UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
Resource Assessment and Conservation Engineering Division
7600 Sand Point Way Northeast
BIN C15700, Building 4
Seattle, Washington 98115-0070

December 3, 1998 F/AKC2:Sd

PRELIMINARY CRUISE RESULTS
NOAA Ship *Miller Freeman*, Cruise No. 98-10

Echo Integration-Trawl Survey Of Pacific Whiting Along The West Coasts Of The United States And Canada

CRUISE PERIOD, AREA, AND SCHEDULE

Scientists from the Alaska Fisheries Science Center (AFSC) investigated the population distribution and characteristics of Pacific whiting (*Merluccius productus*) along the U.S. and Canadian west coasts from July 6 to August 27, 1998 (a total of 52 sea days) using echo integration-trawl (EIT) survey techniques aboard the NOAA ship *Miller Freeman*. The cruise began and ended in Seattle, Washington. The EIT survey portion began near Monterey, California and progressed north to just south of the Queen Charlotte Islands, British Columbia.

The itinerary for the *Miller Freeman* was as follows:

Leg 1

July 6-9	Embark portion of scientific party in Seattle. Depart Seattle for Monterey. Offshore reconnaissance and acoustic system noise collection.
July 9	Begin EIT survey of west coast. Touch and go at Monterey to exchange personnel.
July 10	Touch and go at Santa Cruz, California to debark personnel.

July 22	Touch and go at Port Orford, Oregon to embark personnel.
July 27-28	Overnight at Newport, Oregon for engine repair.
July 30	Fish avoidance research with acoustic buoy.
Aug 1	Fish avoidance research with acoustic buoy.
Aug 3	Inport Astoria, Oregon.

Leg 2

Aug 4	Continue EIT survey of west coast.
Aug 11	Touch and go at Neah Bay, Washington to exchange personnel.
Aug 21	Sphere calibration in Howe Bay, Kunghit Island (Queen Charlotte Islands), British Columbia.
Aug 21-23	Intership calibration with Canadian research vessel *W. E. Ricker*.
Aug 25	Finish EIT survey. Transit to area west of Cape Flattery, Washington.
Aug 26	Fish avoidance research with acoustic buoy.
Aug 27	Arrive Seattle. End of cruise.

OBJECTIVES

The primary objective of the cruise was to collect echo integration data and midwater and demersal trawl data necessary to determine the distribution, biomass, and biological composition of Pacific whiting in the survey area.

Secondary objectives were to:

1) collect Pacific whiting target strength data for use in scaling echo integration data to estimates of absolute abundance;

2) calibrate the 38 kHz and 120 kHz scientific acoustic systems using standard sphere techniques;

3) conduct an intership calibration of acoustic systems between the *Miller Freeman* and the Canadian research vessel *W. E. Ricker;*

4) collect acoustic data with a buoy to determine the behavior of Pacific whiting in response to ship noise;

5) collect echo integration data and midwater trawl data necessary to determine the distribution and biological composition of common macrozooplankton species (e.g., euphausiids) in the survey area;

6) collect physical oceanographic data by determining water column profiles of temperature (and salinity, on occasion) at selected sites and by continuously monitoring near-surface currents, temperature, salinity, and ambient light level;

7) calculate density factors for volumetric catch weight estimation of Pacific whiting;

8) collect Pacific whiting stomach samples for food habits studies;

9) collect one year-old and adult hake for a parasite/stock structure study;

10) continuously filter water with a submerged pumping system to identify and map the horizontal egg distribution of epipelagic fishes;

11) collect near-shore water samples for a bio-toxin study; and

12) conduct noise tests of the vessel's acoustic system.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

Acoustic data were collected with a Simrad EK500[1] quantitative echo-sounding system on board the NOAA ship *Miller Freeman*, a 66 m (216 ft) stern trawler equipped for fisheries and oceanographic research. Simrad 38 kHz and 120 kHz split-beam transducers were mounted on the bottom of the vessel's centerboard. With the centerboard fully extended, the transducers were 9 m below the water surface. System electronics

[1] Reference to trade names or commercial firms does not constitute U.S. Government endorsement.

were housed in a permanent laboratory space dedicated to acoustics. Data from the Simrad EK500 echo sounder/receiver were processed on a SUN workstation using Simrad BI500 echo integration and target strength data analysis software. Results presented in this document are based on the 38 kHz data.

Midwater echosign was sampled with an Aleutian Wing 30/26 trawl (AWT), a full-mesh wing trawl constructed of nylon except for polyethylene toward the aft section of the body and the codend. The headrope and footrope each measured 81.7 m (268 ft). Mesh sizes tapered from 3.25 m (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. A 3.2 cm (1.25 in) codend liner was used. The net was fished with 82.3 m (270 ft) of 1.9 cm (0.75 in) diameter 8x19 non-rotational dandylines, 340 kg (750 lb) or 227 kg (500 lb) tom weights on each side, and 5 m^2 (53.8 ft^2) "Fishbuster" doors (1,247 kg [2,750 lb.])

Fish on and near bottom were sampled with a polyethylene Nor'eastern (PNE) high-opening bottom trawl equipped with roller gear. The trawl was constructed with stretch mesh sizes ranging from 12.7 cm (5 in) in the forward portion of the net to 8.9 cm (3.5 in) in the codend. It was fitted with a nylon codend liner with a mesh size of 3.2 cm (1.25 in). The 27.2 m (89.1 ft) headrope held 21 floats [30.5 cm (12 in) diameter]. A 24.7 m (81 ft) chain fishing line was attached to a 24.9 m (81.6 ft) footrope constructed of 1 cm (3/8 in) 6 x 19 wire rope wrapped with polypropylene rope. The 24.2 m (79.5 ft) roller gear was constructed with 35.6 cm (14 in) rubber bobbins spaced 1.5-2.1 m (5-7 ft) apart. A solid string of 10.2 cm (4 in) rubber disks separated some of the bobbins in the center section of the roller gear. Two 5.9 m (19.5 ft) wire rope extensions with 10.2 cm (4 in) and 20.3 cm (8 in) rubber disks were used to span the two lower flying wing sections and were attached to the roller gear. The roller gear was attached to the fishing line using chain toggles [2.9 kg (6.5 lb.) each] which comprised five links and one ring. The trawl was rigged with triple 54.9 m (180 ft) galvanized wire rope dandylines. The net was fished with the "Fishbuster" doors.

A Methot trawl was used to sample macrozooplankton (oblique tows to 250 m [820 ft] depth). This trawl had a rigid square frame with 2.3 m (7.5 ft) sides forming the mouth of the net. A 1.8 m (6 ft) dihedral depressor modified from an Isaacs-Kidd midwater trawl was suspended from the square frame. Mesh sizes were 2 mm x 3 mm (0.08 in x 0.12 in) in the main part of the net and 1 mm (0.04 in) in the codend. The Methot trawl was attached to a single cable that was fed through the ship's stern-mounted A-frame. A calibrated General Oceanics flow meter was attached to

the mouth of the net and used to determine the volume of water filtered. The Methot trawl was lost at sea on July 21 when the cable parted. Until a replacement Methot trawl was obtained on August 3, a 0.5 m Bongo net (333 µm mesh size) was used (oblique tows, 250 m [820 ft] maximum depth).

The AWT and PNE trawl hauls were monitored with a WesMar third wire or a Furuno wireless net sounder system attached to the head rope; vertical net opening, depth, and water temperature were measured. Vertical net openings averaged 22.4 m (73.5 ft) for the AWT and 6.4 m (21.0 ft) for the PNE. The Methot was monitored using a Scanmar or Netmind sounder system.

Conductivity-temperature-depth (CTD) data were collected with a Seabird CTD system at calibration sites and selected locations. Expendable bathythermographs (XBTs) were used north of 41°N to collect water temperature data every 0.5 degree of latitude along transects at their offshore endpoints, and over bottom depths of 150 m (492 ft) and 400 m (1,312 ft), as well as at several haul sites. Sea surface temperature and salinity data, as well as other environmental (e.g., meteorological, sea state) and operational (Marine Operations Abstract [MOA]) data were collected using the *Miller Freeman*'s Scientific Collection System (SCS). Velocity data to describe ocean currents were obtained using the vessel's acoustic Doppler current profiler system whose transducer was mounted in the centerboard. Temperature and depth profile data were collected during most trawl hauls by attaching a micro bathythermograph (MBT) to the trawl headrope or the Methot frame. When no MBT data were available to determine gear temperature during a trawl, recording real-time temperature readouts from the WesMar system was the preferred substitute, followed by temperature data from an XBT or CTD cast if located within about one nmi (1.9 km) of the trawl site.

The acoustic buoy consisted of an aluminum cylinder (length 130 cm [51.2 in]) with a "donut" Ionomer foam floatation collar and mast at one end. A bulkhead inside the cylinder separated the cylinder into an upper (i.e., instrument) and lower (i.e., battery) watertight compartment which was accessed by removing an aluminum end cap. The acoustic-buoy electronic components included a Simrad EY500 echosounder operating at 38 kHz, communications hardware, and other instrumentation. Data were stored onboard the buoy and telemetered directly to the *Miller Freeman*. A UHF radio link between the buoy and vessel was used to control the echosounder, receive buoy positions based on GPS, and remotely generate echograms in real time. The GPS data from the buoy were also transmitted via an Argos satellite system to the vessel to locate the buoy in the event that visual, radar, and direct radio contact were lost. A split-beam transducer and

heading sensor were suspended 6.5 m (21.3 ft) below the buoy, and a copper sphere was suspended about 25 m (82 ft) below the transducer. Transducer heading data from the buoy were collected and used in analyses to assess the direction of fish response (i.e., movement relative to vessel). Four 100 ampere-hour gel cell batteries powered the buoy; one battery powered the GPS/Argos transceiver while three powered the remaining instruments. The total weight of the buoy was about 300 kg (661 lb).

SURVEY METHODS

The EIT survey consisted of 102 parallel, east-west transects that started near Monterey (Fig. 1) and proceeded north along the U.S. and Canadian west coasts to just south of the Queen Charlotte Islands. Average transect length was about 37 nmi (69 km) and ranged from about 15 nmi (28 km) to 92 nmi (170 km). Transect spacing was about 10 nmi (18.5 km) apart except inshore near the U.S./Canada border where spacing was reduced to 5 nmi (9.3 km). Transects were generally run between the 50 m (164 ft) and 1,500 m (4,921 ft) depth contours, although sometimes a transect was extended to deeper water when fish sign was found at or near its predetermined offshore endpoint. About 3,615 nmi (6,695 km) of transect lines were run.

Standard survey operations occurred only during daylight hours; night operations were used to collect Pacific whiting target strength data, conduct trawl hauls on echosign observed during daytime survey operations, trawl on aggregations of macrozooplankton and other midwater fishes, or sample areas outside the daytime survey trackline for epipelagic fish eggs and bio-toxins. Vessel speeds during daytime transecting were usually around 11-12 knots (6 m/s). Acoustic data from the 38 kHz system were collected from 14 m (46 ft) below the surface to within 0.5 m (1.6 ft) of the bottom except in deeper waters where data were collected to maximum depths of 500-1,000 m (1,640-3,281 ft). Acoustic data from the 120 kHz system were collected no deeper than 250 m (820 ft). Only the 38 kHz data were scrutinized by one or more scientists and then stored in an INGRES database. When properly scaled, these data were used to provide estimates of Pacific whiting density.

Midwater and bottom trawl hauls were made at selected locations to identify echosign and to provide biological data and Pacific whiting samples. Haul duration was kept to the minimum necessary to ensure an adequate sample. Average trawling speed was about 3 kts (1.5 m/s). Each trawl catch was completely sorted unless it exceeded about 1,000 kg (2,200 lb), at which point

representative splits of the catch were sorted instead. Total weights and numbers of individuals, by species, were determined for each catch. Individual Pacific whiting were further sampled to determine sex, length (standard length for fish <80 mm, fork length for fish >80 mm), body weight, sexual maturity, and to collect otoliths for age determination. Both otoliths were removed and stored in a solution of 50% ethanol. Electronic scales were used to determine all weights. Fish fork lengths were determined to the nearest cm with a polycorder measuring device (a combination of a bar code reader and a hand-held computer). Standard lengths of age-0 Pacific whiting were measured to the nearest mm and recorded onto a tally sheet before being transferred to a personal computer. Sexual maturities were determined by visual inspection of gonads based initially on an 8-stage scale, then later consolidated into a 5-stage scale. Stages were categorized as immature, developing, pre-spawning, spawning, and post-spawning. Pacific whiting stomachs and macro-zooplankton samples were preserved in a 10% formalin solution. Whole Pacific whiting were frozen.

Collection of target strength data required suitable conditions (e.g., low fish density, single-species aggregations, unimodal size distribution, and calm seas) and involved passing repeatedly over an aggregation of Pacific whiting at speeds of less than 4 kts (2 m/s) and then collecting biological data from trawl hauls conducted in conjunction with the collection of acoustic data.

A second method of collecting target strength data was used when echosign was deeper than about 150 m (492 ft). The vessel was stopped and a 38 kHz transducer was lowered to a depth just above the fish sign for data collection using a lowered-transducer winch assembly. A CTD unit mounted onto the transducer housing measured tilt angles of the transducer.

The primary acoustic buoy objective during the survey was to determine if a change occurred in the total water-column area back-scattering coefficient (S_A) attributed to Pacific whiting as a result of vessel noise generated while free-running at normal survey vessel speed (i.e., 12 knots). Acoustic data were collected by the buoy while the vessel steamed as close as possible past the buoy after starting from a distance of 1-2 miles away. The vessel maintained its speed and direction until it was 1-2 miles past the buoy where it remained until beginning another pass 10-15 minutes later. The vessel path during each pass was conducted perpendicular to the buoy drift-trajectory to minimize the disturbance to fish that were in the path of the buoy and might be encountered during subsequent passes.

PRELIMINARY RESULTS

Standard Sphere Calibrations

Two standard sphere calibrations of the 38 kHz and 120 kHz acoustic systems were conducted in conjunction with the survey (Table 1), one of which was completed prior to the cruise on June 30 in Puget Sound, WA. No significant differences in system parameters were observed between the two calibrations.

Intership Calibration

The *Miller Freeman* and the Canadian research vessel *W. E. Ricker* conducted an intership calibration of their acoustic data collection systems on August 21-23 to enable comparison of density estimates derived from the two systems. Acoustic data were collected in Queen Charlotte Sound along 20 transects which were about 7-11 nm (13-20 km) long. One vessel followed directly astern of the other along each transect. Inter-ship spacing was 0.5 nm (0.9 km) for the first four transects, then 1.0 nm (1.9 km) thereafter. The vessel taking the lead position changed after each pair of transects. Vessel speeds were about 9-10 knots (5 m/s). Preliminary analysis suggested that acoustic densities measured by the Canadian system were slightly higher than those measured by the U. S. system.

EIT Survey

Biological data and specimens were collected from 95 midwater and 13 bottom trawl hauls (Fig. 1). Trawl station and catch data are summarized in Table 2. Pacific whiting was the dominant fish species captured in the midwater trawl hauls by weight and by numbers, followed by Pacific herring (*Clupea pallasi;* Table 3). The next most abundant species -- yellowtail rockfish (*Sebastes flavidus*), jack mackerel (*Trachurus symmetricus*), widow rockfish (*S. entomelas*), and redstripe rockfish (*S. proriger*) -- contributed a total of about five percent by weight to the catch. Pacific whiting was the most dominant species by weight caught in bottom trawl hauls, but shortbelly rockfish (*S. jordani*) were more numerous (Table 4). Spiny dogfish (*Squalus acanthias*) and redstripe rockfish were the next most common species numerically and by weight. Types of biological data and numbers of samples and measurements collected from midwater and bottom trawls are listed in Table 5. Haul statistics for 18 Methot trawls (Fig. 2) are presented in Table 6. Catches from these hauls appeared dominated by euphausiids and mesopelagic fishes.

The size composition of Pacific whiting differed over the survey area (Fig. 3). Nearly all fish off California (38°-42°N)

comprised a dominant mode at 25-35 cm (primarily 2 year-olds) although a few fish occurred between 35-50 cm. Fish off Oregon and most of Washington (42°-48°N) were generally larger with dominant modes between 30-50 cm. Fish north of 48°N exhibited a strong mode centered around 45 cm. A second, smaller mode at 25 cm (1 year-olds) was also observed north of 49°N. Modal lengths of the adult fish generally increased from south to north.

Relatively dense Pacific whiting echosign was observed off northern California/southern Oregon (near 42°N), off central Oregon (43^0-44°N), over Juan de Fuca Canyon near Cape Flattery, and north of 50° along Vancouver Island and in Queen Charlotte Sound (Fig. 4). Low densities of Pacific whiting were observed off California south of about 41°N.

Temperature profile data (MBT) were collected at most trawl haul locations (Tables 2 and 6). Additional vertical temperature profile data were successfully collected from 38 CTD and 95 XBT casts (Tables 7 and 8) conducted throughout the study area (Figure 5).

Target Strength Data Collection

Pacific whiting target strength data were collected on seven occasions. Target strength data were collected five times using only the hull-mounted transducer (July 19, 30; August 8, 9, 12) and twice using the lowered transducer assembly (August 19, 20). Ten hauls were conducted in association with the target strength work. Analysis of target strength data is in progress.

Acoustic Buoy Deployment

The acoustic buoy was deployed six times during the survey (Table 9). During each deployment, the vessel made repeated passes within 2-20 m (6-66 ft) of the buoy. A total of 44 passes were conducted over adult Pacific whiting during daylight periods. Analysis of the data is in progress.

SCIENTIFIC PERSONNEL

Name	Sex/ Nationality	Position	Organization	Dates Aboard
		Leg 1		
Chris Wilson	M/USA	Chief Scientist	AFSC	7/6-8/2
Dan Twohig	M/USA	Instrument Chief	AFSC	7/6-7/9
Mike Guttormsen	M/USA	Fish. Biologist	AFSC	7/9-8/2
Steve de Blois	M/USA	Fish. Biologist	AFSC	7/6-8/2
Kevin Landgraf	M/USA	Fish. Biologist	AFSC	7/9-8/2
Bob Clark	M/USA	Computer Specialist	AFSC	7/6-7/9, 7/22-8/2
Michiyo Shima	F/Japan	Fish. Biologist	UW	7/9-8/2
Elaine Acuna	F/USA	Fish. Biologist	SWFSC	7/9-7/10, 7/22-8/2
Dave Griffith	M/USA	Fish. Biologist	SWFSC	7/6-8/2
Justine Stohler	F/USA	Fish. Biologist	NWFSC	7/6-8/2
Mariya Sweetwyne	F/USA	Fish. Biologist	NWFSC	7/6-8/2
Mildred Chamblee	F/USA	Teacher-At-Sea	OLA	7/6-8/2
		Leg 2		
Neal Williamson	M/USA	Chief Scientist	AFSC	8/4-8/27
Taina Honkalehto	F/USA	Fish. Biologist	AFSC	8/4-8/27
Steve de Blois	M/USA	Fish. Biologist	AFSC	8/4-8/27
Kevin Landgraf	M/USA	Fish. Biologist	AFSC	8/4-8/27
Bob Clark	M/USA	Computer Specialist	AFSC	8/4-8/11
Yoshimi Takao	M/Japan	Fish. Acoustician	NRIFE	8/4-8/27
Martin Dorn	M/USA	Fish. Biologist	AFSC	8/4-8/27
Sherry Charter	F/USA	Fish. Biologist	SWFSC	8/4-8/27
Ron Dotson	M/USA	Fish. Biologist	SWFSC	8/4-8/27
Mike Smith	M/Canada	Fish. Biologist	DFO	8/11-8/27

AFSC - Alaska Fisheries Science Center, Seattle, WA
DFO - Department of Fisheries and Oceans, Nanaimo, BC, Canada
NRIFE - National Research Institute of Fisheries Engineering, Hasake, Japan
NWFSC - Northwest Fisheries Science Center, Seattle, WA
OLA - NOAA Office of Legislative Affairs, Teachers at Sea Program, Washington, DC
SWFSC - Southwest Fisheries Science Center, La Jolla, CA
UW - University of Washington, Seattle, WA

For further information, contact Dr. Gary Stauffer, Director, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE, BIN C15700, Seattle, WA, 98115-0070. Telephone (206)526-4170.

Table 1. Summary of sphere calibrations associated with the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10. TS represents target strength and S_v represents volume backscattering.

Date	Location	Freq (kHz)	Water temp (deg. C) At transducer*	Water temp (deg. C) At sphere	Sphere range from transducer (m)	Gain (dB) TS	Gain (dB) S_v	3dB beam Width (deg.)	Angle offset Along	Angle offset Athwart
30 Jun	Port Susan, WA	38	11.9	9.9	34.2	27.2	27.2	6.81	0.01	-0.04
		120	11.9	10.0	27.5	24.9	25.2	--	--	--
21 Aug	Howe Bay, BC	38	12.7	12.4	29.8	27.2	27.2	6.72	-0.01	-0.04
		120	12.7	12.5	24.0	24.4	24.5	7.20	-0.23	0.16
Jul-Aug	System settings during survey	38	--	--	--	27.1	27.1	6.7	-0.09	-0.02
		120	--	--	--	25.0	25.0	7.1	0.00	0.02

* The transducer was located approximately 9 m below the water surface.

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

Table 2. Summary of Aleutian wing and bottom trawl stations and catch data from the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10.

Haul	Gear [1]		Time	Duration	Start Position				Depth (m)		Temp. (°C)		MBT[3]	P. whiting Catch		Other Catch
No.	Type	Date	(GMT)	(minutes)	Latitude (°N)		Longitude (°W)		Gear	Bottom	Gear[2]	Surface	No.	kg	number	kg
1	P	10 Jul	19:33	4	36	48.44	122	7.32	157	158	9.0	12.4	1	4.3	13	2,545.7
2	A	12 Jul	21:02	31	38	7.48	123	24.27	160	244	8.9	11.1	3	1,516.3	7,847	3.7
3	P	13 Jul	15:38	13	38	27.99	123	37.15	261	261	8.1	11.4	4	11.8	34	1,794.3
4	A	13 Jul	19:52	30	38	17.48	123	24.28	97	170	9.1	10.8	5	280.9	1,970	16.9
5	P	15 Jul	4:42	50	39	20.84	123	55.62	149	156	8.3	12.5	7	42.0	153	2.7
6	P	15 Jul	15:17	20	39	38.14	123	58.33	231	234	7.8	12.6	9	228.1	583	50.9
7	P	15 Jul	17:14	8	39	38.19	123	57.24	167	167	8.1	12.8	10	253.6	894	111.8
8	A	16 Jul	3:42	21	39	48.10	124	4.45	248	359	7.9	12.7	11	315.1	914	10.9
9	A	16 Jul	10:47	38	39	48.59	123	59.94	125	134	8.3	11.8	--	976.0	4,997	10.5
10	A	17 Jul	1:13	40	40	18.44	124	29.58	378	417	7.3	12.0	--	156.6	531	14.5
11	A	17 Jul	17:52	32	40	28.27	124	36.66	89	129	8.4	10.7	--	2.8	5	2,787.2
12	A	18 Jul	2:05	11	40	48.03	124	30.59	129	454	8.2	12.7	--	688.9	1,435	40.0
13	A	18 Jul	8:51	60	40	48.59	124	44.69	279	1168	6.6	12.1	--	0.0	0	13.3
14	A	18 Jul	20:11	3	41	8.13	124	22.97	220	310	7.4	12.3	--	1,082.0	5,271	35.9
15	A	19 Jul	0:55	10	41	18.86	124	28.47	207	386	7.3	13.1	--	969.3	4,159	0.2
16[T]	A	19 Jul	6:24	60	41	17.89	124	21.83	92	122	8.0	13.1	--	1,185.7	5,937	36.5
17	A	19 Jul	15:19	16	41	29.22	124	32.41	321	550	6.7	12.5	--	1,188.3	4,565	8.4
18	A	20 Jul	0:43	16	41	47.81	124	40.90	347	719	6.2	13.1	--	1,755.7	3,639	4.3
19	A	20 Jul	6:50	40	41	58.89	124	31.52	112	128	7.8	10.0	--	996.8	3,180	31.4
20	A	20 Jul	16:22	3	41	58.46	124	35.33	213	249	7.1	10.4	--	2,340.0	8,630	10.0
21	A	21 Jul	0:32	7	42	8.03	124	40.78	259	531	6.9	10.4	--	727.2	1,941	15.8
22	A	21 Jul	6:28	30	42	18.60	124	40.06	310	320	6.5	9.8	--	669.4	1,657	8.6
23	A	21 Jul	16:28	15	42	18.38	124	44.59	248	519	7.1	10.1	--	399.2	1,150	0.6
24	A	21 Jul	22:42	25	42	28.17	124	50.30	406	480	6.6	10.9	--	784.8	1,802	34.3
25	A	22 Jul	6:02	15	42	37.83	124	40.39	123	151	7.9	9.8	--	2,054.0	9,768	0.0
26	A	22 Jul	16:01	21	42	37.85	124	45.56	154	634	7.5	13.4	--	1,569.5	6,971	0.5
27	A	22 Jul	18:30	20	42	37.89	124	49.92	310	717	6.8	13.4	--	414.2	1,730	2.9
28	P	23 Jul	4:10	10	42	48.04	124	48.60	348	348	6.4	9.7	--	688.2	1,437	436.1
29	P	23 Jul	15:15	5	42	58.07	124	51.15	123	123	7.5	12.7	--	6.9	14	980.1
30	A	23 Jul	17:22	13	42	57.91	124	54.01	239	335	6.9	12.9	701	2,099.7	4,607	0.3
31	A	24 Jul	4:18	32	43	17.76	124	51.24	266	502	6.5	13.3	--	300.3	638	13.5

Table 2. (cont.)

Haul No.	Gear[1] Type	Date	Time (GMT)	Duration (minutes)	Start Position Latitude (°N)		Start Position Longitude (°W)		Depth (m) Gear	Depth (m) Bottom	Temp. (°C) Gear[2]	Temp. (°C) Surface	MBT[3] No.	P. whiting Catch kg	P. whiting Catch number	Other Catch kg
32	A	24 Jul	18:29	6	43	28.49	124	46.38	342	533	6.1	14.3	--	1,723.7	5,374	6.3
33	A	25 Jul	1:02	9	43	37.41	124	42.81	236	504	7.3	13.8	--	2,093.8	5,351	0.2
34	P	25 Jul	18:51	10	43	48.25	124	35.63	231	231	6.6	13.3	--	161.6	580	22.4
35	P	26 Jul	0:51	8	43	57.26	124	34.69	166	166	7.4	14.7	--	412.6	1,619	1.3
36	A	26 Jul	7:13	60	43	57.63	125	1.43	296	990	6.9	15.1	--	1,280.3	3,156	2.8
37	A	26 Jul	15:12	30	44	8.57	125	16.96	278	1500	6.3	12.5	--	755.7	1,787	64.8
38	P	27 Jul	2:09	12	44	18.08	124	53.10	270	270	6.5	13.3	--	233.3	469	19.7
39	A	27 Jul	5:00	25	44	18.52	125	11.44	332	1500	6.2	14.8	--	91.4	209	6.3
40	A	27 Jul	8:51	75	44	18.40	124	56.46	177	583	7.2	13.0	--	269.6	674	40.6
41	A	27 Jul	18:26	30	44	28.60	124	53.40	439	469	5.8	14.5	--	1,955.2	4,207	84.8
42	A	27 Jul	21:05	12	44	28.24	124	51.96	308	358	6.3	15.3	--	934.2	2,112	7.8
43	A	28 Jul	23:59	15	44	48.15	124	45.08	371	409	6.2	16.4	--	486.2	969	6.4
44	P	29 Jul	2:12	12	44	48.09	124	36.34	298	298	6.7	16.3	--	15.0	29	35.8
45	A	29 Jul	15:54	17	44	57.80	124	24.99	225	241	7.3	16.3	19	3,591.6	10,655	188.4
46	A	30 Jul	3:45	10	45	18.16	124	17.01	165	179	7.4	16.4	20	1,052.7	3,380	11.0
47[T]	A	30 Jul	8:16	45	45	13.32	124	13.07	149	154	7.8	16.3	21	939.1	2,415	5.3
48	A	31 Jul	6:12	90	45	19.04	124	39.01	353	499	6.2	17.2	22	285.6	599	5.6
49	A	1 Aug	4:22	45	45	47.92	124	16.11	121	141	7.6	16.3	24	234.2	800	7.8
50	A	1 Aug	14:00	30	45	29.00	124	34.84	304	469	6.4	16.8	25	482.9	1,200	2.4
51	A	1 Aug	23:29	19	45	27.85	124	20.06	171	178	7.4	16.7	26	1,562.7	5,277	177.3
52	P	2 Aug	2:44	12	45	37.82	124	31.79	233	233	6.8	16.8	27	21.9	55	16.2
53	A	2 Aug	9:29	12	45	58.01	124	35.34	126	147	7.7	16.7	28	114.5	294	149.6
54	A	5 Aug	19:35	25	45	58.15	124	47.02	427	532	6.0	17.5	30	184.2	394	82.2
55	A	6 Aug	6:52	30	46	17.94	124	31.67	75	137	8.7	16.4	31	339.1	944	1.6
56	A	6 Aug	20:38	42	46	38.01	124	33.71	135	143	7.8	16.2	33	973.0	2,012	38.3
57	A	7 Aug	4:07	30	46	47.91	124	48.72	88	169	9.0	16.5	34	49.2	84	355.1
58	A	7 Aug	20:04	34	46	58.15	124	55.98	153	202	7.6	16.7	37	36.4	81	718.6
59	A	8 Aug	1:25	26	47	8.10	124	57.57	183	287	7.5	16.3	38	6,210.5	17,247	87.5
60[T]	A	8 Aug	7:43	40	47	8.06	124	58.28	149	173	7.6	15.8	--	485.6	1,107	11.6
61[T]	A	8 Aug	11:56	45	47	7.99	124	58.46	160	170	7.6	16.4	40	548.6	1,313	35.0
62	P	8 Aug	19:26	15	47	18.11	124	43.80	140	140	--	16.3	--	2,263.7	3,898	506.3
63	A	9 Aug	0:45	6	47	28.03	124	49.85	141	158	7.9	16.3	42	4,808.4	10,698	610.6
64[T]	A	9 Aug	7:18	50	47	27.99	124	45.75	113	129	7.8	15.2	43	744.5	1,583	28.9

Table 2. (cont.)

Haul No.	Gear[1] Type	Date	Time (GMT)	Duration (minutes)	Start Position Latitude (°N)		Longitude (°W)		Depth (m) Gear	Bottom	Temp. (°C) Gear[2]	Surface	MBT[3] No.	P. whiting Catch kg	number	Other Catch kg
65[T]	A	9 Aug	11:56	40	47	28.19	124	45.42	108	121	8.2	15.2	44	651.8	1,396	16.3
66	A	10 Aug	0:28	10	47	48.25	125	10.22	200	487	7.3	16.4	45	5,301.3	12,036	4.7
67	A	10 Aug	5:21	30	47	48.20	125	1.04	108	155	8.1	15.8	46	496.1	1,097	10.3
68	A	10 Aug	16:32	19	47	58.12	125	3.08	115	124	8.1	15.7	47	459.7	952	252.3
69	A	10 Aug	21:07	4	48	2.96	125	28.37	122	140	8.0	15.2	48	0.0	0	1,004.9
70	A	11 Aug	5:28	15	47	58.27	125	19.34	78	472	8.8	16.3	49	141.9	344	17.9
71	A	11 Aug	7:21	60	47	58.16	125	18.94	259	590	6.9	16.7	50	542.9	1,168	10.9
72	A	11 Aug	14:56	3	48	13.13	125	28.88	117	139	7.4	14.5	--	1,179.4	2,046	226.0
73	A	12 Aug	1:00	15	48	23.15	125	26.98	126	150	7.3	16.3	53	1,555.4	1,876	18.7
74[T]	A	12 Aug	8:37	40	48	23.35	124	58.04	99	227	7.6	14.7	54	1,520.4	3,453	2.0
75	A	12 Aug	16:24	6	48	28.06	125	8.36	125	152	7.1	14.5	55	2,704.7	5,637	25.3
76	A	13 Aug	1:46	12	48	33.11	124	47.43	114	125	8.3	12.3	--	847.7	1,261	22.2
77	A	13 Aug	6:19	30	48	32.83	125	9.80	102	109	7.5	12.0	57	1,455.1	2,582	438.9
78	A	13 Aug	18:48	4	48	34.93	125	22.77	119	140	7.3	13.0	58	1,045.2	1,824	57.1
79	A	14 Aug	1:48	15	48	42.38	125	43.28	106	176	8.6	16.3	59	1,287.7	2,344	11.6
80	A	14 Aug	3:30	15	48	42.60	125	43.60	142	192	8.2	16.0	60	1,548.5	2,541	17.4
81	A	14 Aug	7:19	3	48	34.75	125	39.19	53	62	10.2	15.1	61	9.2	11	1,068.6
82	A	14 Aug	19:35	7	48	8.02	125	33.27	121	140	7.9	13.2	62	378.8	735	410.4
83	A	15 Aug	0:30	15	48	17.59	125	55.22	279	290	6.3	16.7	63	537.9	1,025	0.4
84	A	15 Aug	20:50	18	48	38.11	126	6.84	135	137	8.0	16.0	66	596.5	1,186	110.4
85	A	15 Aug	23:30	20	48	34.84	126	11.86	441	655	5.6	16.4	67	253.2	471	8.7
86	A	16 Aug	9:46	20	48	47.79	126	18.96	152	179	8.1	15.4	70	471.0	875	509.7
87	A	16 Aug	17:51	9	48	48.04	126	10.28	121	128	7.8	15.2	71	1,457.8	2,738	18.3
88	A	17 Aug	2:34	20	48	58.16	126	13.87	106	117	8.0	16.3	72	726.6	2,284	129.5
89	A	17 Aug	9:18	8	49	7.90	127	20.44	187	1000	7.4	15.6	74	607.3	1,187	0.0
90	A	18 Aug	0:20	12	49	8.24	126	26.10	100	108	8.1	15.0	75	709.6	1,319	16.4
91	A	18 Aug	5:41	15	49	18.12	126	43.24	109	120	8.1	14.6	76	0.0	0	61.3
92	A	18 Aug	15:51	6	49	18.21	127	9.02	187	245	7.2	15.6	78	114.7	228	72.9
93	A	18 Aug	21:22	8	49	27.88	127	9.39	140	154	7.7	14.8	79	2,381.9	4,831	8.1
94[T]	A	19 Aug	7:17	37	49	38.20	127	9.53	112	128	7.6	15.7	80	539.7	1,013	102.4
95	A	20 Aug	0:18	19	50	7.53	128	4.73	164	568	7.3	14.5	82	3,133.9	7,393	41.1
96[T]	A	20 Aug	7:08	13	50	7.40	128	2.01	124	527	7.8	14.9	83	462.1	955	17.6
97[T]	A	20 Aug	11:37	10	50	7.59	128	2.07	127	370	7.8	14.4	84	621.5	1,127	12.7

Table 2. (cont.)

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

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

[2] gear temperatures were measured at the head rope depth

[3] cast 701 was a Seabird CTD attached to the trawl headrope

[T] target strength data collection haul

Table 3. Summary of catch by species from 95 Aleutian wing trawl hauls during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
Pacific whiting	*Merluccius productus*	98,068.9	88.8	257,884
Pacific herring	*Clupea pallasi*	4,404.6	4.0	42,996
Yellowtail rockfish	*Sebastes flavidus*	1,991.6	1.8	1,717
Jack mackerel	*Trachurus symmetricus*	1,841.6	1.7	1,471
Widow rockfish	*Sebastes entomelas*	1,254.2	1.1	2,263
Redstripe rockfish	*Sebastes proriger*	1,085.4	1.0	2,150
Yellowmouth rockfish	*Sebastes reedi*	646.2	0.6	630
Chinook salmon	*Oncorhynchus tshawytscha*	301.0	0.3	100
Chub mackerel	*Scomber japonicus*	147.4	0.1	313
Spiny dogfish	*Squalus acanthias*	141.4	0.1	262
Pacific ocean perch	*Sebastes alutus*	62.1	0.1	61
King-of-the-salmon	*Trachipterus altivelis*	60.0	0.1	11
Ragfish	*Icosteus aenigmaticus*	55.0	<0.1	2
Squid unidentified	Teuthoidea	47.1	<0.1	284
American shad	*Alosa sapidissima*	43.5	<0.1	67
Brown cat shark	*Apristurus brunneus*	31.3	<0.1	38
Silvergray rockfish	*Sebastes brevispinis*	28.9	<0.1	15
Lanternfish unidentified	Myctophidae	26.1	<0.1	3,615
Jellyfish unidentified	Scyphozoa	23.2	<0.1	57
Arrowtooth flounder	*Atheresthes stomias*	22.5	<0.1	24
Canary rockfish	*Sebastes pinniger*	19.1	<0.1	8
Salps unidentified	Thaliacea	18.1	<0.1	28
Bocaccio	*Sebastes paucispinis*	17.4	<0.1	4
Darkblotched rockfish	*Sebastes crameri*	16.7	<0.1	66
Robust clubhook squid	*Moroteuthis robusta*	11.3	<0.1	2
Pacific sardine	*Sardinops sagax*	7.6	<0.1	51
Magistrate armhook squid	*Berryteuthis magister*	5.9	<0.1	25
Shrimp unidentified	Natantia	5.7	<0.1	2,715
Lingcod	*Ophiodon elongatus*	5.1	<0.1	12
Shortraker rockfish	*Sebastes borealis*	4.8	<0.1	3
California market squid	*Loligo opalescens*	3.6	<0.1	20
Starry flounder	*Platichthys stellatus*	2.8	<0.1	3
Sablefish	*Anoplopoma fimbria*	2.5	<0.1	1
Longnose skate	*Raja rhina*	2.5	<0.1	1
Robust blacksmelt	*Bathylagus milleri*	2.3	<0.1	452
Flathead sole	*Hippoglossoides elassodon*	2.3	<0.1	7
Slender sole	*Lyopsetta exilis*	2.1	<0.1	25
Eulachon	*Thaleichthys pacificus*	2.0	<0.1	111
English sole	*Parophrys vetulus*	1.6	<0.1	5
Viperfish unidentified	Chauliodontidae	1.0	<0.1	39
Spotted ratfish	*Hydrolagus colliei*	0.9	<0.1	1
Chilipepper	*Sebastes goodei*	0.7	<0.1	2
Deepsea smelt unidentified	Bathylagidae	0.7	<0.1	16

Table 3. (cont.)

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

Table 4. Summary of catch by species from 13 bottom trawl hauls during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
Pacific whiting	*Merluccius productus*	4,342.9	40.0	9,778
Shortbelly rockfish	*Sebastes jordani*	2,423.2	22.3	16,980
Spiny dogfish	*Squalus acanthias*	1,493.4	13.7	2,650
Redstripe rockfish	*Sebastes proriger*	810.0	7.5	5,580
Sablefish	*Anoplopoma fimbria*	273.3	2.5	218
Chilipepper	*Sebastes goodei*	261.5	2.4	492
Dover sole	*Microstomus pacificus*	212.4	2.0	948
Rex sole	*Glyptocephalus zachirus*	164.2	1.5	1,144
Splitnose rockfish	*Sebastes diploproa*	162.9	1.5	1,386
Sharpchin rockfish	*Sebastes zacentrus*	107.4	1.0	1,127
Yellowtail rockfish	*Sebastes flavidus*	102.0	0.9	110
Pygmy rockfish	*Sebastes wilsoni*	79.5	0.7	1,067
Pacific herring	*Clupea pallasi*	62.6	0.6	601
American shad	*Alosa sapidissima*	58.7	0.5	86
Stripetail rockfish	*Sebastes saxicola*	52.9	0.5	527
Jack mackerel	*Trachurus symmetricus*	47.9	0.4	44
Magistrate armhook squid	*Berryteuthis magister*	26.3	0.2	7
Shortspine thornyhead	*Sebastolobus alascanus*	26.1	0.2	184
English sole	*Parophrys vetulus*	22.2	0.2	78
Bigfin eelpout	*Lycodes cortezianus*	19.2	0.2	159
Longnose skate	*Raja rhina*	19.0	0.2	3
Arrowtooth flounder	*Atheresthes stomias*	16.0	0.1	25
Darkblotched rockfish	*Sebastes crameri*	15.8	0.1	24
Slender sole	*Lyopsetta exilis*	12.9	0.1	256
Lingcod	*Ophiodon elongatus*	8.4	0.1	3
Greenstriped rockfish	*Sebastes elongatus*	6.3	0.1	27
Petrale sole	*Eopsetta jordani*	5.9	0.1	10
Sea urchin unidentified	Echinoidea	4.5	<0.1	36
Widow rockfish	*Sebastes entomelas*	3.8	<0.1	3
Coho salmon	*Oncorhynchus kisutch*	2.8	<0.1	1
Chub mackerel	*Scomber japonicus*	2.6	<0.1	6
Rosethorn rockfish	*Sebastes helvomaculatus*	2.2	<0.1	11
Silverside unidentified	Atherinidae	2.0	<0.1	13
Spotted ratfish	*Hydrolagus colliei*	1.9	<0.1	11
Pacific ocean perch	*Sebastes alutus*	1.7	<0.1	3
Salps unidentified	Thaliacea	1.6	<0.1	1
Pacific sanddab	*Citharichthys sordidus*	1.4	<0.1	10
Squid unidentified	Teuthoidea	1.3	<0.1	2
Canary rockfish	*Sebastes pinniger*	1.1	<0.1	1
Starfish unidentified	Echinodermata	1.1	<0.1	21
Redbanded rockfish	*Sebastes babcocki*	0.8	<0.1	2
Pacific lamprey	*Lampetra tridentata*	0.8	<0.1	2
Rougheye rockfish	*Sebastes aleutianus*	0.7	<0.1	1

Table 4. (cont.)

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
Pink seaperch	*Zalembius rosaceus*	0.6	<0.1	13
Dungeness crab	*Cancer magister*	0.6	<0.1	1
Sea cucumber unidentified	Holothuroidea	0.5	<0.1	2
Eelpout unidentified	Zoarcidae	0.4	<0.1	3
Shrimp unidentified	Natantia	0.4	<0.1	64
Deepsea skate	*Bathyraja abyssicola*	0.4	<0.1	1
Plainfin midshipman	*Porichthys notatus*	0.3	<0.1	3
Threadfin sculpin	*Icelinus filamentosus*	0.2	<0.1	3
Northern shrimp	*Pandalus borealis*	0.2	<0.1	20
Snailfish unidentified	Cyclopteridae	0.1	<0.1	1
Hermit crab unidentified	Paguridae	<0.1	<0.1	1
Totals		10,866.22		43,750

Table 5. Summary of Pacific whiting biological samples and measurements collected during the 1998 echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10.

Haul	Length	Maturity	Otoliths	Fish Weight
1	4	0	0	0
2	307	81	81	81
3	34	34	34	34
4	402	65	65	65
5	153	54	54	54
6	342	108	108	108
7	486	81	81	81
8	342	100	100	100
9	408	60	60	60
10	269	57	57	57
11	5	0	0	0
12	376	64	64	64
14	535	70	70	70
15	469	51	51	51
16	331	73	73	73
17	459	54	54	54
18	327	77	77	77
19	410	43	43	43
20	347	62	62	62
21	354	48	48	48
22	409	43	43	43
23	286	94	94	94
24	403	40	40	40
25	339	70	70	70
26	341	54	25	54
27	345	57	33	57
28	301	44	44	44
29	14	0	0	0
30	366	76	76	76
31	334	57	57	57
32	355	79	79	79
33	338	85	68	85
34	326	73	35	73
35	394	89	50	89
36	340	78	50	78
37	315	78	50	78
38	327	50	50	50
39	209	52	52	52
40	325	72	50	72
41	386	70	56	70
42	380	77	0	77

Haul	Length	Maturity	Otoliths	Fish Weight
43	340	78	48	78
44	29	0	0	0
45	421	115	54	115
46	360	118	56	118
47	352	66	56	66
48	409	48	48	48
49	448	130	51	130
50	351	91	61	91
51	475	117	53	117
52	55	0	0	0
53	294	0	0	0
54	327	67	46	67
55	350	75	49	75
56	337	106	55	106
57	84	0	0	0
58	81	81	50	81
59	365	75	40	75
60	384	0	0	0
61	363	0	0	0
62	336	119	62	119
63	409	75	49	75
64	392	0	0	0
65	347	0	0	0
66	230	34	34	34
67	274	0	0	0
68	333	96	52	96
70	257	87	48	87
71	290	58	45	58
72	338	88	50	88
73	320	92	50	92
74	427	67	50	67
75	399	82	53	82
76	335	63	38	63
77	347	53	53	53
78	302	114	54	114
79	317	71	41	71
80	353	82	50	82
81	11	0	0	0
82	338	118	57	118
83	362	119	61	119
84	267	73	53	73
85	344	52	52	52
86	241	50	50	50
87	380	65	54	65
88	312	90	49	90

Haul	Length	Maturity	Otoliths	Fish Weight
89	318	71	42	71
90	286	63	39	63
92	228	38	38	38
93	387	71	54	71
94	368	59	48	59
95	320	65	48	65
96	382	0	0	0
97	328	46	0	46
98	307	56	56	56
99	308	63	42	63
100	274	80	51	80
101	345	80	54	80
102	300	47	29	47
103	135	0	0	0
104	289	57	43	57
105	321	88	51	88
106	485	79	46	79
107	300	74	50	74
108	387	0	0	0
Totals	33,347	6,472	4,667	6,472

Table 6. Summary of Methot trawl and bongo net stations from the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10. Hauls 201-218 were Methot trawls and hauls 301-305 were bongo net tows.

Haul		Time	Duration	Start Position				Depth (m)		Temp. (°C)		MBT[1]
No.	Date	(GMT)	(minutes)	Latitude (°N)		Longitude (°W)		Gear	Bottom	Gear	Surface	No.
201	12 Jul	8:20	38	37	42.83	123	13.76	250	1030	8.5	14.3	2
202	14 Jul	9:08	42	38	57.38	124	4.81	250	869	7.5	13.0	6
203	15 Jul	11:31	50	39	27.04	124	6.04	250	784	7.3	12.2	8
204	16 Jul	6:45	35	39	47.61	124	11.90	246	746	9.4	12.1	12
205	17 Jul	6:02	54	40	18.35	125	8.11	246	1301	8.9	13.2	15
206	18 Jul	6:24	32	40	46.93	124	34.25	251	553	7.6	12.6	--
207	20 Jul	10:19	57	41	57.18	124	50.29	244	856	6.9	--	--
208	6 Aug	10:13	53	46	26.14	124	59.47	250	1500	6.8	17.0	32
209	7 Aug	7:14	39	46	57.06	125	2.23	251	774	6.6	16.5	35
210	7 Aug	10:30	41	46	47.04	124	57.69	247	621	6.9	15.6	36
211	11 Aug	11:32	45	48	12.02	125	43.30	250	638	6.5	14.6	51
212	15 Aug	5:34	39	48	17.86	126	8.97	252	767	6.6	15.7	65
213	16 Aug	6:42	43	48	45.70	126	37.24	248	802	6.7	16.3	69
214	17 Aug	6:21	45	48	54.38	126	36.65	259	792	6.3	16.8	73
215	18 Aug	10:39	47	49	7.21	126	59.54	260	514	6.3	15.5	77
216	19 Aug	12:23	15	49	37.81	127	12.21	87	128	7.5	15.5	81
217	24 Aug	7:22	46	51	18.21	130	8.42	207	819	6.6	15.2	91
218	25 Aug	10:09	52	50	48.77	129	27.33	258	873	6.1	15.2	95
301	22 Jul	9:44	25	42	48.16	124	56.32	254	646	6.7	13.8	532/301
302	27 Jul	11:45	28	44	18.53	125	1.61	252	772	6.7	13.7	533/302
303	31 Jul	8:51	23	45	25.55	124	49.30	254	834	6.7	17.2	534/303
304	1 Aug	7:31	28	45	54.07	124	46.87	253	556	6.7	16.6	535/304
305	1 Aug	10:30	26	45	38.56	124	41.42	252	397	6.5	16.0	536/305

[1] CTDs were used for bongo net tows

Table 7. Summary of conductivity-temperature-depth (CTD) casts made prior to and during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10.

Number	Date	Time (GMT)	Latitude (N)	Longitude (W)	Depth (m) Cast	Depth (m) Bottom
500	30 Jun	19:36	48 9.00	122 23.81	77	81
501	10 Jul	9:45	36 32.90	123 6.33	1015	>1500
502	11 Jul	10:45	36 58.22	122 40.59	756	781
503	12 Jul	7:16	37 43.53	123 14.22	993	>1000
504	12 Jul	10:08	37 44.17	123 25.49	1014	>1100
505	13 Jul	5:31	38 18.16	123 38.71	912	966
506	16 Jul	5:35	39 48.12	124 6.28	603	617
507	16 Jul	7:48	39 47.87	124 11.97	496	748
508	16 Jul	8:51	39 47.36	124 12.76	691	957
509	18 Jul	5:35	40 47.62	124 34.19	543	545
510	22 Jul	7:49	42 38.00	124 43.62	423	427
511	23 Jul	9:08	42 58.45	124 57.96	476	769
512	23 Jul	9:57	42 58.19	124 55.86	453	455
513	26 Jul	11:52	44 8.39	125 33.89	1218	>1500
514	31 Jul	9:47	45 25.18	124 48.82	608	804
515	1 Aug	8:56	45 48.48	124 49.60	823	866
516	2 Aug	6:58	46 8.13	124 44.92	823	825
517	5 Aug	5:24	45 58.49	125 10.75	1015	1405
518	5 Aug	7:21	45 58.34	124 56.13	578	579
519	5 Aug	8:46	45 58.27	124 41.87	213	219
520	5 Aug	10:11	45 57.77	124 27.42	142	148
521	5 Aug	11:28	45 58.23	124 14.05	98	106
522	6 Aug	11:53	46 33.87	124 55.03	837	839
523	7 Aug	8:30	46 58.26	125 3.29	899	901
524	7 Aug	11:48	46 47.09	125 3.22	678	682
525	15 Aug	4:32	48 18.28	126 11.03	861	925
526	16 Aug	5:26	48 48.13	126 40.55	903	923
527	17 Aug	5:22	48 54.66	126 35.41	790	792
528	17 Aug	10:27	48 59.00	127 6.61	1522	>1600
529	21 Aug	19:23	52 0.25	131 1.01	63	64
530	24 Aug	8:43	51 18.19	130 9.46	800	813
531	25 Aug	7:22	50 49.18	129 28.66	671	852
532/301	22 Jul	9:44	42 48.16	124 56.32	254	646
533/302	27 Jul	11:45	44 18.53	125 1.61	252	772
534/303	31 Jul	8:51	45 25.55	124 49.30	254	834
535/304	1 Aug	7:31	45 54.07	124 46.87	253	556
536/305	1 Aug	10:30	45 38.56	124 41.42	252	397
537/701	23 Jul	17:22	42 57.93	124 53.99	272	335

Table 8. Summary of expendable-bathythermograph (XBT) casts made during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10

Number MOA	Number SEAS	Date	Time (GMT)	Latitude (N)		Longitude (W)		Bottom Depth (m)
1	6	7 Jul	17:19	47	7.60	125	26.16	>800
2	7	11 Jul	22:58	37	40.61	123	49.91	>800
3	8	12 Jul	19:39	38	8.14	123	25.37	225
4	9	14 Jul	14:21	38	48.19	123	50.99	179
5	10	15 Jul	8:46	39	29.80	124	34.23	>800
6	11	17 Jul	2:41	40	21.91	124	29.33	378
7	12	17 Jul	19:33	40	31.23	124	38.07	172
8	13	18 Jul	1:42	40	46.52	124	30.25	351
9	14	18 Jul	17:21	41	8.11	124	49.35	1097
10	15	18 Jul	19:00	41	8.07	124	23.87	397
11	16	18 Jul	19:15	41	8.09	124	19.84	144
12	17	19 Jul	0:00	41	18.03	124	30.19	597
13	18	19 Jul	5:52	41	16.55	124	23.16	156
14	19	19 Jul	16:13	41	30.52	124	33.87	633
15	20		*** Bad Probe	***				
16	21	19 Jul	22:30	41	47.71	124	58.14	1045
17	22	19 Jul	23:58	41	47.25	124	37.86	645
18	23	20 Jul	2:39	41	48.12	124	31.10	408
19	24	20 Jul	2:53	41	48.21	124	27.79	153
20	25	20 Jul	5:54	41	58.17	124	31.60	132
21	26	20 Jul	9:35	41	58.29	124	49.69	847
22	27	20 Jul	17:32	41	58.16	124	35.37	283
23	28	20 Jul	19:42	41	58.99	125	5.68	1256
24	29	20 Jul	21:24	42	8.33	125	4.98	811
25	30	20 Jul	23:08	42	8.10	124	39.49	479
26	31	21 Jul	2:06	42	8.25	124	33.49	151
27	32	21 Jul	5:31	42	17.84	124	40.15	367
28	33	21 Jul	8:55	42	18.21	124	53.96	1011
29	34	21 Jul	17:31	42	18.29	124	44.93	529
30	35	22 Jul	0:10	42	28.11	124	48.76	297
31	36	22 Jul	5:20	42	37.48	124	41.47	176
32	37	22 Jul	19:26	42	40.32	124	49.67	681
33	38	22 Jul	21:59	42	39.15	125	23.56	270
34	39	23 Jul	3:36	42	48.12	124	48.68	328
35	40	23 Jul	15:51	42	58.20	124	51.16	119
36	41	23 Jul	22:00	43	8.10	125	12.53	936
37	42	23 Jul	23:24	43	8.05	124	52.85	406
38	44	24 Jul	0:18	43	8.07	124	39.70	153
39	45	24 Jul	17:45	43	26.64	124	45.63	510
40	46	24 Jul	23:25	43	38.16	124	29.57	150
41	47	25 Jul	0:06	43	38.09	124	40.11	400
42	48	25 Jul	3:56	43	38.07	125	11.60	801
43	49	25 Jul	18:14	43	48.35	124	35.24	225
44	50	26 Jul	1:13	43	58.09	124	34.17	158
45	51	26 Jul	8:51	44	2.88	124	59.52	835
46	52	26 Jul	16:18	44	12.02	125	16.73	802
47	53	26 Jul	17:41	44	8.18	124	59.15	392

Table 8. (cont.)

Number MOA	Number SEAS	Date	Time (GMT)	Latitude (N)		Longitude (W)		Bottom Depth (m)
48	54	26 Jul	17:58	44	8.26	124	54.42	151
49	55	27 Jul	1:32	44	18.28	124	53.03	306
50	56	27 Jul	5:58	44	20.71	125	13.71	>450
51	57	27 Jul	20:15	44	28.25	124	52.92	417
52	58		*** Bad Probe ***					
53	59	28 Jul	21:33	44	48.20	125	3.96	1466
54	60	28 Jul	22:26	44	48.10	124	49.04	388
55	61	29 Jul	2:50	44	48.04	124	39.07	360
56	62	29 Jul	3:41	44	48.14	124	26.87	151
57	63	29 Jul	20:58	45	6.30	125	9.00	>800
58	64	29 Jul	22:19	45	8.10	124	49.08	>400
59	65	30 Jul	0:07	45	8.20	124	18.80	200
60	66	31 Jul	18:36	45	38.08	124	20.90	156
61	67	31 Jul	19:58	45	38.19	124	41.70	404
62	68	31 Jul	21:26	45	38.49	125	4.67	1483
63	69	5 Aug	15:15	46	8.22	124	34.80	154
64	70	5 Aug	15:44	46	7.75	124	43.25	728
65	71	5 Aug	17:04	46	8.14	125	4.75	1406
66	72	6 Aug	19:00	46	38.14	124	37.48	150
67	73	6 Aug	19:18	46	38.22	124	42.26	415
68	74	7 Aug	0:08	46	38.10	125	13.35	>700
69	75	7 Aug	23:08	47	7.30	125	19.09	<200
70	76	8 Aug	0:23	47	8.07	124	59.24	370
71	77	8 Aug	0:41	47	8.13	124	54.14	150
72	78	9 Aug	15:28	47	38.09	124	57.19	142
73	79	9 Aug	16:04	47	38.16	125	7.21	406
74	80	9 Aug	18:08	47	38.12	125	41.31	1365
75	81	11 Aug	1:59	48	8.20	125	14.13	274
76	82	14 Aug	16:57	48	8.14	126	7.73	1395
77	83	14 Aug	18:13	48	8.11	125	45.08	395
78	84	14 Aug	18:43	48	8.13	125	35.98	151
79	85	15 Aug	19:15	48	38.13	126	7.74	150
80	86	15 Aug	19:36	48	38.14	126	13.38	423
81	87	16 Aug	2:31	48	38.58	126	47.34	1455
82	88	17 Aug	17:12	49	8.09	127	24.54	801
83	89	17 Aug	21:21	49	8.20	126	58.11	403
84	90	17 Aug	21:54	49	8.16	126	48.00	149
85	91	19 Aug	1:56	49	38.11	127	18.33	150
86	92	19 Aug	2:16	49	38.13	127	24.27	419
87	93	19 Aug	3:46	49	38.01	127	50.85	1360
88	94	19 Aug	23:04	50	8.14	128	2.71	264
98	95	19 Aug	23:11	50	8.15	128	4.79	432
90	96	20 Aug	2:55	50	8.23	128	34.22	805
91	97	21 Aug	1:17	50	38.12	128	32.70	155
92	98	21 Aug	2:14	50	38.08	128	50.30	468
93	99	23 Aug	14:11	51	38.11	129	47.70	201
94	100	23 Aug	14:17	51	38.14	129	49.54	204
95	101	23 Aug	15:19	51	38.15	130	9.54	494
96	102	23 Aug	19:24	51	38.16	130	48.05	1005
97	103	24 Aug	16:31	51	8.13	130	23.00	809

Table 9. Summary of acoustic buoy operations during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10.

Date	Deployment Sequence	No. of Passes	Echosign Depth (m)
30 Jul	1	7	80 - 130
	2	4	100 - 140
1 Aug	3	10	300 - 350
26 Aug	4	5	100 - 150
	5	3	100 - 130
	6	15	80 - 125

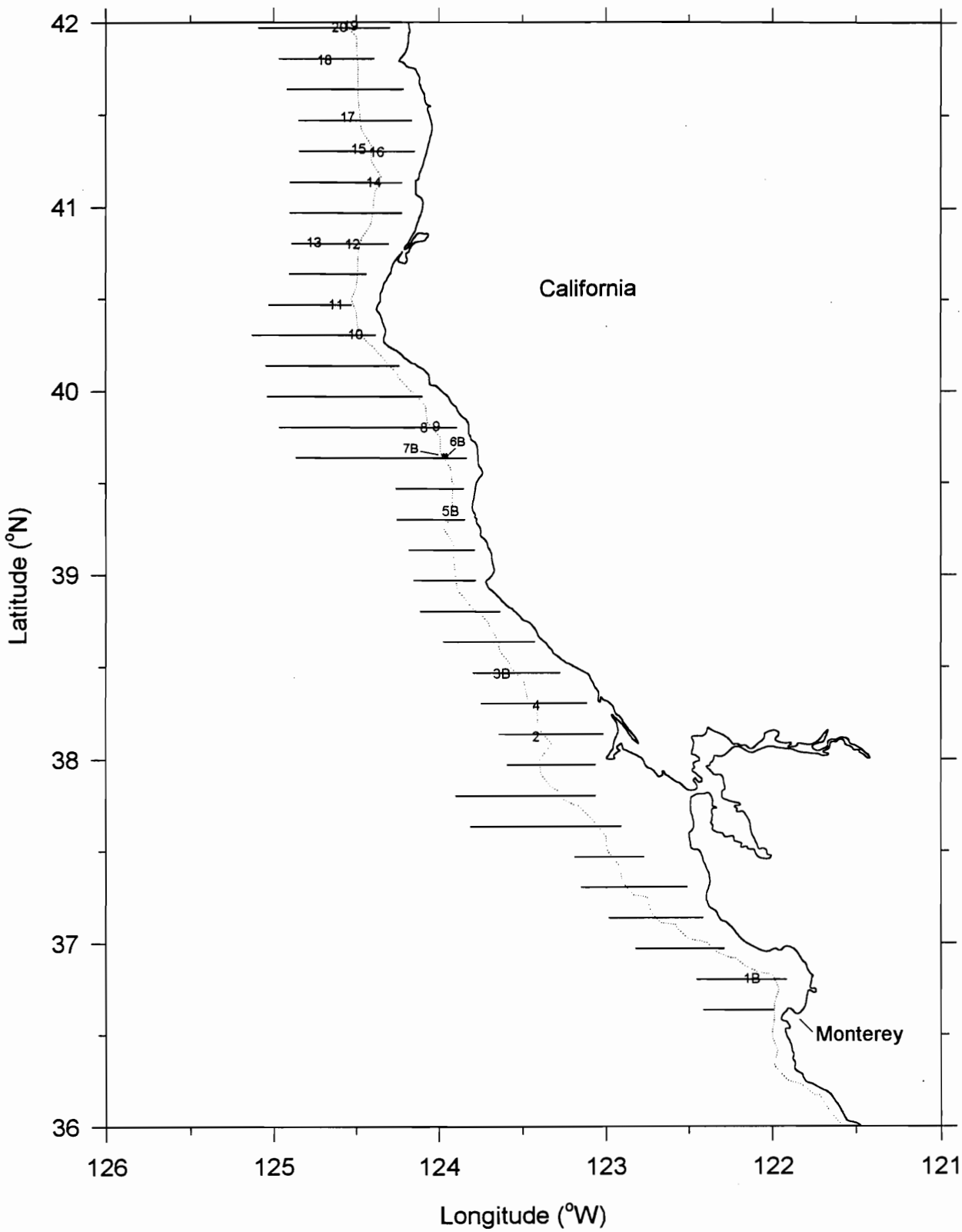

Figure 1a. Survey trackline with haul locations for the Aleutian wing trawl and poly Nor'eastern bottom trawl (B) during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10. The dotted line represents the 200-m bottom contour.

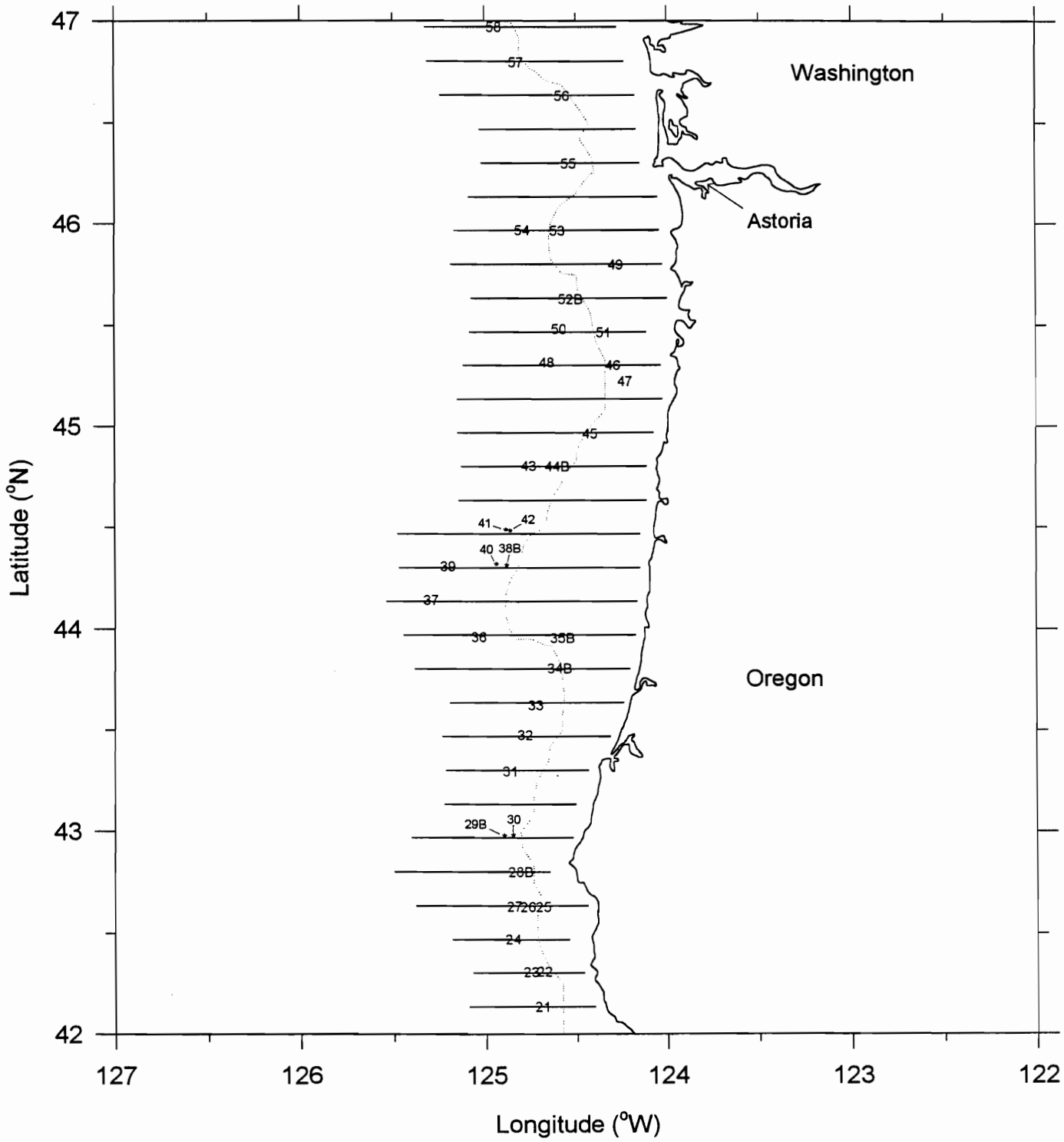

Figure 1b. Survey trackline with haul locations for the Aleutian wing trawl and poly Nor'eastern bottom trawl (B) during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10. The dotted line represents the 200-m bottom contour.

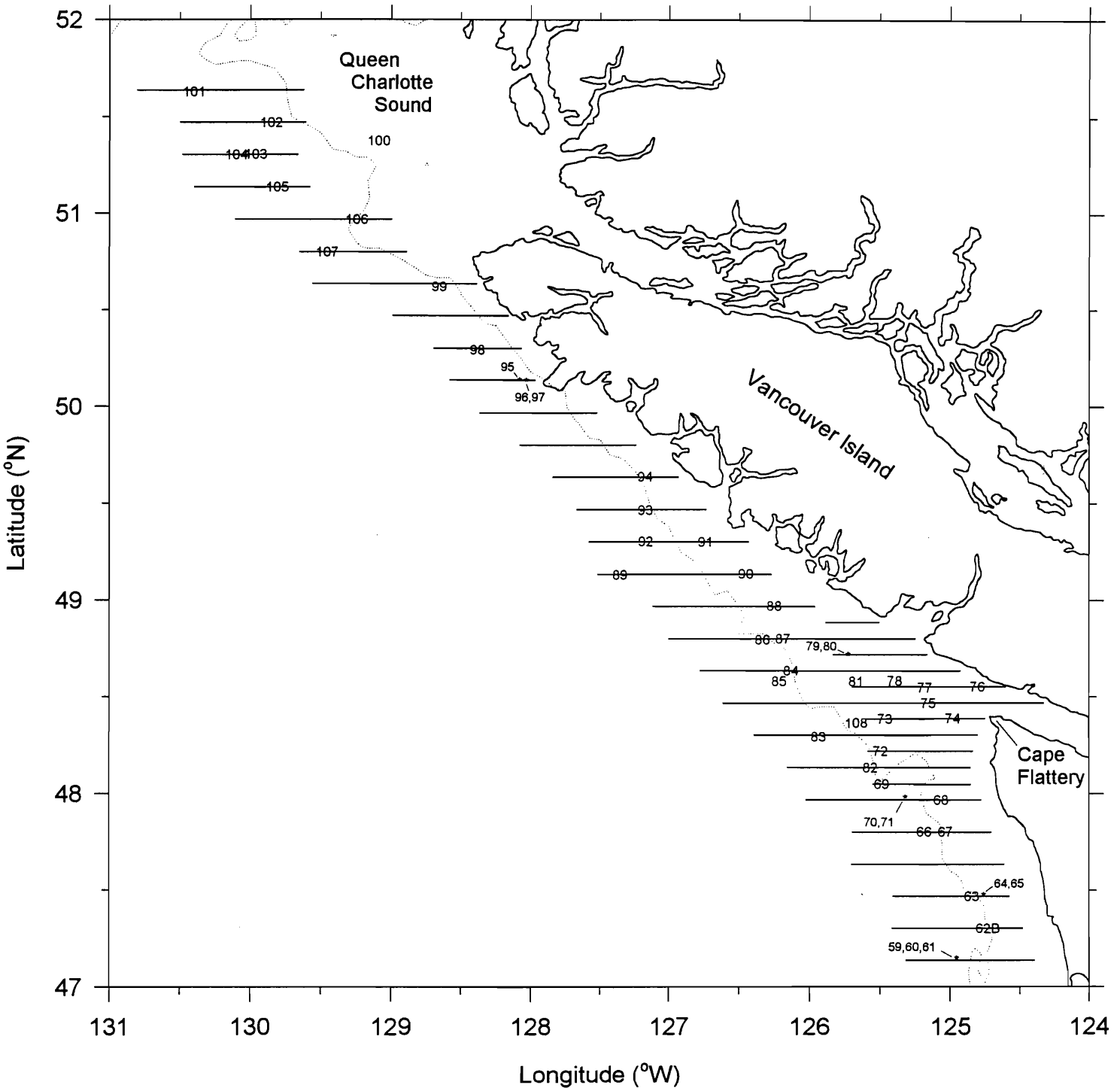

Figure 1c. Survey trackline with haul locations for the Aleutian wing trawl and poly Nor'eastern bottom trawl (B) during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10. The dotted line represents the 200-m bottom contour.

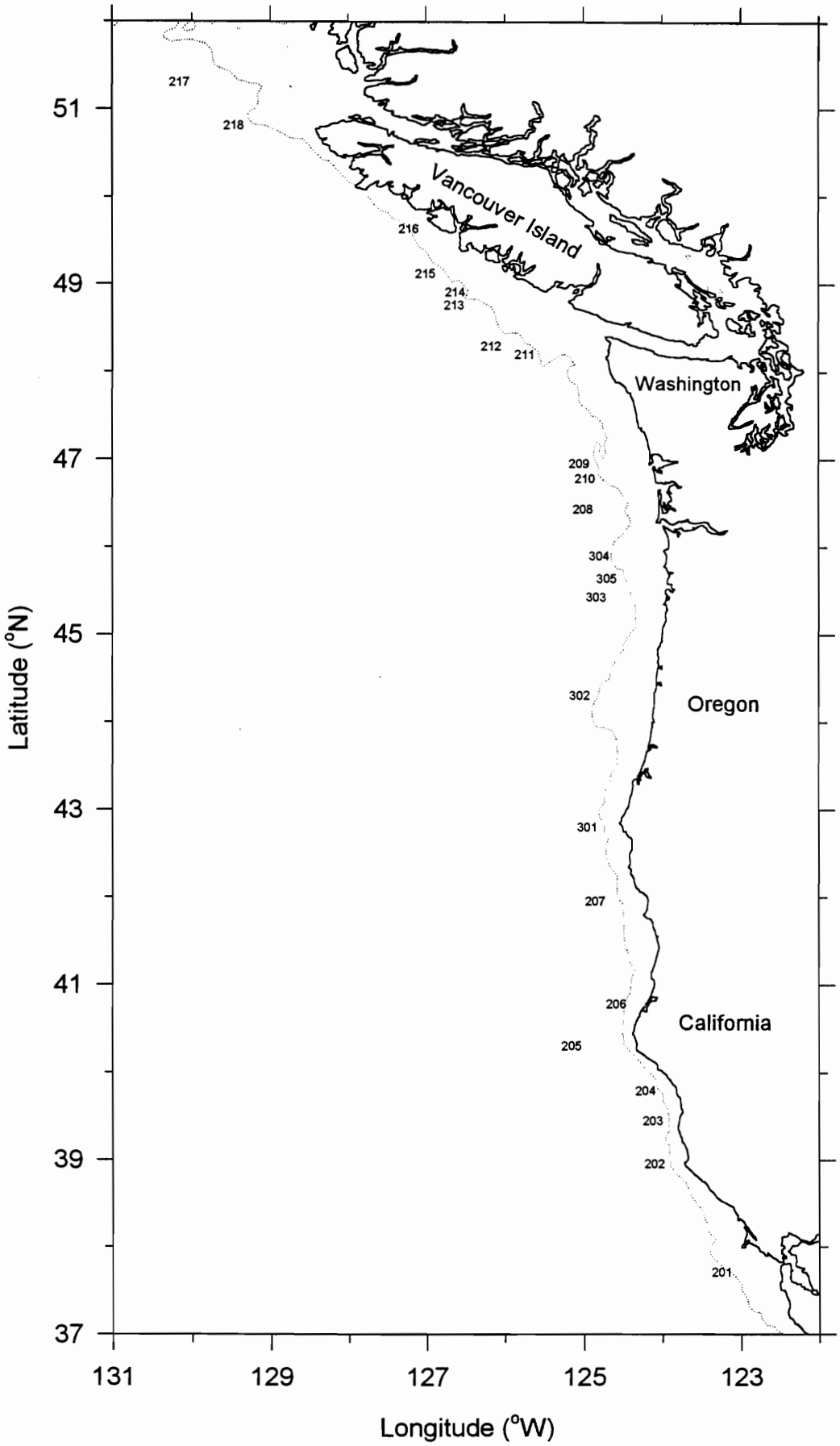

Figure 2. Haul locations for the Methot trawl (201-218) and the bongo net (301-305) during the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10. The dotted line represents the 200-m bottom contour.

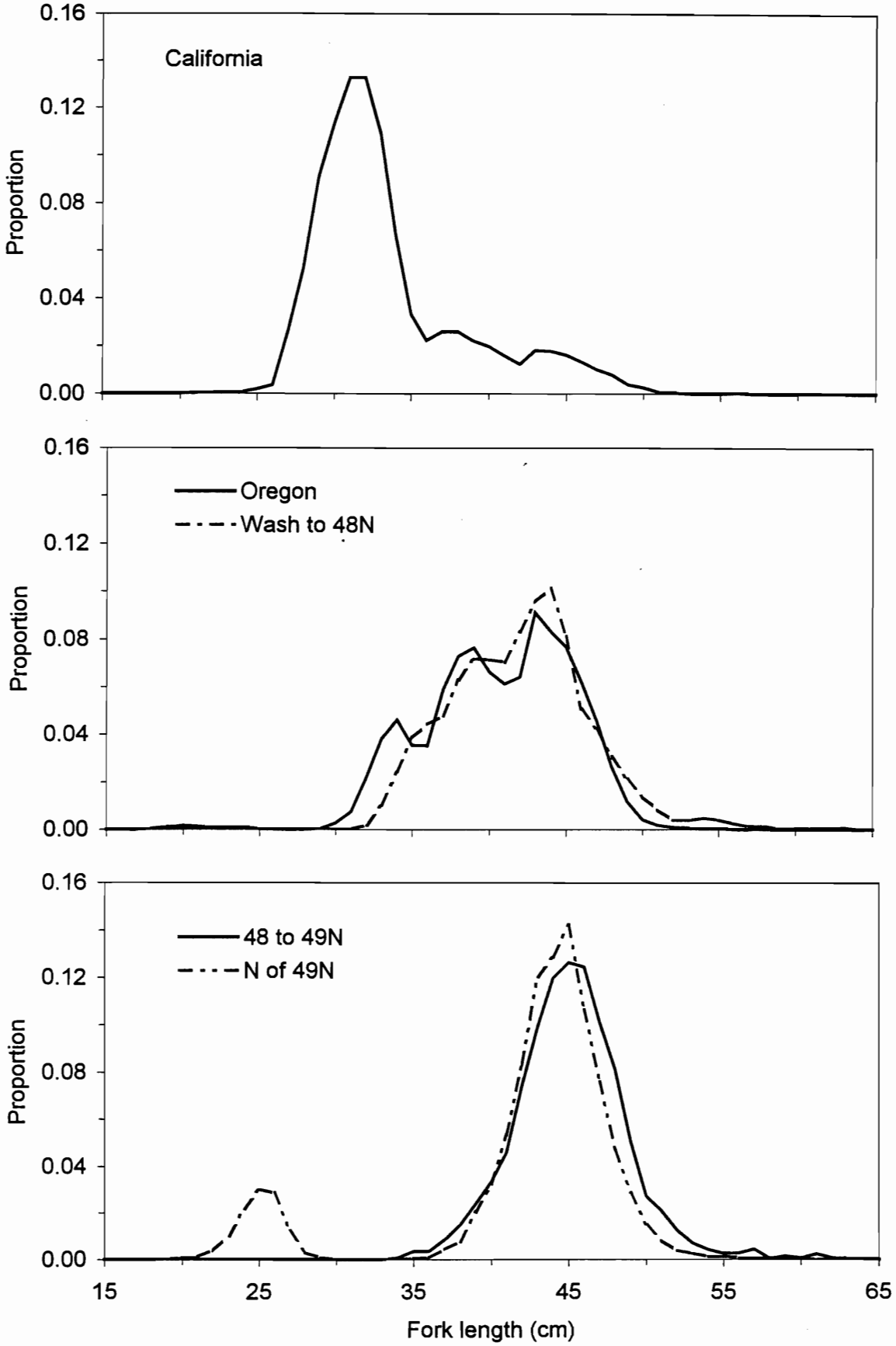

Figure 3. Proportion (by number) at length of Pacific whiting during the 1998 echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10.

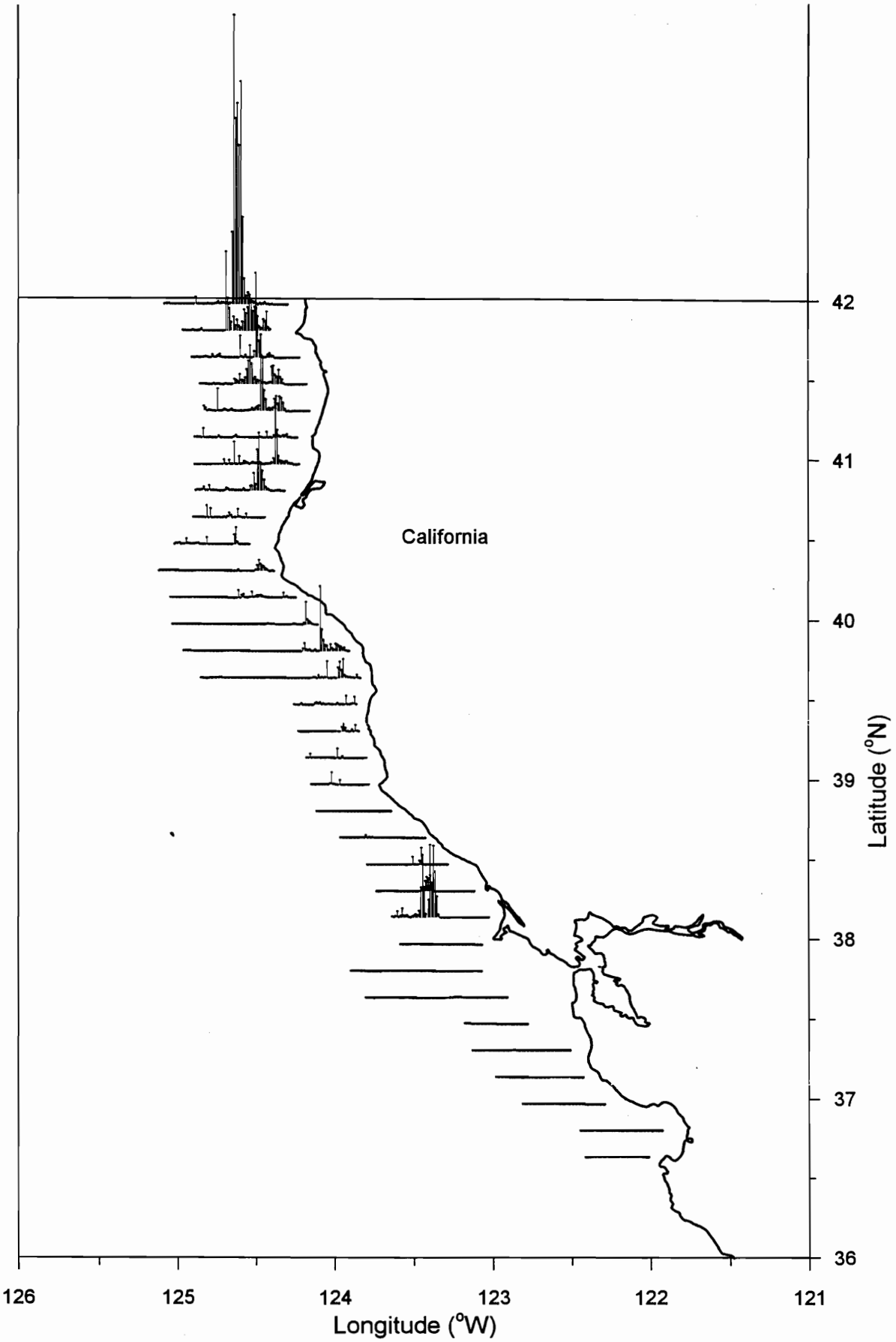

Figure 4a. Acoustic backscattering attibuted to Pacific whiting along transects off the U.S. and Canadian west coasts during the 1998 echo integration-trawl survey, MF98-10.

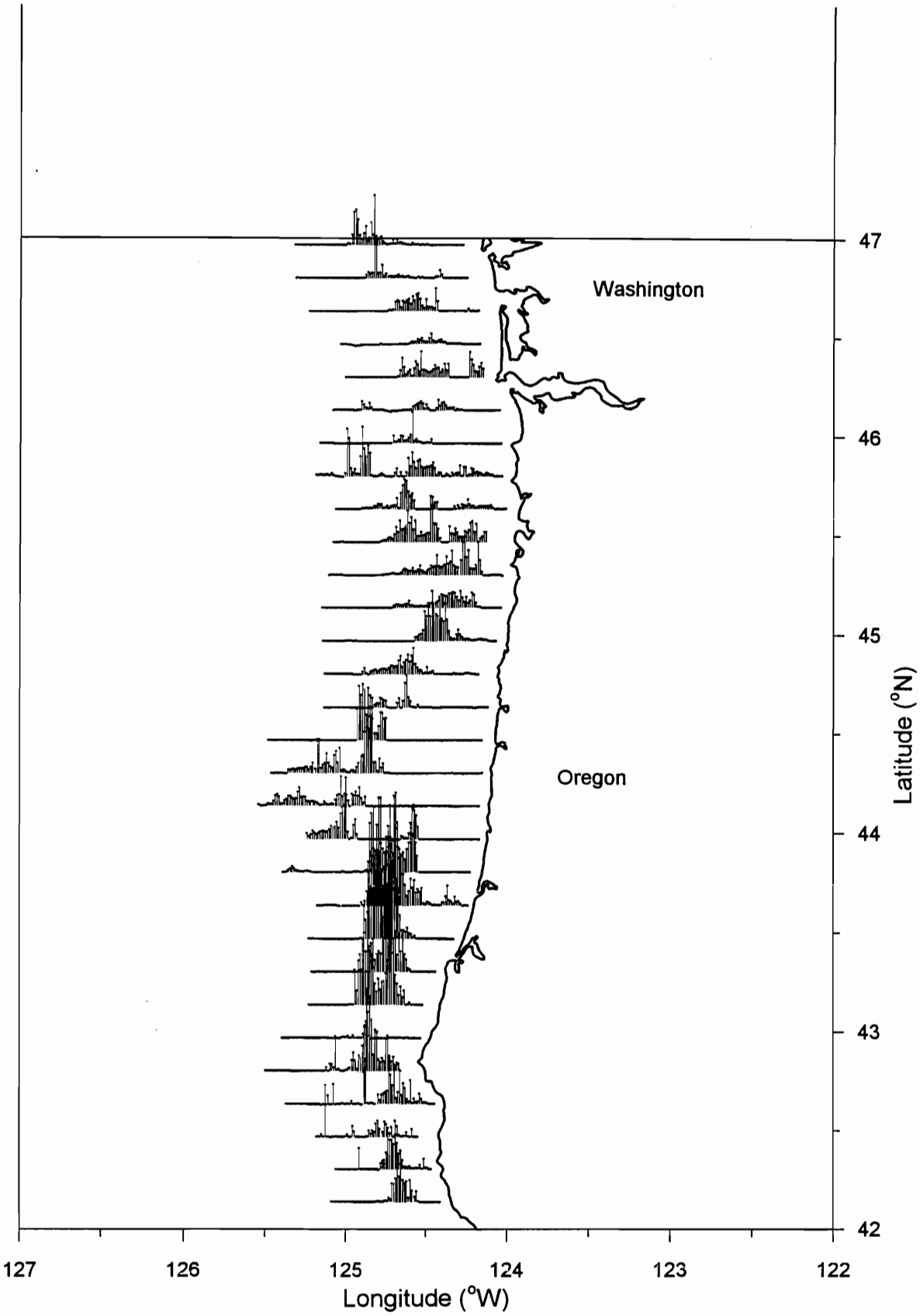

Figure 4b. Acoustic backscattering attibuted to Pacific whiting along transects off the U.S. and Canadian west coasts during the 1998 echo integration-trawl survey, MF98-10.

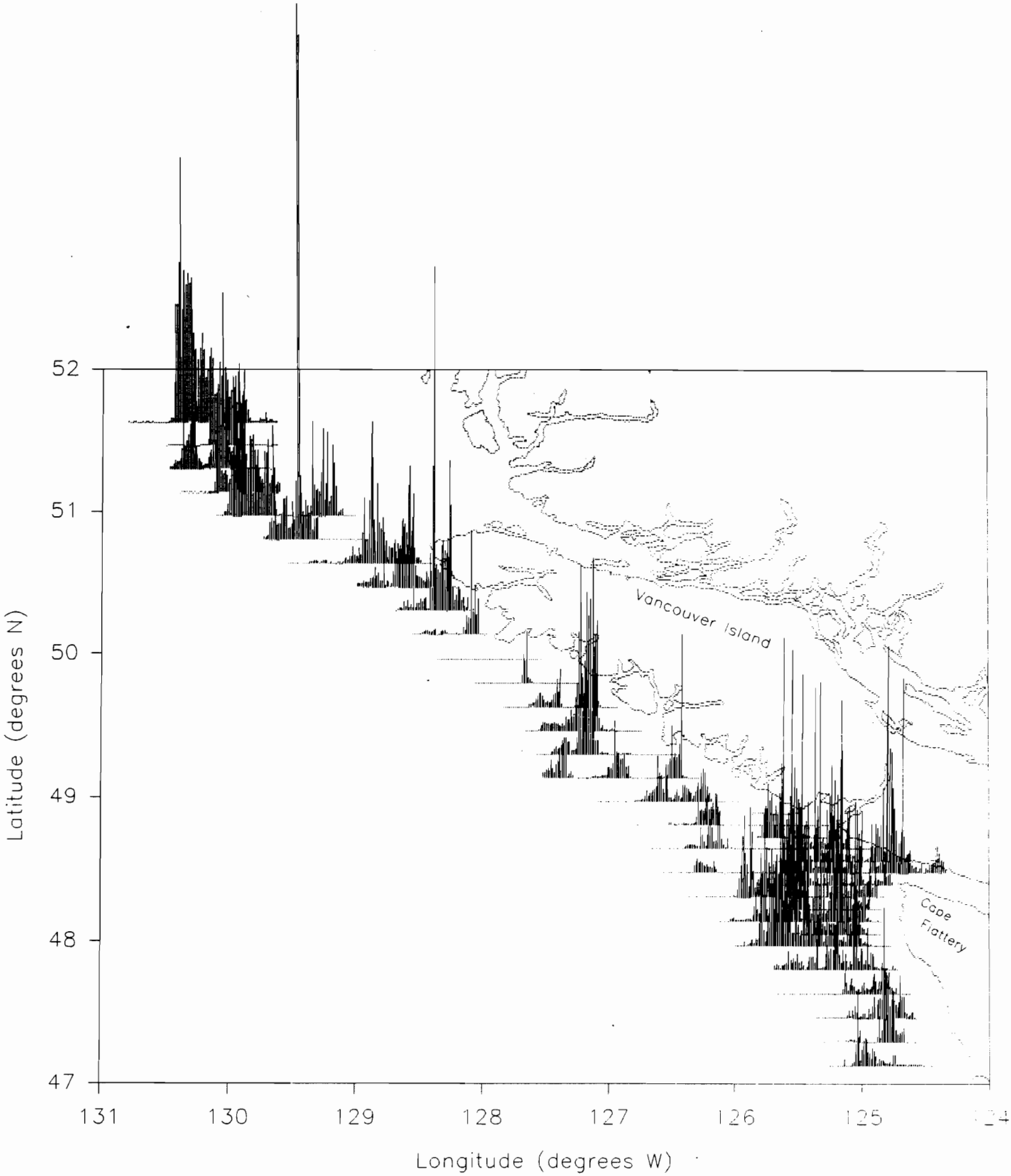

Figure 4c. Acoustic backscattering attributed to Pacific whiting along transects off the U.S. and Canadian west coasts during the 1998 echo integration–trawl survey, MF98–10.

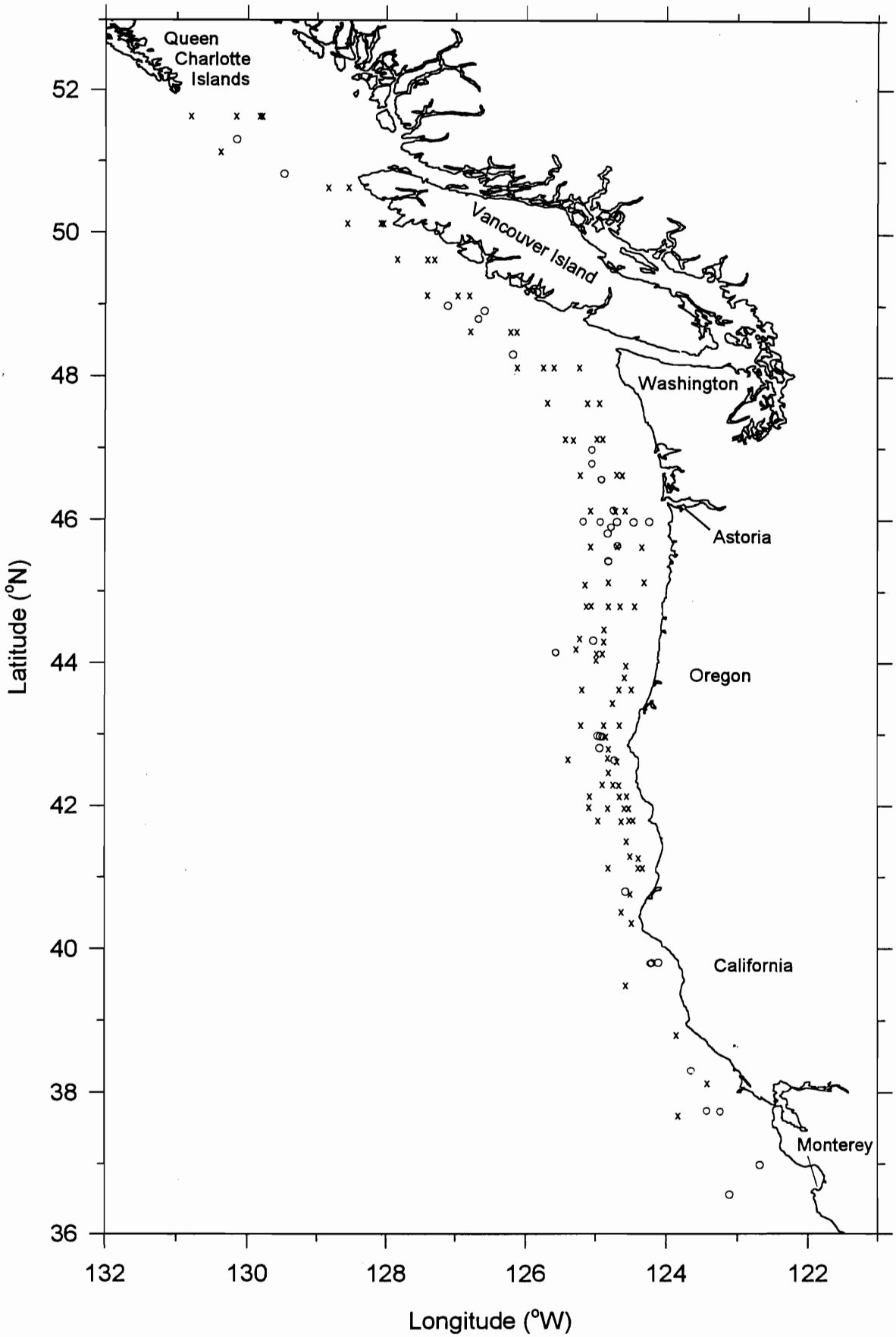

Figure 5. Conductivity-temperature-depth (CTD) and expendable bathy-thermograph (XBT) cast locations for the 1998 Pacific whiting echo integration-trawl survey of the U.S. and Canadian west coasts, MF98-10. CTD casts are labeled with an "o" and XBT casts are labeled with an "x".