UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest and Alaska Fisheries Center
Resource Assessment and Conservation
Engineering Division
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CRUISE RESULTS
NOAA ship MILLER FREEMAN
Cruise No. 86-08
Pacific Whiting Echo Integrator/Midwater Trawl Survey
June 30-July 31 and August 7-10, 1986

Cruise Period, Area, and Schedule

Between June 30 and July 31, 1986, the MILLER FREEMAN conducted an echo integrator/midwater trawl survey of Pacific whiting (Merluccius productus) along the Pacific coast. The survey area included the coastal waters between 30 and 200 fm from Monterey Bay, California (37°00'N) to Nootka Sound, Vancouver Island (49°30'N). The vessel's itinerary was as follows:

Leg I (June 30-July 31)

June 30	Acoustic system calibration at Pier 36 in Seattle; embark scientists; gear tests in Puget Sound.
July 1-3	Transit to California.
July 3-23	Survey operations (Monterey Bay to Nootka Sound)
July 24-30	Resurvey of area from the mouth of the Columbia River (46°00'N) to Clayoquot Sound, Vancouver Island (49°10'N).
July 31	Arrive Seattle.

Leg II (August 7-10)

August 7-8	Acoustic system calibration at Pier 36 in Seattle.
August 9-10	Standard target measurements and specimen collection in Port Susan, WA.

OBJECTIVES

The cruise was conducted as part of a multi-vessel survey of Pacific coast groundfish resources. During July to September, the region covered by the MILLER FREEMAN, excepting Canadian waters, was surveyed by two chartered bottom trawl vessels--PAT SAN MARIE and ALASKA. This survey was the fourth in a triennial series begun in 1977.

The principal objectives of the cruise were to:

1) Collect echo integrator and midwater trawl data necessary to determine the distribution, biomass, and biological composition of the off-bottom component of the Pacific whiting stock along the Pacific coast from central California to central Vancouver Island.

2) Collect whiting target strength data (especially during daylight hours) for use in scaling echo integrator outputs to estimates of absolute abundance.

3) Collect split beam and dual beam measurements of a standard calibration sphere to provide an independant check of acoustic system calibration and to detect changes in system performance with changes in transducer depth.

4) Obtain specimens of Pacific whiting and walleye pollock (Theragra chalcogramma) for swim bladder morphology studies.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

The MILLER FREEMAN is a 215 ft, 1900 ton, stern trawler equipped for fisheries and oceanographic research.

Acoustic data were collected using a computerized echo integration and target strength measurement system installed in a 16 ft long x 10.5 ft wide x 10 ft high cargo container. The system included a 38 kHz echo sounder used with a multi-beam transducer. The transducer was mounted in a deadweight body towed at a depth of 10-15 m behind the stern of the vessel on the starboard side. The echo sounder's receiver consisted of one 20 log R TVG channel for echo integration, two 40 log R TVG channels for dual beam target strength measurement, and four 40 log R TVG channels used to obtain the phase measurements required for split beam target strength data collection. 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/].

For the first six trawl hauls, echo sign was sampled using a 3/4 scale Norsenet rectangular midwater trawl (Fig. 1) with 6 ft x 9 ft steel V-doors, 30 fm double dandylines, a 1-1/4 in mesh cod end liner, and a 250 lb chain tom weight attached to each lower wing tip. During Haul 6, the headrope separated from the net, and, consequently, a Diamond 1000 midwater trawl (Fig. 2) was used for the remainder of the survey. This trawl was fished with the same gear accessories. However, unlike the Norsenet, it was equipped with headrope floats. Trawl mouth opening and depth were estimated from cable netsounder echograms. The average vertical mouth opening of the 3/4 scale Norsenet was approximately 10 fm, and for the Diamond, it was approximately 8 fm.

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

Water temperature/depth profile data were collected at each trawl station using an expendable bathythermograph (XBT). Surface temperatures were measured with a bucket thermometer.

SURVEY METHODS

Survey work began off the coast of California and proceeded northward. Echo integration data were collected along a zig-zag trackline placed perpendicular to bottom depth contours with transect endpoint spacing at 15 nm. Upon completion of the initial survey from California to Vancouver Island on July 23, the area between the mouth of the Columbia River and Clayoquot Sound was surveyed again. Vessel speed along the trackline averaged 11 kn until July 20 when a problem with the acoustic cable forced a modification of the towed body - cable connection and a subsequent reduction in speed to 8 kn to ensure fin stability.

Echo integrator data collection along the trackline was confined to daylight hours (0600-2100 PDT) because of the tendency of whiting schools to disperse and mix with other species at night. 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. These 1 m values are summed over the water column to provide estimates of surface density (kg/m^2) which are in turn averaged and applied to the areal extent of a whiting aggregation to yield an estimate of biomass.

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 3 kn. Standard catch sorting and biological sampling procedures were used to provide estimates of total weight and numbers by species, length composition data for abundant species, individual weight measurements for Pacific whiting, and otolith samples for Pacific whiting and shortbelly rockfish.

During target strength data collection, the average vessel speed was approximately 3 kn. Trawl sampling at appropriate depths was done just before and/or after each period of data collection to provide species composition and biological data. A Loran C plotter was used to record vessel movements during data collection and associated trawl hauls.

The standard target work was conducted with the vessel at anchor. It consisted of split beam and dual beam measurements of two standard calibration spheres (tungsten carbide and copper) with known acoustic properties. Each sphere, in turn, was suspended with monofilament line 30 m below the fin. Acoustic measurements were then made with the fin positioned at selected depths ranging from 2 to 86 m.

Whiting and pollock were caught on hook and line to obtain specimens for swim bladder morphology studies. Once captured, the fish were acclimated to surface water conditions in a live tank. Once acclimated, each fish was immersed for several minutes in an alcohol bath maintained at a temperature between -15° and -30°C and then stored in a shipboard freezer at -35°C.

RESULTS

The coastwide survey trackline (from Monterey Bay to Nootka Sound) consisted of 112 transects totalling 2092 nmi (Fig. 3). The replicate survey trackline (from Astoria, Oregon to Clayoquot Sound, Vancouver Island) totalled 701 nmi on 27 transects (Fig. 4). The largest concentrations of whiting were observed between San Francisco and Point Arena, California (37°30'N - 39°00'N) and off the Strait of Juan de Fuca between Cape Alava, Washington and Barkeley Sound, Vancouver Island (48°00'N - 49°00'N). Lesser concentrations of whiting were encountered off Point Delgada, California (40°00'N), off Coos Bay, Oregon (43°10'N), and off Newport, Oregon (44°40'N). The data analysis required to derive estimates of absolute biomass is in progress.

A total of 48 midwater trawl hauls were made during the survey (Table 1). Of these, eight were made in conjunction with target strength data collection. The frequency of occurrence and total catch of each species taken is shown in Table 2. Because of the targetted nature of the trawl sampling, whiting was the dominant species in the catches. A tally of the biological data collected for whiting is presented in Table 3. In addition, 302 length measurements and 91 otoliths were collected from random samples of shortbelly rockfish (Sebastes jordani) from the catches of Hauls 4 and 5. The shortbelly rockfish data were forwarded to Dr. William Lenarz, NMFS Southwest Fisheries Center, Tiburon, California, for analysis. The frozen whiting samples (Table 3) collected in Canadian waters were requested by Sara Alderstein of the University of Washington as part of a coastwide parasitology study.

Whiting length composition data from the midwater trawl samples are summarized in Figure 5. As has been observed in the past, whiting tend to be larger as one moves north up the coast, with the biggest fish found in the Vancouver INPFC (International North Pacific Fisheries Council) Area. Few, if any, whiting < 40 cm were found north of 46°00'N. With the exception of a single trawl (Haul 9) in the Monterey INPFC area, no age 0 or 1-year-old whiting were captured during the survey. Preliminary age composition data indicate that the 1984 year class may be relatively strong. The adult whiting population continues to be dominated by the strong 1980 year class.

Target strength measurements were obtained only at night when whiting were more dispersed and the occurrence of single fish echoes was increased. (The higher densities encountered during daylight hours precluded target strength data collection because of the problem of multiple echoes). Target strength data were collected successfully on four nights at four different locations (Table 4). Each collection yielded a set of dual beam and a set of split beam target strength data. Analysis of these data will provide estimates of average target strength as well as a comparison of the dual beam and split beam measurement techniques.

Approximately 30 hours were spent collecting measurements of the calibration spheres. There was an observed increase in total system sensitivity with fin depth, but quantification of this change must await analysis of the data.

A total of 60 fish (59 walleye pollock and 1 Pacific whiting) were frozen for swim bladder morphology studies. These specimens were forwarded to Dr. Kenneth Foote, Institute of Marine Research, Bergen, Norway.

SCIENTIFIC PERSONNEL

Leg I (June 30-July 31)

Jim Traynor	Chief Scientist (6/30 - 7/13)	NWAFC
Neal Williamson	Chief Scientist (7/14 - 7/31)	NWAFC
Daniel Twohig	Electronic Technician	NWAFC
John Garrison	Electronic Technician	NWAFC
Jan McCrory	Biological Technician	NWAFC
Denise Adams	Biological Technician	NWAFC
Doug Smith	Fisheries Biologist	NWAFC
Fred Wathne	Fisheries Biologist (6/30 - 7/13)	NWAFC
Bob Riemann	Deputy Director, OFIS (7/14 - 7/31)	NWAFC
Norm Lemberg	Fisheries Biologist (7/14 - 7/18)	Wash. Dept. of Fisheries

Leg II (August 7-10)

Jim Traynor	Chief Scientist	NWAFC
Ed Nunnalllee	Fisheries Biologist	NWAFC
Daniel Twohig	Electronic Technician	NWAFC
Neal Williamson	Statistician	NWAFC

For further information contact Dr. Gary Stauffer, Director, Resource Assessment and Conservation Engineering Division, Northwest and Alaska Fisheries Center (NWAFC), 7600 Sand Point Way NE, BIN C15700, Bldg. 4, Seattle, WA 98115-0070. Telephone (206) 526-4174.

Table 1. Midwater trawl haul station and catch data, MF86-8.

HAUL NO.	DATE (1986)	TIME (PDT)	START POSITION LAT. (N)	START POSITION LONG. (W)	TRAWL TYPE	INPFC AREA	DEPTH (FM) FOOTROPE/ BOTTOM	CATCH (lbs) PACIFIC WHITING	CATCH (lbs) YELLOW-TAIL ROCKFISH	CATCH (lbs) SHORT-BELLY ROCKFISH	CATCH (lbs) PACIFIC HERRING	CATCH (lbs) OTHER SPECIES
1	3 July	1944-2002	38 22.1	123 21.1	3/4 Norse	Monterey	61/69	2981	--	--	--	24
2	3 July	2205-2305	38 09.0	123 21.3	3/4 Norse	Monterey	75/83	429	--	--	--	18
3	4 July	0137-0220	38 01.5	123 08.7	3/4 Norse	Monterey	28/41	895	--	--	--	88
4	4 July	1752-1802	37 26.9	122 54.9	3/4 Norse	Monterey	87/126	1138	--	24	--	9
5	4 July	2317-2338	37 22.0	122 51.0	3/4 Norse	Monterey	60/83	711	--	1322	--	T
6	5 July	0540-0616	37 55.3	123 17.1	3/4 Norse	Monterey	49/59	3997	--	--	--	3
7	5 July	2320-2351	38 53.0	123 51.0	Diamond	Monterey	63/69	1265	--	--	--	--
8	6 July	0237-0315	38 38.8	123 40.6	Diamond	Monterey	56/80	189	--	--	--	7
9	6 July	2254-2319	40 10.2	124 25.6	Diamond	Monterey	40/223	50	--	--	--	9
10	7 July	0149-0239	40 00.4	124 14.4	Diamond	Monterey	71/309	274	--	--	--	28
11	7 July	2129-2219	41 53.7	124 31.5	Diamond	Eureka	90/110	89	--	--	--	8
12	8 July	0109-0155	41 32.9	124 16.0	Diamond	Eureka	30/35	2209	--	--	--	75
13*	8 July	2254-2400	43 01.6	124 53.8	Diamond	Columbia	59/395	438	--	--	--	T
14*	9 July	0434-0550	43 02.0	124 59.5	Diamond	Columbia	50/775	140	--	--	--	T
15	9 July	1934-2036	43 30.2	124 38.8	Diamond	Columbia	114/219	92	--	--	--	5
16	9 July	2235-2315	43 20.6	124 27.2	Diamond	Columbia	41/48	354	--	--	--	6
17	11 July	0140-0225	44 19.8	124 14.6	Diamond	Columbia	34/38	328	--	--	--	9
18	11 July	2041-2110	44 59.1	124 23.9	Diamond	Columbia	108/142	107	--	--	--	1
19	12 July	0018-0118	44 45.5	124 21.3	Diamond	Columbia	61/65	108	--	--	4	21
20	12 July	1127-1155	45 21.0	124 08.3	Diamond	Columbia	51/54	1383	--	--	--	3
21	12 July	2042-2055	45 42.0	124 35.8	Diamond	Columbia	107/125	1493	--	--	--	--
22	13 July	1345-1401	46 01.7	124 16.5	Diamond	Columbia	55/60	20	--	--	--	71
23	14 July	2314-2357	46 16.3	124 16.6	Diamond	Columbia	32/36	690	--	--	2	128
24	14 July	1259-1338	46 58.3	124 38.1	Diamond	Columbia	55/60	--	13	--	--	15
25	15 July	1242-2048	47 10.6	124 55.2	Diamond	Columbia	95/175	1279	--	--	--	--
26	16 July	1037-1113	47 19.6	124 39.3	Diamond	Columbia	34/39	822	--	--	--	266
27	16 July	1912-1932	47 43.9	124 46.6	Diamond	Vancouver	48/51	--	--	--	22	19
28	17 July	1122-1152	47 53.0	125 13.1	Diamond	Vancouver	100/200	672	--	--	--	5
29	17 July	1727-1753	47 56.5	125 00.4	Diamond	Vancouver	59/61	--	--	--	2	--
30	17 July	2210-2310	48 06.1	125 38.4	Diamond	Vancouver	64/154	255	68	--	--	9
31	18 July	1021-1039	48 14.1	125 00.5	Diamond	Vancouver	78/130	52	--	--	--	--
32	18 July	1126-1137	48 14.1	124 59.8	Diamond	Vancouver	83/156	1995	--	--	--	5
33	19 July	0858-0912	48 24.6	125 34.5	Diamond	Vancouver	65/70	3982	15	--	--	3
34	19 July	1510-1522	48 30.6	125 14.4	Diamond	Vancouver	69/74	2492	--	--	--	8
35*	20 July	0415-0506	48 24.8	125 33.2	Diamond	Vancouver	49/70	1821	56	--	1	122
36	20 July	1407-1428	48 46.9	125 35.0	Diamond	Vancouver	58/85	1386	--	--	--	131
37	20 July	2034-2130	48 39.3	126 13.1	Diamond	Vancouver	84/254	102	3	--	--	T
38	21 July	1243-1246	48 43.8	125 49.5	Diamond	Vancouver	55/60	2485	--	--	--	16
39	21 July	2131-2200	48 44.3	126 16.3	Diamond	Vancouver	50/127	1163	18	--	--	--
40	22 July	1628-1637	49 07.6	126 27.2	Diamond	Vancouver	56/64	117	20	--	--	5
41	24 July	1254-1329	45 59.9	124 26.9	Diamond	Columbia	57/79	1139	16	--	--	1
42*	25 July	0110-0200	45 58.8	124 21.7	Diamond	Columbia	56/78	175	52	--	--	9
43*	25 July	2102-2115	47 22.0	124 37.1	Diamond	Columbia	38/46	2413	4	--	--	84
44*	26 July	0324-0423	47 25.1	124 37.1	Diamond	Columbia	34/43	3862	28	--	--	109
45	26 July	1930-1956	48 02.4	125 22.2	Diamond	Vancouver	72/140	3000	--	--	--	--
46*	27 July	0426-0500	48 01.7	125 20.0	Diamond	Vancouver	58/225	104	--	--	--	T
47*	27 July	0554-0654	48 02.9	125 17.8	Diamond	Vancouver	70/172	830	--	--	--	2
48	30 July	1656-1726	48 45.4	125 35.9	Diamond	Vancouver	69/84	1356	--	--	--	63
							TOTALS	50876	292	1345	30	1384

* Hauls made in conjunction with the collection of Pacific whiting target strength data.
"T" indicates catch less than one pound.

Table 2. Frequency of occurence and total catch by species in 48 midwater trawl hauls, MF86-8.

Species	Frequency		Total Catch	
	No.		lb	
Pacific whiting (Merluccius productus)	45	93.8%	50876	94.3%
Spiny dogfish (Squalus acanthias)	15	31.3%	858	1.6%
Yellowtail rockfish (Sebastes flavidus)	11	22.9%	292	0.5%
Chinook salmon (Oncorhynchus tshawytscha)	11	22.9%	111	0.2%
Jellyfish (Unidentified)	10	20.8%	56	0.1%
Northern lantern fish (Stenobrachius leucopsarus)	8	16.7%	2	<.1%
Pacific sand dab (Citharichthys sordidus)	8	16.7%	15	<.1%
Squid (Unidentified)	6	12.5%	6	<.1%
Pacific herring (Clupea harengus pallasi)	5	10.4%	30	0.1%
Widow rockfish (Sebastes entomelas)	4	8.3%	70	0.1%
Pollock (Theragra chalcogramma)	4	8.3%	30	0.1%
Arrowtooth flounder (Atheresthes stomias)	4	8.3%	8	<.1%
Eulachon (Thaleichthys pacificus)	3	6.3%	9	<.1%
Black cod (Anoplopoma fimbria)	3	6.3%	5	<.1%
English sole (Parophrys vetulus)	3	6.3%	3	<.1%
Flathead sole (Hippoglossoides elassodon)	3	6.3%	1	<.1%
Shortbelly rockfish (Sebastes jordani)	2	4.2%	1345	2.5%
Chilipepper rockfish (Sebastes goodei)	2	4.2%	33	0.1%
Rex sole (Glyptocephalus zachirus)	2	4.2%	23	<.1%
Coho salmon (Oncorhynchus kisutch)	2	4.2%	11	<.1%
Smelt (Atherinopsis californiensis)	2	4.2%	3	<.1%
Splitnose rockfish (Sebastes diploproa)	2	4.2%	3	<.1%
Shrimp (Unidentified)	2	4.2%	T	<.1%
Tom cod (Microgadus proximus)	2	4.2%	T	<.1%
Big skate (Raja binoculata)	1	2.1%	50	0.1%
Longnose skate (Raja rhina)	1	2.1%	38	0.1%
Blue rockfish (Sebastes mystinus)	1	2.1%	29	0.1%
Midshipman (Porichthys sp.)	1	2.1%	15	<.1%
Bocaccio rockfish (Sebastes paucispinis)	1	2.1%	3	<.1%
Sea anemone (Unidentified)	1	2.1%	3	<.1%
Dover sole (Microstomus pacificus)	1	2.1%	T	<.1%
Dungeness crab (Cancer magister)	1	2.1%	T	<.1%
Flatfish larvae (Unidentified)	1	2.1%	T	<.1%
Shortfin eelpout (Lycodes brevipes)	1	2.1%	T	<.1%
Slender sole (Lyopsetta exilis)	1	2.1%	T	<.1%
Northern anchovy (Engraulis mordax)	1	2.1%	T	<.1%
Total			53,928	

"T" indicates catch less than one pound

Table 3.--Biological data and samples of Pacific whiting by INPFC statistical area, MF86-8.

INPFC Area	#Lengths	#Weights	#Otoliths	#Maturities	Frozen #Samples
Monterey (35°30' - 40°30'N)	4,085	276	479	276	-
Eureka (40°30' - 43°00'N)	474	180	100	180	-
Columbia (43°00' - 47°30'N)	4,393	899	761	418	-
Vancouver (47°30' - 49°30'N)	3,750	955	748	-	113
Totals	12,702	2,310	2,088	874	113

Table 4.--Target strength data collection for Pacific whiting, MF86-8.

Date (1986)	Time (PDT)	Location Lat (N)	Location Long (W)	Associated Hauls	%Whiting (Nos.)	Mean Length
9 July	0144-0703	43° 02'	124° 56'	13, 14	95%	43 cm
19-20 July	2221-0330	48° 25'	125° 33'	35	95%	47 cm
25-26 July	2246-0236	47° 22'	124° 37'	43, 44	98%	46 cm
26-27 July	2259-0346	48° 02'	125° 20'	45, 46, 47	94%	46 cm

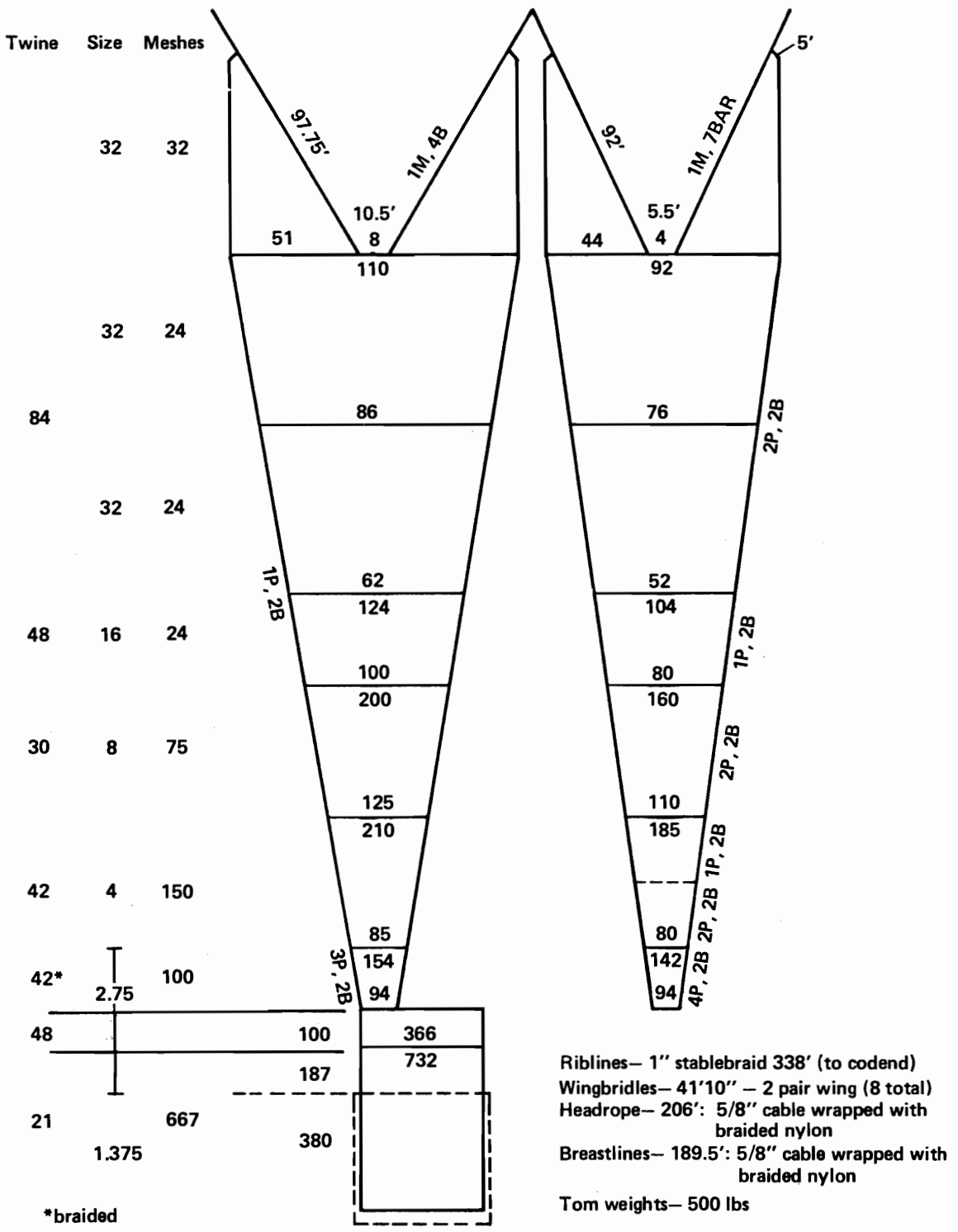

Figure 1.--3/4 Norsenet midwater trawl.

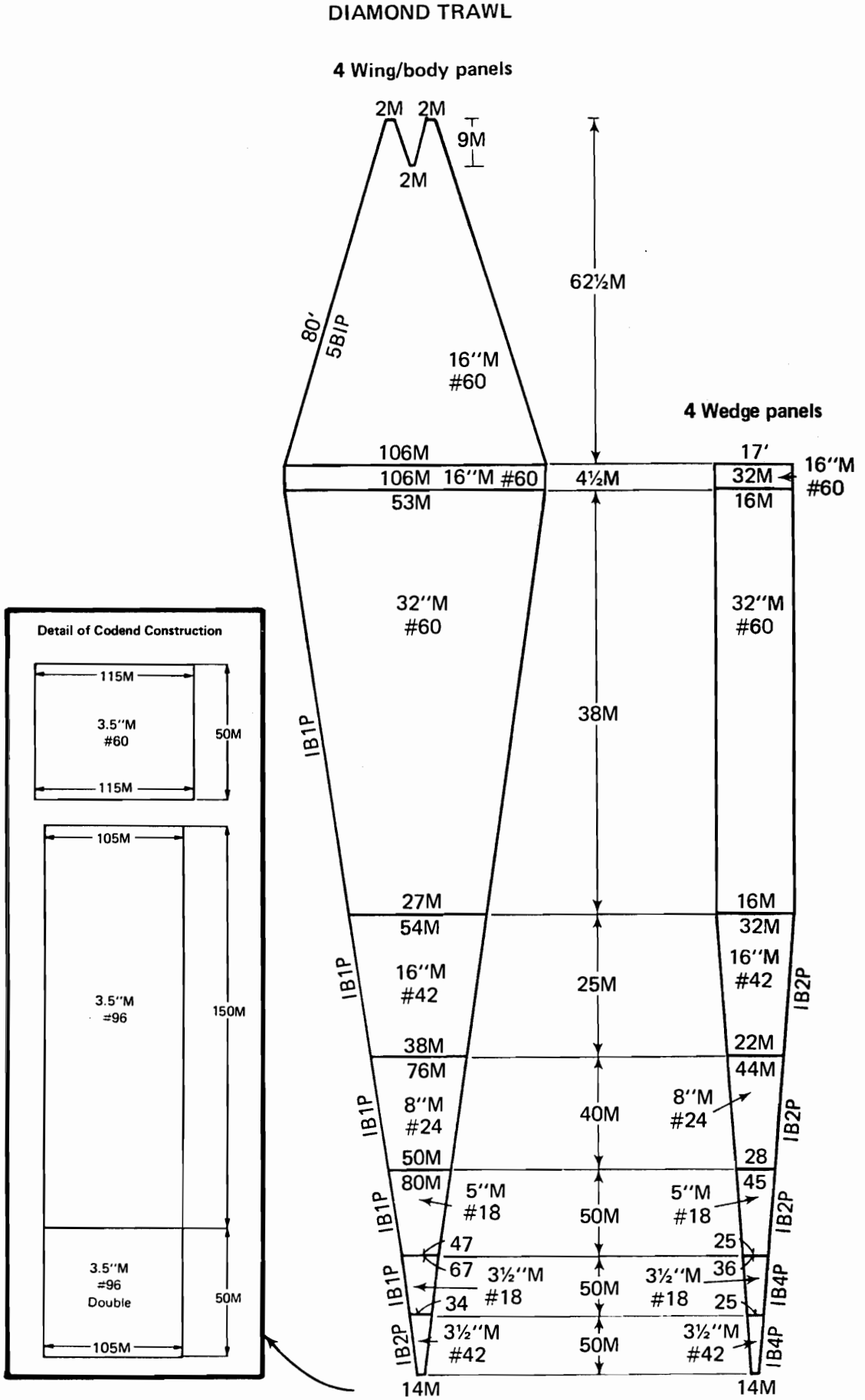

Figure 2.--Diamond 1000 midwater trawl.

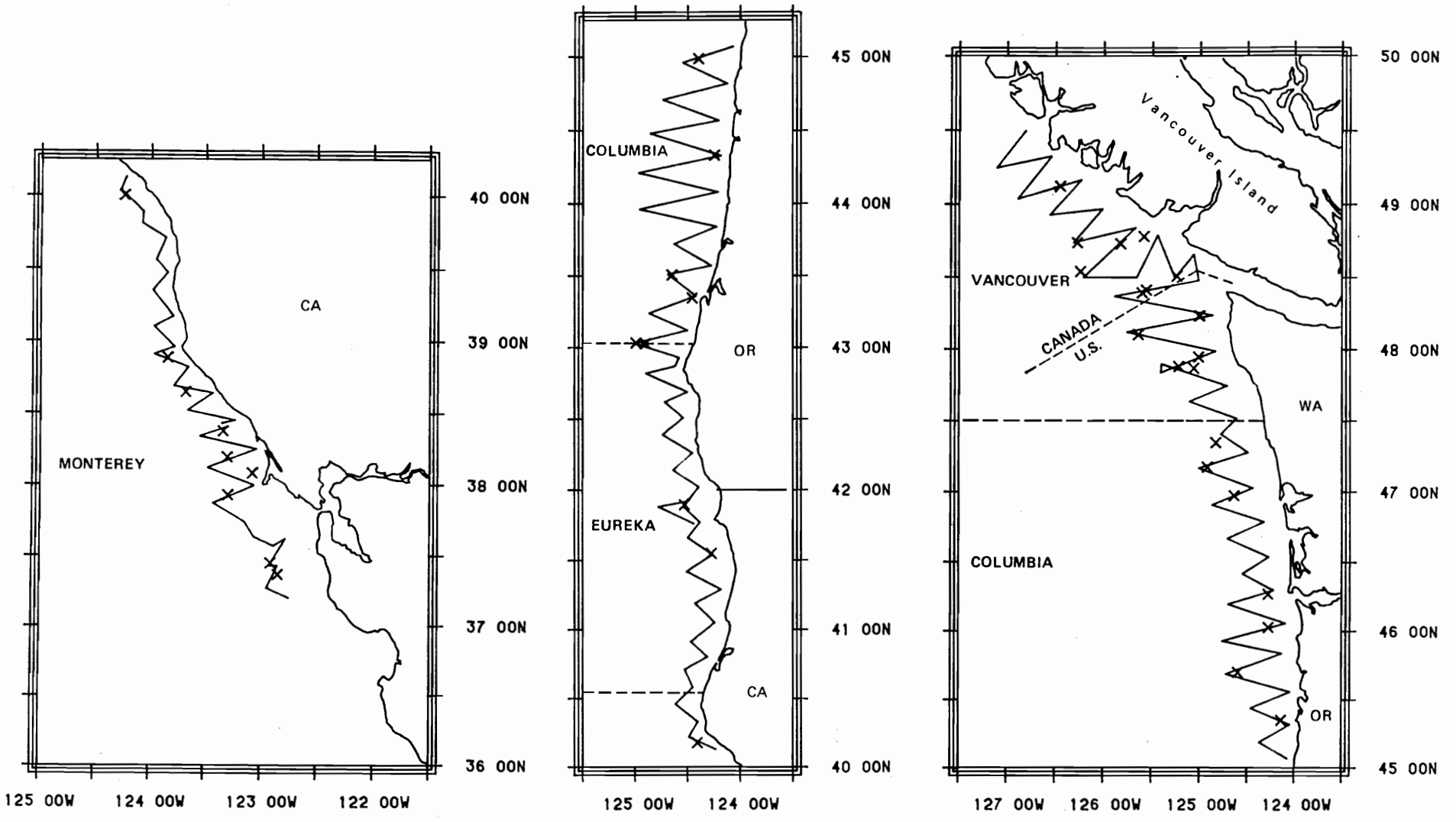

Figure 3.--Coastwide survey trackline and midwater trawl stations (x), MF86-8.

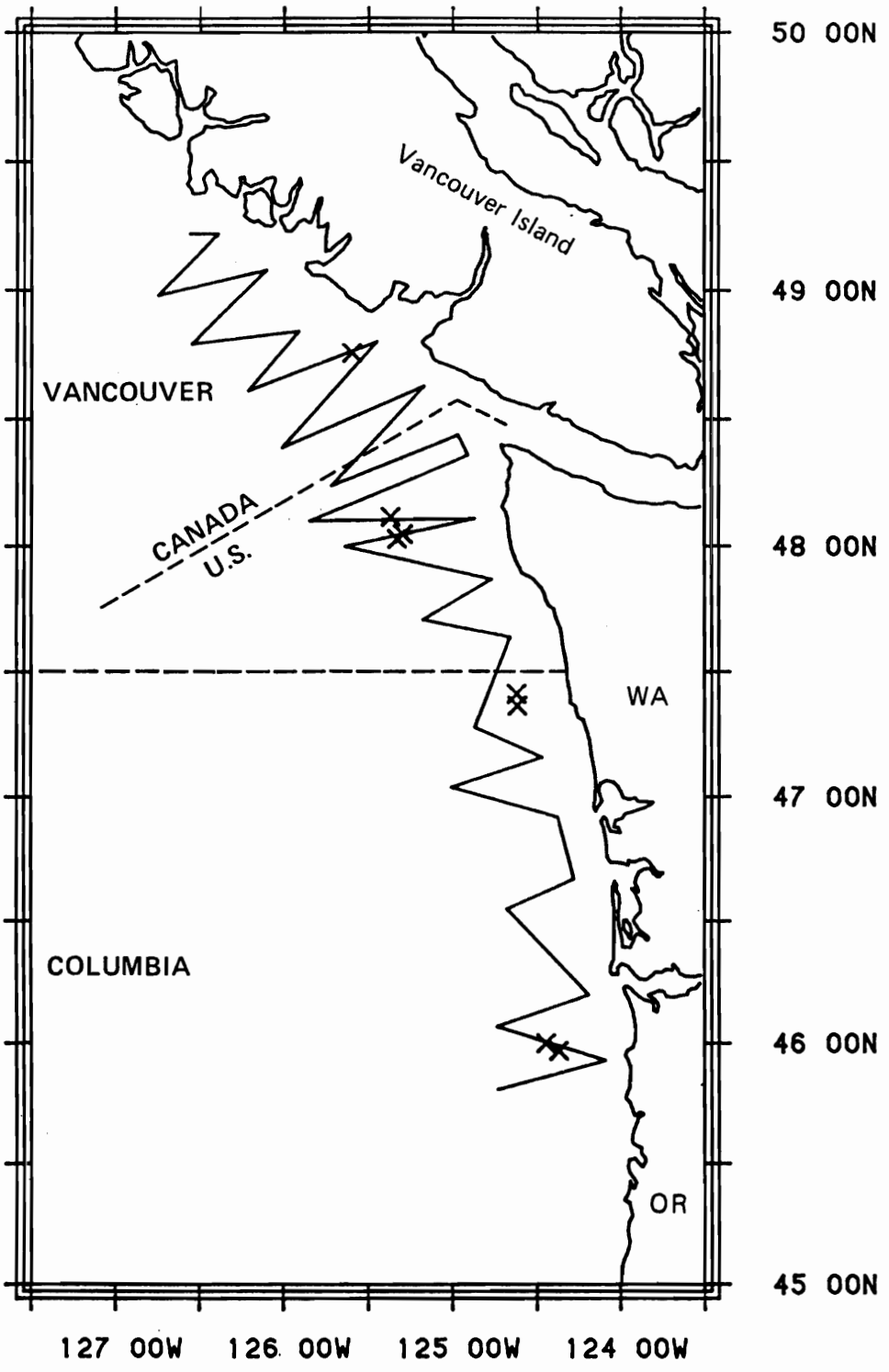

Figure 4.--Replicate survey trackline and midwater trawl stations (x), MF86-8.

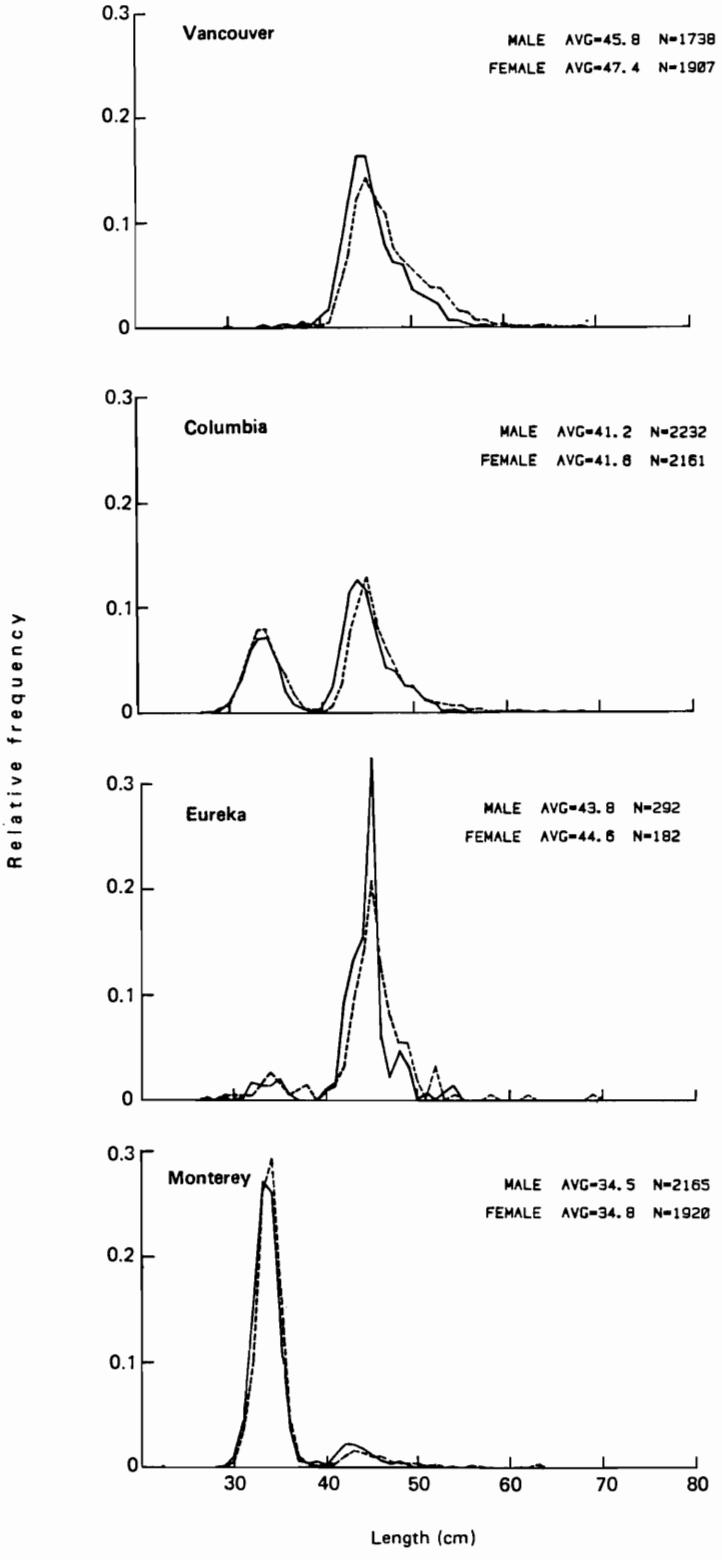

Figure 5.--Whiting length distributions (unweighted by population size) by sex and INPFC area, determined from midwater trawl samples, MF86-8.