.2	352.3	587,631	351.02
103	52.7698	130.6167	52.7698	129.7500	31.5	314.6	10,568,595	7,820.45
104	52.9365	129.8667	52.9365	130.6500	28.3	283.3	2,526,867	1,869.81
105	53.1032	130.8833	53.1032	130.0500	30.0	300.2	0	0.00
106	53.2698	130.5050	53.2698	130.9167	14.8	147.7	1,675,675	1,239.95
107	53.4365	131.0000	53.4365	130.6300	13.2	132.2	0	0.00
108	53.6032	130.6833	53.6032	130.9500	9.5	94.9	3,420,161	2,530.82

Table A-1 continued. Individual transect coordinates, length, corresponding area, and estimated Pacific hake population numbers and biomass in metric tons for the 2007 integrated acoustic and trawl survey of Pacific hake in U.S. and Canadian waters off the Pacific coast.

Transect	Start latitude	Start longitude	End latitude	End longitude	Length (nmi)	Area (nmi^2)	*N*	*B* (mt)
109	53.7698	130.9667	53.7698	130.6167	12.4	124.1	13,947,272	10,320.58
110	53.9365	130.9000	53.9365	131.1333	8.2	82.4	743,796	550.39
111	54.1032	131.2667	54.1032	130.8667	14.1	140.7	5,003,155	3,702.19
112	54.2583	131.5417	54.7667	131.5417	30.5	305.0	8,867,416	6,561.63
113	54.7667	131.8300	54.1667	131.8300	36.0	360.0	18,285,816	13,530.97
114	54.1667	132.1150	54.6750	132.1150	30.5	305.0	9,190,987	6,801.06
115	54.7083	132.4033	54.1250	132.4033	35.0	350.0	12,785,130	9,460.62
116	54.1833	132.6883	54.6550	132.6883	28.3	283.0	3,395,228	2,512.37
119	54.9365	133.1667	54.9365	134.6250	50.3	502.7	0	0.00
118	54.7698	134.3000	54.7698	132.9583	46.4	464.4	7,111,829	5,262.55
117	54.6032	132.9767	54.6032	134.1667	41.4	620.4	16,571,670	12,262.55
126	54.4365	134.0500	54.4365	132.9767	37.5	749.1	3,756,176	2,779.46
127	54.2698	132.9767	54.2698	134.2333	44.0	660.5	1,177,657	871.43
128	54.1032	134.0000	54.1032	133.2000	28.1	281.4	0	0.00
129	53.9365	133.3367	53.9365	133.7370	14.1	141.4	3,673,284	2,718.12
130	53.7698	133.7333	53.7698	133.1667	20.1	201.0	2,218,406	1,641.56
131	53.6032	133.0475	53.6032	133.4667	14.9	149.2	1,450,801	1,073.55
132	53.4365	133.3667	53.4365	132.7601	21.7	216.8	1,373,525	1,016.37
133	53.2698	132.7667	53.2698	133.3500	20.9	314.0	675,130	499.58
134	53.1032	133.1667	53.1032	132.6000	20.4	306.2	1,156,763	855.97
135	52.9365	132.4167	52.9365	132.9333	18.7	373.7	0	0.00
136	52.7698	132.6667	52.7698	132.2000	16.9	338.8	0	0.00
137	52.6032	131.9333	52.6032	132.0833	5.5	109.3	0	0.00
138	52.4365	131.8500	52.4365	131.6667	6.7	134.1	0	0.00
139	52.2698	131.5000	52.2698	131.7698	9.9	198.1	0	0.00
140	52.1032	131.6333	52.1032	131.2667	13.5	270.3	0	0.00
141	51.9365	131.2667	51.9365	131.0500	8.0	160.3	0	0.00