UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest and Alaska Fisheries Center
Resource Assessment and Conservation Engineering
2725 Montlake Boulevard East
Seattle, WA 98112

April, 1984

CRUISE RESULTS
Charter Vessel GOLD N SUN
Cruise No. GS-83-1
Pacific Whiting Echo Integrator-Midwater Trawl Survey
July 27 - September 29, 1983

CRUISE PERIOD, AREA and SCHEDULE

An acoustic (echo integrator)-midwater trawl survey of the Pacific whiting (Merluccius productus) stock in the region between Santa Cruz, California (36°48'N) and Clayoquot Sound, Vancouver Island, British Columbia (48°15'N) was conducted aboard the charter vessel Gold N Sun during August 4 to September 22, 1983. The vessel's itinerary was as follows:

July 27 - Aug.3	Vessel loading and acoustic system calibration, Seattle, WA; transit to Santa Cruz (vessel off charter on July 29).
	Leg I
Aug. 4-18	Conducted survey from Santa Cruz to near Coos Bay, OR; in port at Eureka, CA on Aug. 11-12 to exchange scientific personnel; arrived Coos Bay on Aug. 18.
	Leg II
Aug. 19-25	Continued survey north to Tillamook Head, OR; in port at Neah Bay, WA on Aug. 25 to exchange scientific personnel.
Aug. 26-27	Completed collection of echo integrator systems intercalibration data with Canadian research vessel G.B.Reed offshore from entrance to Strait of Juan de Fuca.
Aug. 28-Sept 8	Conducted survey of northern Washington-Vancouver Island area between 48°00'N and 48°50'N; arrived Neah Bay on Sept. 8 to exchange scientific personnel.

Leg III

Sept. 9-11	Completed survey off Vancouver Island (48°50'N to 49°15'N).
Sept. 12-22	Surveyed area from Tillamook Head, OR to 48°00'N and collected data for Pacific whiting target strength estimation studies; arrived Seattle on Sept. 22.
Sept. 28-29	Acoustic system calibration and vessel unloading, Seattle (vessel off charter during Sept. 23-27).

OBJECTIVES

The objectives of the survey were to:

1) Collect echo integrator and midwater trawl data necessary to estimate the distribution, biomass and biological composition of the midwater (off-bottom) component of the commercially available Pacific whiting stock, and to provide data on the relative abundance of pre-recruit age groups.

2) Conduct cooperative survey effort with Canadian scientists (Pacific Biological Station, Nanaimo, British Columbia) to provide data required to: (a) compare target densities estimated by echo integrator systems used on the Gold N Sun and the Canadian research vessel G. B. Reed, and (b) obtain comparable independent U.S. and Canadian estimates of Pacific whiting biomass in the area between 48°00'N and 49°00'N.

3) Obtain measurements of the target strength (acoustic size) of Pacific whiting using a dual beam system.

4) Obtain data on the distribution, abundance and biological composition of shortbelly rockfish (Sebastes jordani) off California between 36°55'N and 37°25'N.

5) Collect biological data on yellowtail rockfish (Sebastes flavidus) captured by midwater trawl for comparisons with bottom trawl samples.

The Gold N Sun's survey was complemented by a bottom trawl survey of the same region that was completed between July 12 and September 29 by the charter vessels Nordfjord and Warrior II. The combined acoustic-bottom trawl survey was the third in a triennial series designed to provide fishery independent information on changes in the abundance and distribution of west coast groundfish stocks, especially Pacific whiting and commercially important species of rockfish.

VESSEL, EQUIPMENT and GEAR

The Gold N Sun is a 38.7 m (127 ft) stern ramp crabber/trawler with a 1,165 horsepower single main engine. Its equipment included a single net reel located above the stern ramp, a main deck hydraulic boom that was used for handling trawl catches and towing the acoustic system's transducer, and a cable netsounder system with its transducer mounted at the center of the headrope.

Acoustic data were collected using a computerized echo integration and target strength measurement system installed in a 4.9 m long x 3.2 m wide x 3.0 m high (16 x 10.5 x 10 ft) sea-land van. The system includes a 38 kHz echo sounder used with a dual beam transducer with 6° narrow (transmit and receive) and 25° (receive only) beams. The transducer was mounted in a deadweight body that was towed behind the stern of the vessel on the starboard side. The echo sounder's receiver consists of one 20 $\log_{10}R$ TVG channel (narrow beam signal for echo integration) and two 40 $\log_{10}R$ TVG channels (narrow and wide beam signals for target strength measurement). The sounder transmitted at a pulse repetition rate of 1 per second with a nominal pulse length of 0.6 milliseconds. Echo data were processed using a Hewlett Packard 1000 computer[1/] and most of the data were also recorded in analog (envelope detected) form on an FM tape recorder.

Echo sign was sampled using a rectangular midwater trawl with 6 m^2 rectangular steel doors, 55 m (30 fm) dandylines (2 per side) and a 113 kg (250 lb) chain tom weight attached to each lower wing tip. Mesh size (stretched measure) tapered from 81 cm (32 in) in the wings and forward part of the body to 3.6 cm (1.4 in) in the codend. The average vertical mouth opening of the trawl varied from 15 to 20 m depending on depth and towing speed. The trawl's mouth opening and depth were estimated from netsounder echograms.

Water temperature profile data were collected using an expendable bathythermograph (XBT). Surface temperatures were measured with a bucket thermometer.

SURVEY AND ANALYSIS METHODS

The survey covered a depth range of 55-366 m (30 to 200 fm) along a zig-zag trackline situated approximately perpendicular to depth contours (Figure 1). The average distance between adjacent transects was usually 5 nmi between 37°00'N and 48°00'N and approximately 4 nmi between 48°00'N and 49°15'N. South of 37°00'N, additional transects were run between depths of 128 and 366 m (70 and 200 fm) in order to improve the sampling for shortbelly rockfish which are typically found concentrated near the shelf break. Operations were confined to daylight hours (~0600-2100 PDT) except when collecting target strength data.

1/ Reference to trade names or commercial firms does not imply endorsements by the National Marine Fisheries Service, NOAA.

The area between 48°00'N and 49°00'N was also surveyed by the Canadian research vessel G. B. Reed (acoustic sampling) and the Canadian charter vessel Marwood (midwater trawl sampling) (Figure 2).

Vessel speed along transects was about 9 kn and the average depth of the towed transducer was approximately 10 m. Echo integrator density estimates were computed at 1 minute intervals (60 pings) for each non-overlapping 1 m depth stratum between the transducer and the bottom. Under most conditions, targets located more than approximately 4 m above the bottom could be detected and isolated from bottom echoes. Echograms and an independent set of bottom referenced echo integrator data were used to help eliminate possible bottom echo data. The bottom referenced data were density estimates for each 1 m depth stratum within 40 m of the bottom.

Midwater trawl hauls were made at selected locations to identify echo sign and/or provide biological samples. The duration of each trawl haul depended on the time considered necessary (based on observation of netsounder recordings) to capture enough fish for biological sampling purposes. The average trawl towing speed was about 3.5 kn. Standard catch sorting and biological sampling procedures were used to provide estimates of weight and number by species for each haul, length frequencies by sex for abundant species, individual weight measurements for Pacific whiting, and otolith samples for Pacific whiting and yellowtail rockfish.

The identification of echo sign, which focused on separating aggregations of Pacific whiting from other species, was done by analysis of echograms and the species composition in midwater trawl catches. Biomass estimates, which for this report include only those obtained for Pacific whiting, were determined by extrapolating average surface density estimates (kg/m^2) over appropriate areas. Surface density estimates were calculated by summing volume densities (kg/m^3) over depth strata. The echo integrator outputs were scaled to estimates of density by assuming the average target strength (i.e., the target strength of the average scattering cross section) of Pacific whiting in the length range encountered on the survey is -35 dB/kg. Age specific biomass and number estimates were calculated for each Pacific whiting aggregation using selected midwater trawl length frequency samples, a length-weight relationship and an age-length key. The aggregation estimates were summed to produce estimates for each International North Pacific Fisheries Commission (INPFC) statistical area.

Target strength measurements were obtained only at night when Pacific whiting were more dispersed and the occurrence of single target echoes was increased. During target strength data collection, the transducer was towed at a speed of approximately 5 kn. Trawl sampling at appropriate depths was done just before or after each period of data collection to provide species composition and biological data.

Data for intercalibration of the U. S. and Canadian echo integrator systems were acquired by running the vessels side-by-side approximately 1/4 nmi apart along a preselected set of transects located between 48°25'N and 48°34'N and 125°10'W and 125°26'W. Data were collected for previously agreed-on time intervals and depth ranges. Significant quantities of fish, which appeared to be mainly Pacific whiting, were present in the area. Trawl sampling was not necessary during the intercalibration period since species composition data are not required to compare results.

RESULTS

Sampling Effort

Echo integrator data were collected on a 3,176 nmi (5,882 km) trackline comprised of 188 transects (Figure 1). Pacific whiting target strength measurement samples were collected off the Washington coast for approximately 15 hours on 4 nights during September 16-21. Thirty-eight midwater trawl hauls were completed, 34 during the daytime survey and 4 in conjunction with the sampling for target strength data (Table 1). XBT and surface temperature data were collected at 58 locations, including 34 of the trawl stations.

Length measurements were obtained for 8,612 Pacific whiting, 441 yellowtail rockfish, 357 Pacific herring, 72 redstripe rockfish, 68 spiny dogfish and 66 widow rockfish. Otoliths were collected from 2,100 Pacific whiting and 205 yellowtail rockfish. Individual weight measurements were recorded for 538 Pacific whiting. Length-weight relationships determined using these measurements are shown in Figure 3.

The frequency of occurrence and total catch of each species taken in midwater trawl hauls are shown in Table 2. As expected, because of the selective nature of the trawl sampling, Pacific whiting was the dominant species in the catches. The average catch per haul for whiting (1,624 lb) was larger than the total catch of any other species. The number of trawl hauls by INPFC area was: Monterey (1 = 2.6%), Eureka (4 = 10.5%), Columbia (11 = 29.0%) and Vancouver (22 = 57.9%). The distribution of trawl stations was caused partly by the more frequent occurrence in the Columbia area and, particularly, the Vancouver area of species other than whiting which are found in significant quantities in midwater. Also, as indicated later in this report, it reflects a very low abundance of whiting and other midwater fish echo sign in the Monterey area, as well as an unusual degree of uniformity in the length and age composition of whiting found south of the Vancouver area. Although the occurrence of midwater species other than whiting was highest in the Vancouver area, their overall abundance in the area and, consequently, the problem of delineating whiting echo sign in the area, were less than during comparable surveys in 1977 and 1980. The difference among years is partially indicated by a comparison of the frequency of occurrence of selected species in midwater trawl hauls made in the Vancouver area in 1977, 1980, and 1983 (Table 3).

Pacific Whiting Abundance and Age and Length Composition

Estimates of the size of the midwater (off-bottom) component of the Pacific whiting population, by age and INPFC area, are shown in Table 4 and Figure 4. The geographic distribution of whiting aggregations is illustrated in Figure 5. Whiting length distributions by INPFC area are shown in Figures 6 and 7.

The whiting population was dominated by the 1980 year class (age 3) and was located mainly in the Vancouver and Columbia areas. Only 25% of the total biomass was in the Eureka and Monterey areas, and no concentrations of whiting were found in the Monterey area except very close to its northern border. The small size and restricted distribution of the population in the Monterey area was unusual, particularly since young fish are typically most abundant in the southern part of the survey region. A further indication of the lack of whiting (and other fish) echo sign in the Monterey area is the fact only one trawl haul was made in the area.

Whiting in the Vancouver area were predominantly age 3 but older age groups were more abundant than in the remainder of the survey region and the strong 1977 year class (age 6) was a significant part of the population (34% of the estimated biomass). There was very little variation among the Columbia, Eureka and Monterey areas in whiting age and length distributions. Only a small fraction of the population in each area was other than age 3. Due mainly to the presence of 6-year-old fish, average age and length were slightly higher in the Columbia area. It is worth noting that there were obvious differences between the length distributions of whiting determined from the acoustic - midwater trawl survey and those resulting from the bottom trawl survey (see Cruise Results report, Chartered Vessels Nordfjord and Warrior II, Cruise No. 83-1). Only a small percentage of whiting taken in bottom trawls in the Vancouver area was less than 45 cm and the length distribution for the area was unimodal with a mean of 50.3 cm. In the Monterey area, the mean length of the whiting population sampled by bottom trawls was 45.3 cm and the length distribution was distinctly bimodal with modes at approximately 36 cm and 47 cm. There was substantially less difference between the two types of surveys in the length distributions for the Columbia and Eureka areas. Both types of sampling indicated the population in these areas was dominated by fish between 35 and 40 cm in length.

Juvenile whiting (ages 0-2) were either not caught during the survey (ages 0 and 1) or occurred in very small quantities (age 2). This result suggests that the 1981-1983 year classes are relatively weak, but it could also be partially due to lower availability of these age groups (especially age 0) and the small amount of trawl sampling in the Eureka-Monterey region.

The total whiting biomass estimate (1,201,000 t) was similar to comparable acoustic-midwater trawl survey estimates for 1977 (1,129,000 t) and 1980 (1,344,000 t). However, the latitudinal distribution of the population by age was markedly different than observed previously, e.g. in 1980, most of the population was age 3 but this age group was unimportant in the Vancouver and Columbia areas.

The acoustic estimates of whiting biomass for all three years were determined by assuming an average target strength of -35dB/kg. Because of a lack of whiting target strength data, the use of this value has been based primarily on the literature on the target strength of anatomically similar species. An average value of -36 dB/kg for whiting with mean lengths of 50-55 cm was recently estimated from dual beam data collected at night during the 1980 survey. However, both the -35 dB/kg and -36 dB/kg estimates may be biased scaling factors for echo integrator data collected during the day. For example, recent research on walleye pollock suggests that the average value of daytime measurements for that species is approximately 3 dB/kg higher than for measurements obtained at night. If such a day vs. night difference should apply to whiting, then the current whiting biomass estimates are biased upwards (since there is an inversely proportional relationship between biomass and target strength). The whiting target strength data obtained at night during the 1983 survey have not been analyzed. Estimates obtained from these data will be compared with those determined from the 1980 data mentioned above. The primary goal of future whiting target strength research is to obtain estimates of whiting target strength during the day, and this requires towing transducers deep enough to allow aggregations of fish to be resolved as single targets.

U.S. - Canada Cooperative Research

During the Gold N Sun - G. B. Reed acoustic systems intercalibration experiment, comparative echo integrator data were collected continuously during 13 hours of side-by-side operations (26 transects, each 30 minutes in duration). The data for each transect were stratified into 15 pairs of 2-minute outputs. All the intercalibration study data are now being analyzed by Canadian scientists. The initial analysis will estimate the difference between systems/vessels using data for the entire water column, i.e., the density per unit surface area data. Depending on the outcome of this analysis, additional comparisons may be made for selected depth strata in order to test for possible depth related differences between vessels.

U.S. and Canadian survey tracklines in the area north of 48°00'N and the locations of midwater trawl hauls made during the joint survey are shown in Figure 2. The Gold N Sun's survey, which

included 17 midwater trawl hauls, was conducted during August 28 to September 11. The Canadian trackline was completed by the G. B. Reed between August 28 and September 7. Forty midwater trawl hauls were completed by the Canadian charter vessel Marwood during August 25 to September 9.

Analysis of the joint survey data is now in progress. Evaluation of the survey results will include comparisons of U.S. and Canadian total biomass and Pacific whiting biomass estimates, as well as the effects of different procedures for averaging and extrapolating density estimates. In analyzing differences between U.S. and Canadian estimates, the results of the intercalibration study will be utilized to control the effect of differences in acoustic system/vessel performance. Further analysis of the joint survey data may be undertaken to investigate selected survey design /methodology questions and to refine age specific estimates of Pacific whiting abundance for the Vancouver area.

Other Results

Shortbelly rockfish were not located in the central California area (36°55'N-37°25'N) where they are usually found in dense midwater concentrations. The absence of shortbelly rockfish and othermidwater fish echo sign in this area, and the fact that there was no midwater trawl sampling in most of the Monterey area, was unexpected given previous survey results.

Yellowtail rockfish occurred in 15 midwater trawl hauls (Table 1), but only three catches were large enough to obtain biological samples suitable for comparison with bottom trawl samples. The yellowtail rockfish length/sex data and otolith samples were provided to the Washington Department of Fisheries.

SCIENTIFIC PERSONNEL

Leg I (August 3-18)

Martin Nelson	Chief Scientist (8/3-11)	NWAFC
Neal Williamson	Statistician Chief Scientist (8/12-18)	NWAFC
Jimmie Traynor	Fishery Biologist (8/3-11)	NWAFC
Daniel Twohig	Electronic Technician	NWAFC
John Garrison	Electronic Technician	NWAFC
Jan McCrory	Biological Technician (8/12-14)	NWAFC

Leg II (August 9-Sept.8)

Neal Williamson	Statistician Chief Scientist (8/19-24)	NWAFC
Martin Nelson	Chief Scientist (8/25-9/8)	NWAFC
Daniel Twohig	Electronic Technician	NWAFC
Eric Stirrup	NOAA Corp Office (Lt.JG)	NWAFC

Janusz Burcynski	Electrical Engineer (8/19-25)	Biosonics, Inc.
Dion Powell	Biological Technician (8/25-9/8)	NWAFC
	Leg III (September 9-22)	
Neal Williamson	Chief Scientist	NWAFC
Daniel Twohig	Electronic Technician	NWAFC
John Garrison	Electronic Technician	NWAFC
Eric Stirrup	NOAA Corp Officer (Lt.JG)	NWAFC
Dion Powell	Biological Technician	NWAFC

For further information contact Dr. Murray L. Hayes, Director, Resource Assessment and Conservation Engineering Division, Northwest and Alaska Fisheries Center, 2725 Montlake Boulevard East, Seattle, WA 98112. Telephone (206) 442-7719.

Table 1.--Midwater trawl haul station and catch data, Gold N Sun Cruise 83-1.

Haul No.	Date (1983)	Time (PDT)	Start Position Lat.(N)	Long.(W)	INPFC Area	Average depth (fm) (footrope/ bottom)	Catch (lb) Pacific whiting	Yellow-tail rockfish	Red-stripe rockfish	Pacific herring	Spiny dogfish	Other species
1	8/9	1730-1740	40°25.7'	124°36.0'	Monterey	79/120	9469.0	--	--	--	531.0	--
2	8/10	1043-1050	40°34.1'	124°32.0'	Eureka	64/67	1831.7	--	--	--	--	1.0
3	8/11	0738-0743	40°54.7'	124°25.0'	Eureka	105/110	125.0	--	--	--	25.0	3.5
4	8/13	1815-1818	42°09.4'	124°32.2'	Eureka	63/78	1584.0	--	--	--	--	--
5	8/16	1110-1123	42°33.7'	124°39.4'	Eureka	62/67	782.0	--	--	--	--	11.8
6	8/18	0840-0846	43°40.2'	124°27.1'	Columbia	62/66	984.0	--	--	--	--	--
7	8/19	2003-2008	43°49.9'	124°26.4'	Columbia	59/65	540.0	2.5	--	--	--	4.1
8	8/20	0852-0909	43°52.6'	124°18.4'	Columbia	55/56	477.0	4.0	--	1.5	--	23.0
9	8/20	2019-2020	44°06.3'	124°56.9'	Columbia	77/143	208.0	--	--	--	--	15.0
10	8/22	1250-1252	44°36.2'	124°37.2'	Columbia	90/118	689.0	--	--	--	--	3.0
11	8/22	1919-1925	44°45.8'	124°28.6'	Columbia	61/79	685.0	9.5	--	--	--	--
12	8/30	1035-1040	48°02.6'	125°20.3'	Vancouver	87/273	592.0	--	--	--	--	10.0
13	8/20	1742-1827	47°59.1'	124°58.0'	Vancouver	55/59	1900.0	5.5	--	0.5	--	29.0
14	8/31	1559-1602	48°17.4'	125°15.5'	Vancouver	90/94	805.0	--	--	--	5.0	--
15	9/1	0950-0955	48°19.4'	125°50.5'	Vancouver	86/96	601.0	--	3.0	--	--	--
16	9/1	1250-1252	48°23.9'	125°55.2'	Vancouver	72/198	806.5	--	--	--	--	--
17	9/1	1758-1803	48°18.8'	125°49.3'	Vancouver	85/100	115.0	--	83.0	--	--	--
18	9/3	0951-1000	48°30.2'	125°10.7'	Vancouver	69/71	4552.0	448.0	--	--	--	--
19	9/3	1646-1652	48°28.3'	125°19.2'	Vancouver	79/87	1159.5	2.0	--	--	--	28.0
20	9/4	0753-0756	48°36.3'	125°29.7'	Vancouver	70/98	1186.0	--	--	--	6.0	--
21	9/4	1207-1242	48°33.3'	125°38.0'	Vancouver	29/39	--	--	--	686.0	--	10.0
22	9/5	1214-1235	48°37.9'	125°52.0'	Vancouver	38/41	4.0	--	--	635.0	6.0	15.0
23	9/5	1625-1634	48°42.4'	125°27.2'	Vancouver	67/73	2500.0	--	--	--	--	--
24	9/6	1242-1249	48°44.5'	125°35.2'	Vancouver	66/83	1449.5	--	--	--	--	2.0
25	9/7	1038-1039	48°46.8'	126°10.0'	Vancouver	46/70	5500.0	3.0	--	--	--	--
26	9/7	1657-1718	48°55.3'	125°41.0'	Vancouver	47/52	563.0	--	--	0.5	6.0	81.1
27	9/9	1406-1415	48°54.0'	126°28.2'	Vancouver	84/91	501.0	32.0	147.0	--	--	12.0
28	9/9	1957-2030	48°59.2'	126°26.9'	Vancouver	61/77	239.0	7.0	--	--	--	0.1
29	9/12	1848-1856	45°45.9'	124°41.2'	Columbia	147/149	740.0	--	--	--	--	1.0
30	9/13	1940-2040	46°01.4'	124°15.8'	Columbia	49/52	1272.5	275.0	--	2.0	--	157.5
31	9/15	1522-1524	46°45.0'	124°50.9'	Columbia	90/124	4965.2	--	--	--	--	34.8
32*	9/16	0642-0700	46°46.0'	124°51.4'	Columbia	87/117	2976.5	--	--	--	--	22.8
33*	9/16-17	2309-0012	46°54.2'	124°46.4'	Columbia	78/82	1636.6	38.5	--	--	--	68.8
34	9/19	0810-0906	47°41.7'	124°50.6'	Vancouver	50/52	14.0	4.0	--	135.0	--	44.6
35	9/19	1643-1656	47°55.7'	125°13.1'	Vancouver	89/98	7470.0	30.0	--	--	--	--
36*	9/20	0457-0520	47°58.5'	125°15.8'	Vancouver	80/93	679.0	265.0	--	--	--	117.0
37*	9/20	2254-2343	47°56.0'	125°14.3'	Vancouver	81/112	450.0	5.0	--	--	--	8.0
38	9/21	1251-1252	48°20.8'	124°52.7'	Vancouver	92/98	1641.6	--	--	--	--	39.5
						TOTALS	61,693.6	1,131.0	239.0	1,460.5	579.0	742.6

* Hauls made in conjunction with the collection of Pacific whiting target strength data.

Table 2.—Frequency of occurrence and total catch by species in 38 midwater trawl hauls made during Gold N Sun Cruise 83-1.

Species	Frequency		Total Catch	
	No.	%	lb	%
Pacific whiting (Merluccius productus)	37	97.4	61,693.6	93.7
Jellyfish (Unidentified)	17	44.7	284.6	.4
Yellowtail rockfish (Sebastes flavidus)	15	39.5	1,131.0	1.7
Pacific herring (Clupea harengus pallasi)	7	18.4	1,460.5	2.2
Chinook salmon (Oncorhynchus tshawytscha)	7	18.4	117.0	.2
Spiny dogfish (Squalus acanthias)	6	15.8	579.0	.9
Eulachon (Thaleichthys pacificus)	5	13.2	37.7	<.1
Sablefish (Anoplopoma fimbria)	5	13.2	41.8	<.1
Walleye pollock (Theragra chalcogramma)	4	10.5	49.7	<.1
Redstripe rockfish (Sebastes proriger)	4	10.5	239.0	.4
Darkblotched rockfish (Sebastes crameri)	2	5.3	1.2	<.1
Canary rockfish (Sebastes pinniger)	2	5.3	73.5	.1
Widow rockfish (Sebastes entomelas)	2	5.3	99.5	.2
Pink salmon (Oncorhynchus gorbuscha)	2	5.3	9.0	<.1
Salps (Unidentified)	2	5.3	3.0	<.1
Bocaccio (Sebastes paucispinis)	1	2.6	2.5	<.1
Northern anchovy (Engraulis mordax)	1	2.6	2.5	<.1
English sole (Parophyrys vetulus)	1	2.6	5.5	<.1
Coho salmon (Oncorhynchus kisutch)	1	2.6	6.5	<.1
Pacific electric ray (Torpedo californica)	1	2.6	8.0	<.1
Squid (Unidentified)	1	2.6	0.1	<.1
Pink shrimp (Pandalus jordani)	1	2.6	0.5	<.1
		Total	65,845.7	

Table 3.--Percent frequency of occurrence of selected species in midwater trawl hauls made in the Vancouver INPFC area during Pacific whiting acoustic surveys in 1977, 1980 and 1983. N indicates total number of hauls.

Species	1977 %	(N=42) (No.)	1980 %	(N=17) (No.)	1983 %	(N=22) (No.)
Spiny dogfish	50.0	(21)	70.6	(12)	18.2	(4)
Walleye pollock	61.9	(26)	23.5	(4)	18.2	(4)
Pacific herring	42.9	(18)	47.1	(8)	22.7	(5)
Eulachon	50.0	(21)	41.2	(7)	9.1	(2)
Yellowtail rockfish	71.4	(30)	70.6	(12)	45.4	(10)
Widow rockfish	21.4	(9)	11.8	(2)	9.1	(2)
Redstripe rockfish	11.9	(5)	41.2	(7)	13.6	(3)

Table 4.--Age specific estimates of Pacific whiting biomass (thousands of metric tons) and population numbers (millions), by INPFC area, determined from 1983 echo integrator-midwater trawl survey (Gold N Sun Cruise 83-1).

Age (yr)	Year Class	Vancouver		Columbia		Eureka		Monterey		T o t a l			
		Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	%	No.	%
1	1982	--	--	--	--	--	--	--	--	--	--	--	--
2	1981	< 0.1	0.03	1.4	5.16	2.9	10.54	0.9	3.25	5.3	0.4	18.98	0.6
3	1980	211.1	506.20	366.5	1,073.60	240.9	778.85	50.0	167.47	868.5	72.3	2,526.12	83.3
4	1979	11.3	22.73	3.7	9.72	1.4	3.96	0.3	.78	16.7	1.4	37.19	1.2
5	1978	10.7	19.86	1.7	3.74	0.2	0.51	0.1	.22	12.7	1.1	24.33	0.8
6	1977	168.9	259.86	14.6	24.06	4.1	7.73	2.5	4.07	190.1	15.8	295.72	9.7
7	1976	14.7	21.61	1.2	1.66	0.2	0.36	0.2	.28	16.3	1.4	23.91	0.8
8	1975	17.1	22.15	1.5	1.98	0.4	0.47	0.4	.44	19.4	1.6	25.04	0.8
9	1974	14.8	18.05	1.3	1.65	0.5	0.58	0.3	.33	16.9	1.4	20.61	0.7
10	1973	25.1	29.06	3.0	3.23	0.7	0.78	0.3	.37	29.1	2.5	33.44	1.1
11	1972	8.9	9.69	0.7	0.81	0.3	0.34	0.9	.68	10.8	0.9	11.52	0.4
12	1971	6.6	7.56	0.5	0.65	0.3	0.29	0.1	.11	7.5	0.6	8.61	0.3
13	1970	4.9	5.23	0.8	0.73	0.2	0.25	0.2	.16	6.1	0.5	6.37	0.2
14	1969	1.0	1.02	0.2	0.15	0.1	0.08	--	--	1.3	0.1	1.25	< 0.1
Area Totals		495.2	923.05	397.1	1,127.14	252.2	804.74	56.2	178.16	1200.7	100.0	3,033.09	100.0
% by Area		41.2	30.4	33.1	37.2	21.0	26.5	4.7	5.9	100.0		100.0	

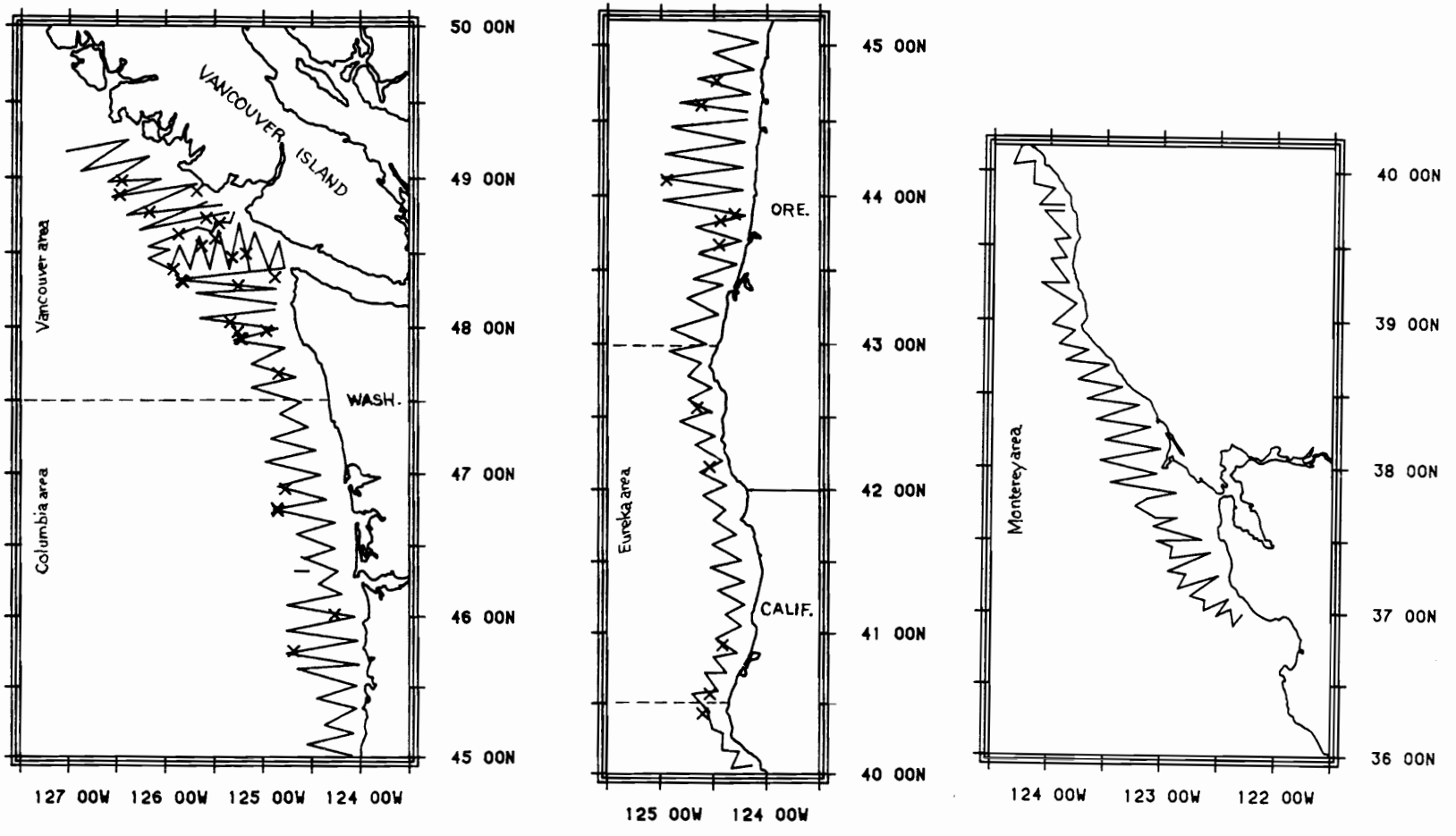

Figure 1.-- Acoustic survey trackline and midwater trawl stations (X), Gold N Sun Cruise 83-1.

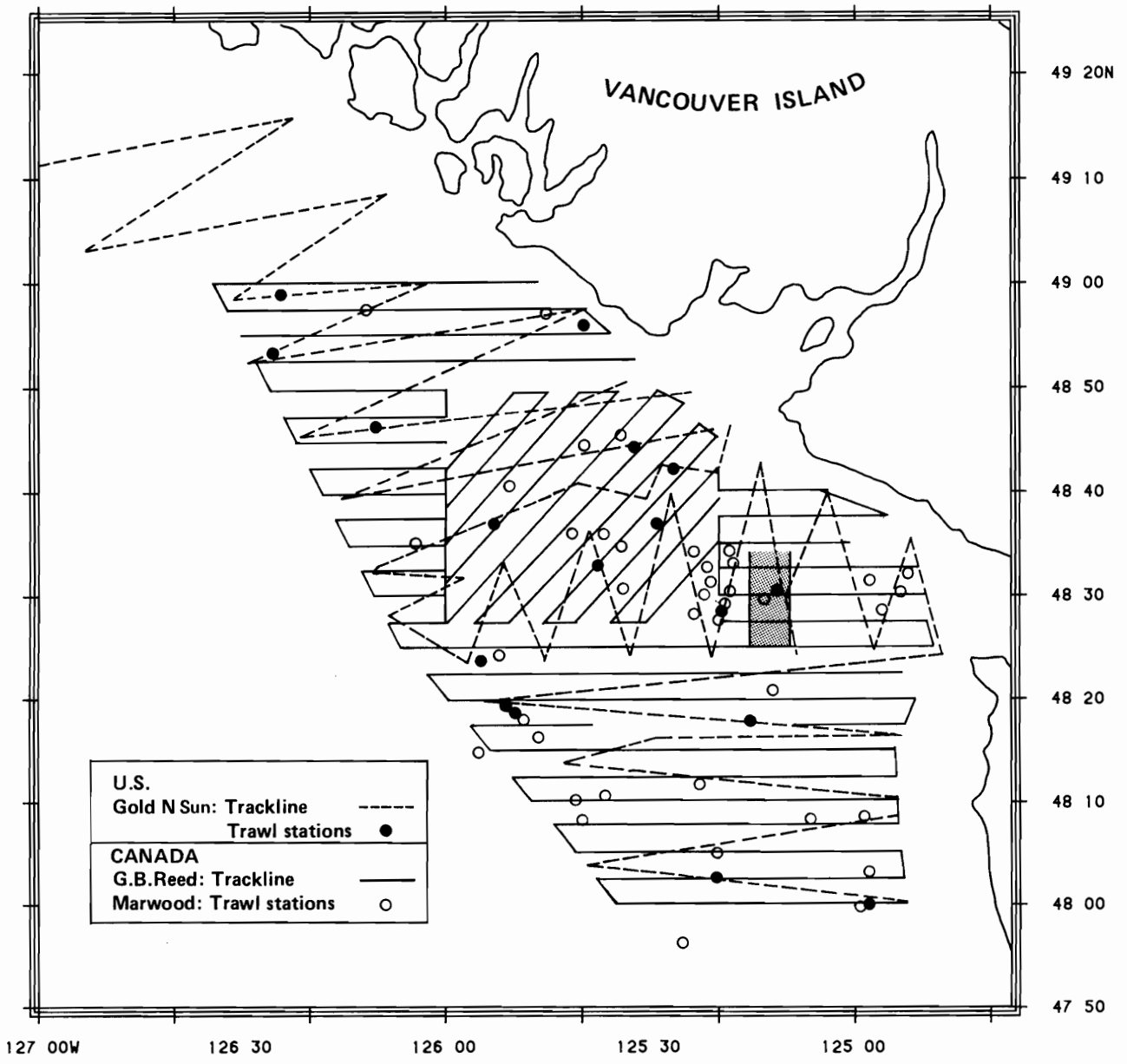

Figure 2.-- U.S. and Canadian acoustic survey tracklines and midwater trawl stations during joint survey in Vancouver INPFC area. Shaded area indicates location of echo integrator systems intercalibration study.

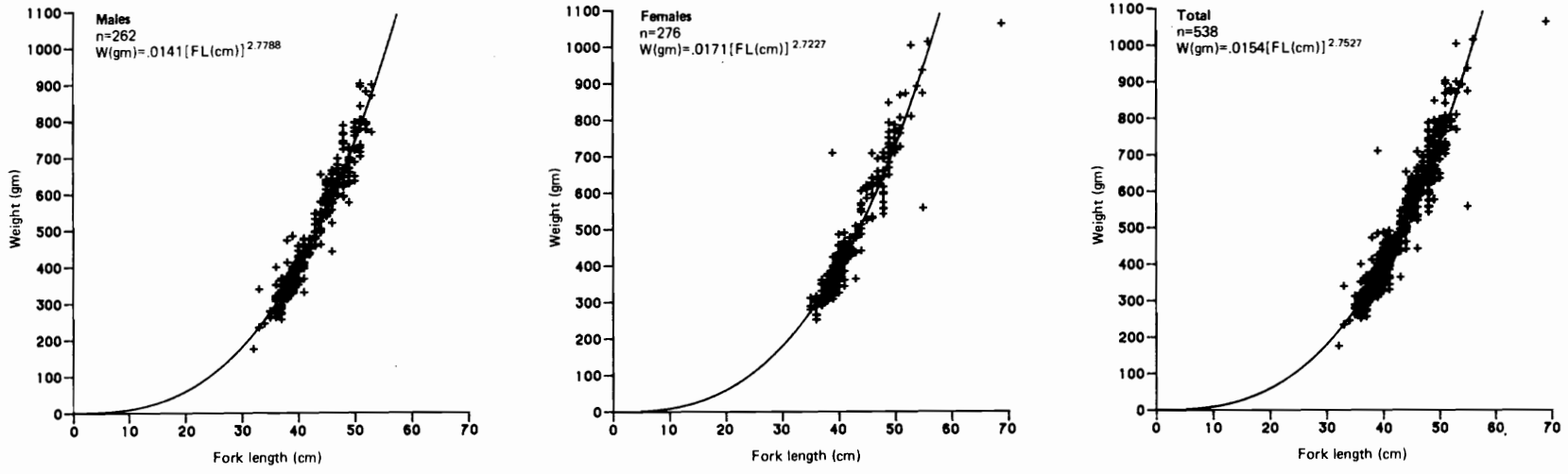

Figure 3.-- Pacific whiting length-weight relationships determined from midwater trawl samples obtained during Gold N Sun Cruise 83-1.

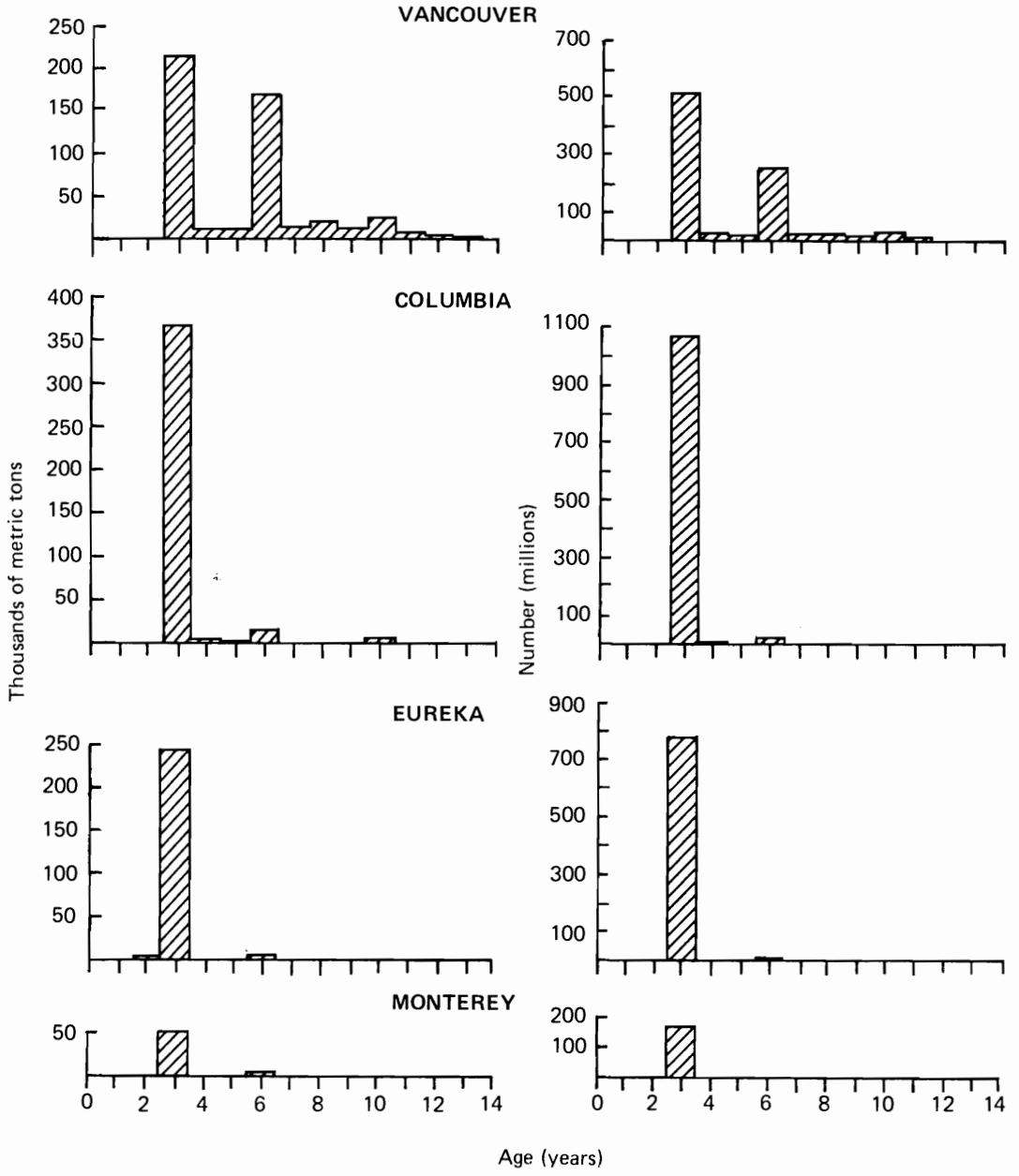

Figure 4.-- Biomass and population (number) estimates for midwater Pacific whiting, by age and INPFC area, determined from 1983 acoustic-midwater trawl survey, Gold N Sun Cruise 83-1.

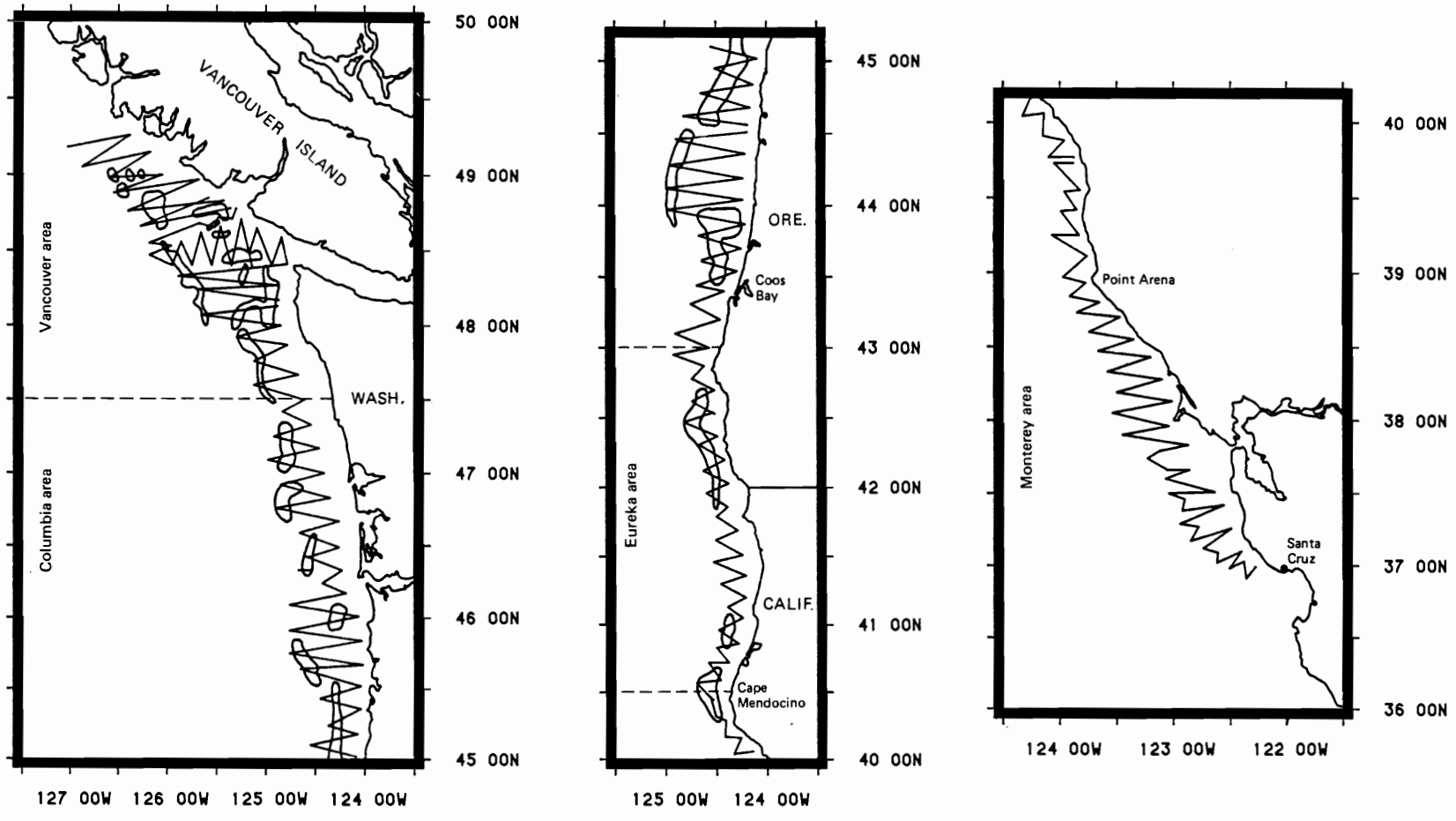

Figure 5.-- Geographic distribution of Pacific whiting aggregations determined from 1983 acoustic-midwater trawl survey, Gold N Sun Cruise 83-1.

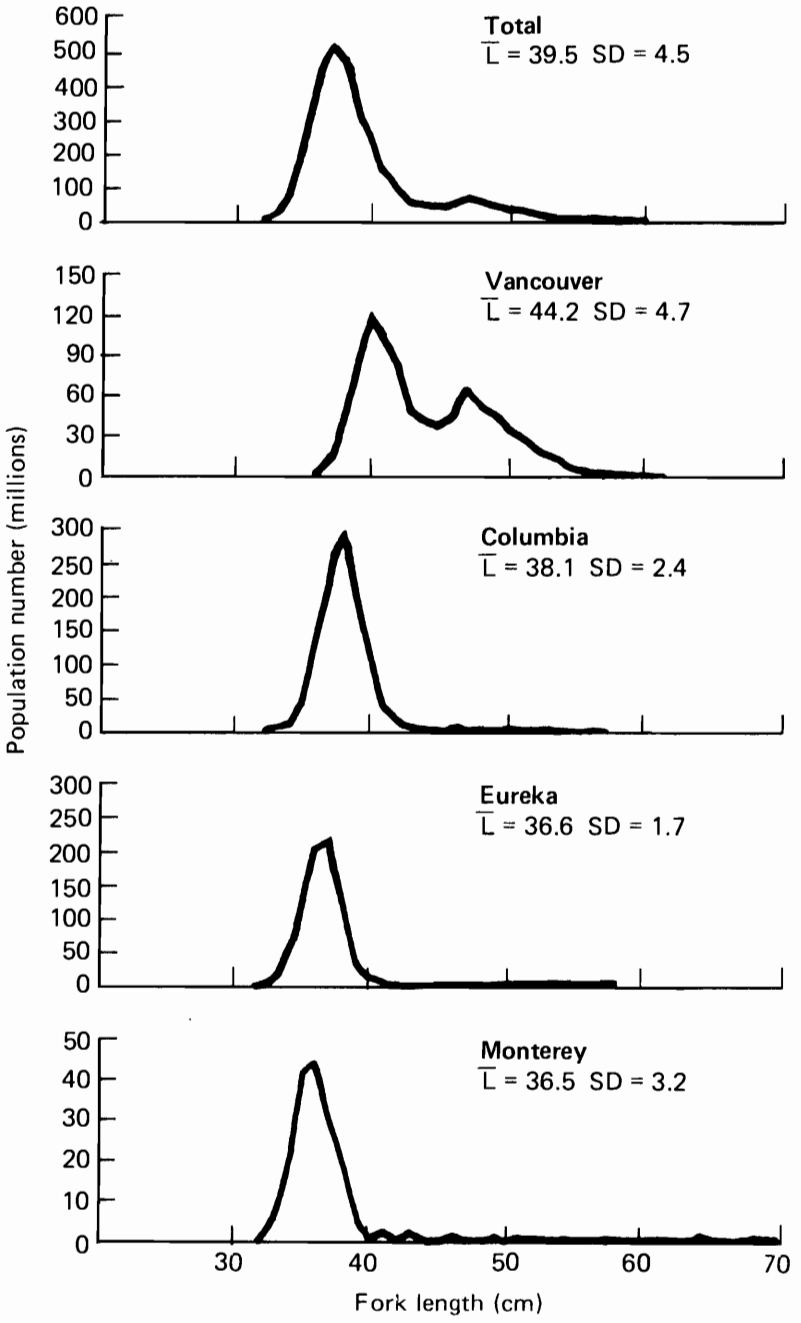

Figure 6.-- Pacific whiting population length distributions (sexes combined), by INPFC area, estimated from 1983 acoustic-midwater trawl survey, Gold N Sun Cruise 83-1.

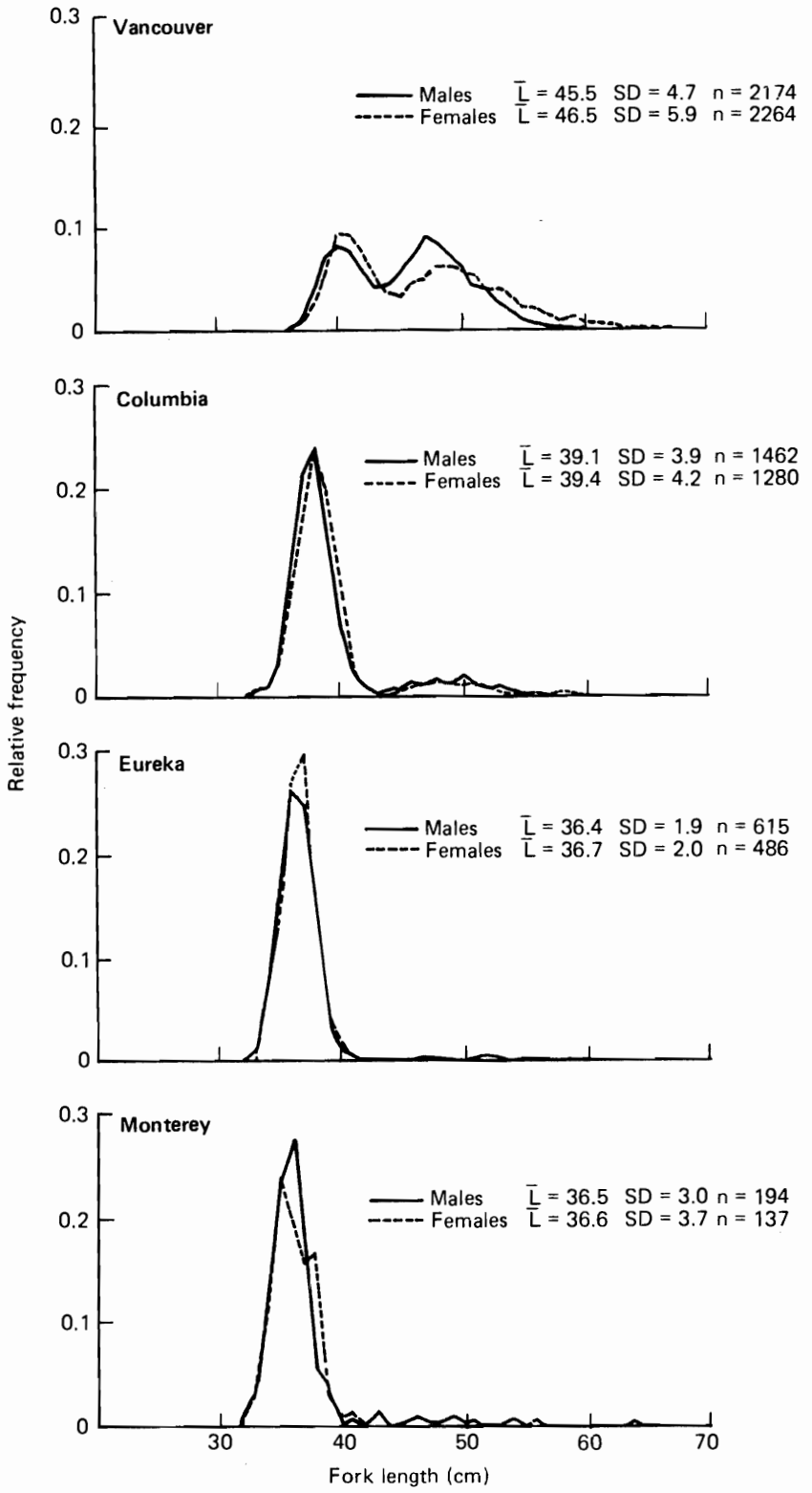

Figure 7.-- Pacific whiting length distributions (unweighted by population size), by sex and INPFC area, determined from midwater trawl sampling during 1983 acoustic-midwater trawl survey, Gold N Sun Cruise 83-1.