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

October 1980

CRUISE RESULTS

NOAA RV MILLER FREEMAN

Cruise No. MF-80-03

Pacific Whiting and Rockfish Hydroacoustic-Midwater Trawl Survey

July 1 - September 11, 1980

CRUISE PERIOD, AREA AND ITINERARY

The Miller Freeman returned to the Pacific Marine Center, Seattle, on September 11, 1980 after completing an echo integrator-midwater trawl survey of Pacific whiting (Merluccius productus) and certain rockfish stocks along the Pacific coast between Santa Cruz, California and Kyuquot Sound, Vancouver Island (36°55' to 50°00'N). The vessel's itinerary was as follows:

Leg I

July 1-3: Depart Pacific Marine Center; completed hydroacoustic system calibration at Pier 36, Seattle and midwater trawl tests in Puget Sound; returned to Pacific Marine Center.

July 7-13: Transit to Columbia River and completed water, sediment and air sampling in estuary and plume region (sampling conducted by Pacific Marine Environmental Laboratory[1]); transit to Santa Cruz.

July 14-25: Pacific whiting and shortbelly rockfish survey from Santa Cruz to the Klamath River, California, with emphasis on shortbelly rockfish in the Santa Cruz-San Francisco area; arrived Eureka, California on July 25.

1/ During July 8-11 and August 25-28 the Pacific Marine Environmental Laboratory (PMEL) collected a variety of environmental data from the Columbia River estuary and adjacent waters to help determine the effects of ash dispersal from the Mount St. Helens eruptions. Results of the PMEL sampling work are not included in this report.

Leg II

July 28-August 9: Continued whiting survey from Klamath River to Tillamook Bay, Oregon; arrived Newport, Oregon on August 9.

Leg III

August 11-23: Conducted survey of widow rockfish grounds off Newport, Oregon; continued whiting survey from Tillamook Bay to the Hoh River, Washington; arrived Astoria, Oregon on August 23.

Leg IV

August 25-28: PMEL sampling in Columbia River plume and estuary; returned to Astoria on August 28.

August 29-September 4: Collection of comparative fish target strength measurements off Washington coast with dual beam and split beam transducer systems; continued whiting survey from Hoh River to Cape Beale, Vancouver Island; arrived Neah Bay, Washington on September 4 to debark University of Washington scientists.

September 4-9: Continued whiting survey from Cape Beale to Kyuquot Sound, Vancouver Island; arrived Pier 91, Seattle on September 9.

September 10-11: Completed hydroacoustic system calibration; returned to Pacific Marine Center on September 11.

OBJECTIVES

The cruise was conducted as part of a multi-vessel survey of West Coast groundfish resources. During July-September the region covered by the Miller Freeman was also surveyed by two charter vessels (the Pat San Marie and Mary Lou) which completed sampling at approximately 600 bottom trawl stations. The survey was the second in a triennial series begun in 1977.

Principal cruise objectives were to: (1) determine, via an echo integrator-midwater trawl survey, the distribution, biomass, and biological composition of the off-bottom component of the Pacific whiting resource in the shelf-upper slope region, (2) collect data on the distribution, abundance, schooling behavior, biological composition and interspecies relationships of shortbelly rockfish (Sebastes jordani) and widow rockfish (Sebastes entomelas) in selected areas off the California-Oregon coast and (3) obtain measurements of the acoustic target strength of Pacific whiting and data necessary for comparison of the performance of dual beam and split beam transducer target strength measurement methods.

EQUIPMENT AND GEAR

Echo sounder data were collected and processed using a computerized echo integration and target strength measurement system housed in a sea-land van. The system included a 38-kHz sounder with three receivers and a towed dual beam transducer. In addition to the real time processing, all data were also tape recorded (as a back-up procedure) on a 7-track FM tape recorder. During part of Leg IV a towed split beam transducer and associated tape recording system were also employed. The split beam system was installed and operated by personnel from the Applied Physics Laboratory, University of Washington.

Except for the first four hauls made during the cruise, trawl sampling of fish echo sign was done with a rectangular midwater trawl (Norsenet Ltd., Norway) fished with 6 m^2 Waco doors and 75 m bridles (2 per side). The circumference of the trawl at the mouth was 440 meshes (1000 mm stretched measure). Mesh size decreased from 1000 mm in the wings and first section of the body to 46 mm in the codend. The mesh sizes of five intermediate sections were 800 mm, 400 mm, 200 mm, 124 mm and 80 mm. The cod end was covered with a double braided bag with a mesh size of 144 mm. While fishing, the average vertical mouth opening of the trawl was 18-20 m. A 3/4 scale version of the trawl was used at the start of the survey. It was replaced after the fourth haul because of broken riblines. A cable netsounder was used during each trawl haul.

A Tucker trawl was used for zooplankton sampling which was carried out as part of a study of shortbelly rockfish feeding habits. Water temperature/depth data were collected using an XBT system.

METHODS

The basic echo integrator survey was conducted during daylight hours (~0530-2030) along a zig-zag trackline which generally was run between the 30 and 250 fm (55-457 m) isobaths (Fig. 1). The distance between transects, i.e., adjacent transect end points, was 10 or 15 nautical miles in most of the survey region. Transects were more closely spaced in the area between Santa Cruz and San Francisco, where the survey effort for shortbelly rockfish was most concentrated. Also, a 100 square nautical miles area of known widow rockfish abundance off Newport, Oregon was intensively surveyed in an attempt to obtain data on the behavior of this species needed for the development of effective survey techniques. The center of this area was the "Crater," a 65 fm (119 m) pinnacle located between the 100 and 200 fm (183-366 m) isobaths at 44°39'N, 124°44'W.

Vessel speed along hydroacoustic survey transects averaged about 9 knots with the transducer towed at a depth of 10 fm (18 m). Echo integrator density estimates were usually computed at one-minute intervals for each 20 m depth stratum between the transducer and the

bottom, as well as for each of 9 bottom referenced depth strata within 50 m of the bottom. During the day, midwater trawl hauls were made to identify echo sign and to collect size/age and other biological data on the target species.

Except while working in the areas selected for studies of shortbelly and widow rockfish, nights were used primarily to collect data on whiting target strengths and to obtain additional midwater trawl samples of whiting needed to satisfy predetermined size and age composition sampling requirements. During the periods devoted to the collecting of target strength data on whiting, considerable time was spent locating dispersed, monospecific aggregations, and midwater trawl hauls were always made to verify echo sign identification and provide size composition data. During the collection of data required for comparison of dual beam and split beam target strength measurement methods, the two systems were operated simultaneously (transmitting alternately). All the data from both systems were recorded in analog form on instrumentation tape recorders. The single target echo data from the dual beam system were also digitally recorded.

As indicated above, survey activities directed at obtaining information on shortbelly rockfish were concentrated between Santa Cruz and San Francisco. This is an area where, as shown by past surveys, the species is highly abundant. The survey activity for shortbelly rockfish included the collection of acoustic data on diel changes in school size, depth and density. Also, an effort was made to obtain midwater trawl samples at each of several preselected bottom depths between 65 and 165 fm (119 and 302 m). This sampling was done off San Gregorio (37°18'N) where previous studies of differences in abundance and size/age composition with bottom depth were focused. To obtain data for research on predator-prey relationships, stomachs of shortbelly rockfish and of potential predators on shortbelly rockfish, e.g. Pacific whiting, were collected from several trawl catches. Also, zooplankton was sampled with a Tucker trawl, particularly at locations where shortbelly rockfish occurred in trawl catches.

Standardized catch sorting and sampling procedures were used to determine the species composition of each trawl catch and to obtain biological data on target species. Each catch was completely sorted by species, unless it exceeded about 2,500 lbs (1,134 kg). Larger catches were sampled and the total catch per species calculated by extrapolation. Standard length-frequency sample sizes were 100 fish per haul for shortbelly rockfish, and 200 for whiting and other rockfish. An attempt was made to collect 200 whiting otoliths from each of two depth strata, 30-100 fm and 101-250 fm (55-183 m and 184-457 m), in each of 12 subareas which the survey area was divided into for biological sampling purposes. Usually otoliths were collected from 100 of the 200 fish in a whiting length frequency sample and from all 100 fish in each shortbelly rockfish length frequency sample. A sample of 20 shortbelly rockfish stomach samples was collected from each catch. During Leg 1 data on the stomach contents of potential predators of shortbelly rockfish were collected. Up to 10 stomachs/species/haul were either examined directly or preserved for later analysis.

RESULTS

Survey and Trawl Sampling Effort

During the basic daytime survey, echo integration data were collected on a 2,360 nautical mile (4,445 km) trackline composed of 163 transects (Fig. 1).

Acoustical data were also collected on approximately 1,500 miles (2,778 km) of transects run at night while collecting target strength measurements, trawl sampling and observing changes in the schooling behavior of shortbelly rockfish and other targets. The echo integration system was operated at night while observing shortbelly rockfish in order to obtain quantitative data on diel differences in their density and vertical distribution.

Seventy-seven midwater trawl hauls were made during the survey, 72 of which could be used to help identify echo sign and/or to provide biological data on the target species (Table 1). Of the useable hauls, 32 were made during the daytime survey and 40 were made at night. Because of the slowness of the vessel's midwater trawling operations, the number of hauls made was significantly less than desired. The geographic distribution of the trawl sampling is shown in Figure 2. All species of fish caught during the survey are listed in Table 2.

During Leg I, 13 Tucker trawl hauls were made in the area between Santa Cruz and Point Arena (39°00'N). The Tucker trawl sampling was done mainly at locations where shortbelly rockfish were caught or detected.

Expendable bathythermograph (XBT) casts were made at most midwater trawl stations and at other selected locations. Eighty-one satisfactory XBT casts were made during the survey.

Relative abundance and size composition of Pacific whiting and shortbelly rockfish

The summary of information on the distribution of Pacific whiting and shortbelly rockfish presented here is based on an analysis of echogram records and the results of midwater trawl sampling. Analysis of the echo integration data has not been completed.

Whiting were available in significant concentrations from Santa Cruz to Eureka, California (40°50'N). Within this area, they were most abundant between Point Arena and Eureka, where large schools were found on the outer shelf and upper slope. Between Santa Cruz and Point Arena whiting were more dispersed and large aggregations were not detected. However, they were quite widely distributed on the inner shelf (30-50 fm; 55-91 m) and total abundance in this area appeared to be higher than on similar surveys conducted in 1975 and 1977.

The abundance of whiting between Eureka and Cape Blanco, Oregon (42°50'N) was lower than in any other part of the survey area. Significant whiting-like echo sign was not detected and no midwater trawl sampling was done along this section of the coast.

Whiting were detected throughout much of the large area between Cape Blanco and Cape Flattery (48°20'N). However, the average size and density of schools was low and no major aggregations were found. A few small concentrations of fish were present off the northern Oregon coast. Large schools of whiting were located off Cape Flattery and in the vicinity of La Perouse Bank. Only small quantities of fish were detected between Cape Beale (48°50'N) and Kyuquot Sound.

The distribution of whiting was quite different from that observed in 1977. The most obvious difference was the lack of fish off northern California

(north of Eureka) and southern Oregon. Approximately half of the total whiting biomass determined from the 1977 survey was derived from this area. Also commercial catches of whiting were concentrated in this area during 1977-79. In the area south of Eureka whiting were more widely distributed than in 1977 and it is likely they were significantly more abundant. Large, commercially available concentrations were found only in the Point Arena - Eureka and Cape Flattery - La Perouse Bank areas. The availability of whiting of northern Oregon and most of Washington was generally comparable to that observed in 1977.

The length composition of whiting, by sex and INPFC statistical area is shown in Fig. 3.2/ The increase in average size with latitude was very similar to that observed in previous years. There was a corresponding latitudinal change in the sex ratio of whiting in midwater trawl samples, i.e., a predominance of females among the larger, older fish in the northern part of the survey area. The male to female ratios in the Monterey-Eureka and Columbia-Vancouver regions were 1.2:1 and 1:1.4.

Shortbelly rockfish were highly abundant between Santa Cruz and San Francisco, particularly in the southern half of this area. Large, dense schools were found near the edge of the shelf between 37°00' and 37°25'N. North of San Francisco shortbelly rockfish were detected and captured only off Newport, Oregon (44°40'N) in the small area which was intensively surveyed for widow rockfish. In both areas they exhibited pronounced diel movements. During the day schools were located near and on bottom. At night they ascended into midwater and, because of a decrease in density, average school size, i.e., the volume of water containing a school, increased. The degree of dispersion at night was definitely limited compared to that characteristic of other species, e.g. whiting, and the basic integrity of schools, or clusters of schools, was maintained. The observations made on the schooling behavior of shortbelly rockfish indicate that they could be commercially fished with midwater trawls 24 hours per day, and that night is the best period to detect them.

Length distributions of midwater trawl samples of shortbelly rockfish taken near Santa Cruz and Newport are shown in Fig. 4. Fish caught in the Newport area were distinctly smaller than those caught off Santa Cruz.

Survey results for shortbelly rockfish corresponded with those of past surveys which have indicated that, during most of the year, a large proportion of the shortbelly rockfish resource is located off Central California, and that adult fish are most available in the Santa Cruz - San Francisco region. Because of the schooling behavior and distributional characteristics of adult shortbelly rockfish, it is likely that regular acoustic-midwater trawl surveys of a limited geographic area, e.g. Monterey Bay to Point Arena, would be effective in monitoring changes in the size and biological condition of the resource.

2/ Length data for a few catches of juvenile whiting are not shown. The sex of juvenile fish (7-25 cm) was not determined.

Observations on widow rockfish and other species

Widow rockfish were not detected in sufficient quantities in the "Crater" area off Newport, Oregon to collect useful data on their schooling behavior. Although the area was intensively surveyed during both day and night periods, only one school of fish was detected and sampled. It was not possible to stay in contact with these fish long enough to observe diel changes in behavior. Similar results were obtained by the simultaneous bottom trawl surveys of the area. Only small catches of widow rockfish were made by the two bottom trawl survey vessels. The results of the survey of the Crater area were somewhat surprising, but they may not be unusual for the summer period when widow rockfish are expected to be less available than they are in the winter and spring.

Except for the efforts directed at obtaining information on shortbelly rockfish, and widow rockfish in the Crater area, the survey was not designed to provide siginificant data on the abundance of rockfish. A limited amount of information on the distribution of several semi-pelagic species, e.g. yellowtail, red stripe and widow was obtained. This is partially reflected in their occurrence in trawl catches (Table 1). Yellowtail and red stripe were the species of rockfish most frequently caught in the northern Oregon-southwest Vancouver Island area. Small quantities of yellowtail were quite often taken in catches which were predominantly whiting.

As expected, Pacific herring, walleye pollock and spiny dogfish were most abundant off Cape Flattery and southwest Vancouver Island. During Leg IV, some of the survey effort was devoted to obtaining data on the abundance of herring on La Perouse Bank.

Three relatively large catches of jack mackerel were taken off California in hauls in which whiting were also caught. These catches of mackerel, in which the average length of the fish was 55 to 58 cm, were significantly larger than those which have been made during past U. S. whiting surveys. Their occurrence may have been partially due to the size of the trawl. The mouth opening of the trawl was more than twice the size of that of any trawl used previously.

Biological Data Collection

Numbers of samples collected for size and age composition and food habit studies are shown in Table 3. The length/weight measurements were obtained at locations where data on fish target strengths were collected. Except for 34 whiting, 10 widow rockfish and 10 yellowtail rockfish stomachs collected during Leg IV, all stomach sampling was done on Leg I in conjunction with research on the ecological relationships of shortbelly rockfish. The shortbelly rockfish investigations are directed by Dr. William Lenarz at the Tiburon, California Laboratory of the NMFS Southwest Fisheries Center.

Target Strength Data Collection

Dual beam target strength data were collected at night intermittently throughout Legs I-III. The data were obtained from dispersed aggregations of fish which were principally whiting. Several samples (each of which included approximately 1,000 single fish targets) were collected off the

northern Oregon and Washington coast at locations where midtrawl catches contained only whiting, or whiting and an insignificant quantity of other species.

During Leg IV an excellent set of data was obtained for a comparison of the performance of the dual beam and split beam techniques. These data were obtained from aggregations of fish which were primarily whiting, but which also included a significant percentage of other species.

U.S. - Canada Cooperative Studies

A Canadian scientist participated on the cruise during the latter part of Leg IV while the vessel was operating off Canada. The primary objective of his work was to obtain data on the distribution and biological composition of Pacific herring. At the end of the cruise he was provided with all data requested by Canada, including echograms, trawl catch records and biological data on herring.

The only other data requested by Canada were estimates of herring density obtained from schools located on La Perouse Bank. These data are provided in the table below. The estimates are based on an estimated target strength value of -33dB/kg.

Area	School Group No.	Mean herring density (kg/m^2 surface area)	Standard Error
Upper La Perouse Bank	1	0.747	.147
	2	0.348	.068
	3	0.195	.066
Lower La Perouse Bank	1	0.621	.123
	2	0.259	.071

SCIENTIFIC PERSONNEL

Leg I

Martin Nelson, Chief Scientist	NWAFC
Jimmie Traynor, Fishery Biologist	NWAFC
Daniel Twohig, Electronic Technician	NWAFC
John Garrison, Electronic Technician	NWAFC
Neal Williamson, Statistician	NWAFC
Jean Jacques Levenez, Fishery Biologist	France, Visiting Scientist
William Lenarz, Fishery Biologist	SWFC
Susan Smith, Fishery Biologist	SWFC
Daniel Ralph, Fishery Biologist	SWFC
Daniel Howard, Fishery Biologist	SWFC
Frank Jacques, Biological Technician	SWFC

Leg II

Edmund Nunnallee, Chief Scientist	NWAFC
Daniel Twohig, Electronic Technician	NWAFC
John Garrison, Electronic Technician	NWAFC
Neal Williamson, Statistician	NWAFC
Raymond Seamans, Statistical Clerk	NWAFC
Michael Converse, Student Aide	Shoreline Comm. College
Marvin Laborn, Student Aide	Shoreline Comm. College
Dwight Daniels, Student Aide	Shoreline Comm. College
Scott Sivertson, Student Aide	Shoreline Comm. College

Leg III

Edmund Nunnallee, Chief Scientist	NWAFC
John Garrison, Electronic Technician	NWAFC
Neal Williamson, Statistician	NWAFC
Jan McCrory, Biological Technician	NWAFC
John Rosapepe, Biological Technician	NWAFC
Nancy Cummings, Student Aide	Univ. Washington
Peggy Murphy, Student Aide	Univ. Washington
Richard Campagna, Biological Technician	Unaffiliated
Elpidio Pineda, Student Aide	Oreg. State Univ.

Leg IV

Jimmie Traynor, Chief Scientist	NWAFC
Daniel Twohig, Electronic Technician	NWAFC
Patricia Livingston, Fishery Biologist	NWAFC
Marcelle Van Houten, Student Aide	Univ. Wash.
Denise McKelvey, Student Aide	Oreg. State Univ.
Jan McCrory, Biological Technician (8/28-9/4)	NWAFC
Thomas Carlson, Research Assoc. (8/28-9/4)	Univ. Wash
William Barry, Electrical Engineer (8/28-9/4)	Univ. Wash.
Robert Wagner, Mechanical Engineer (8/28-9/4)	Univ. Wash.
Kathleen Edwards, NOAA Corps Officer (9/4-9/9)	NWAFC
Douglas Miller, Chief Herring Technician (9/4-9/9)	Pac. Biol. Sta., Can.

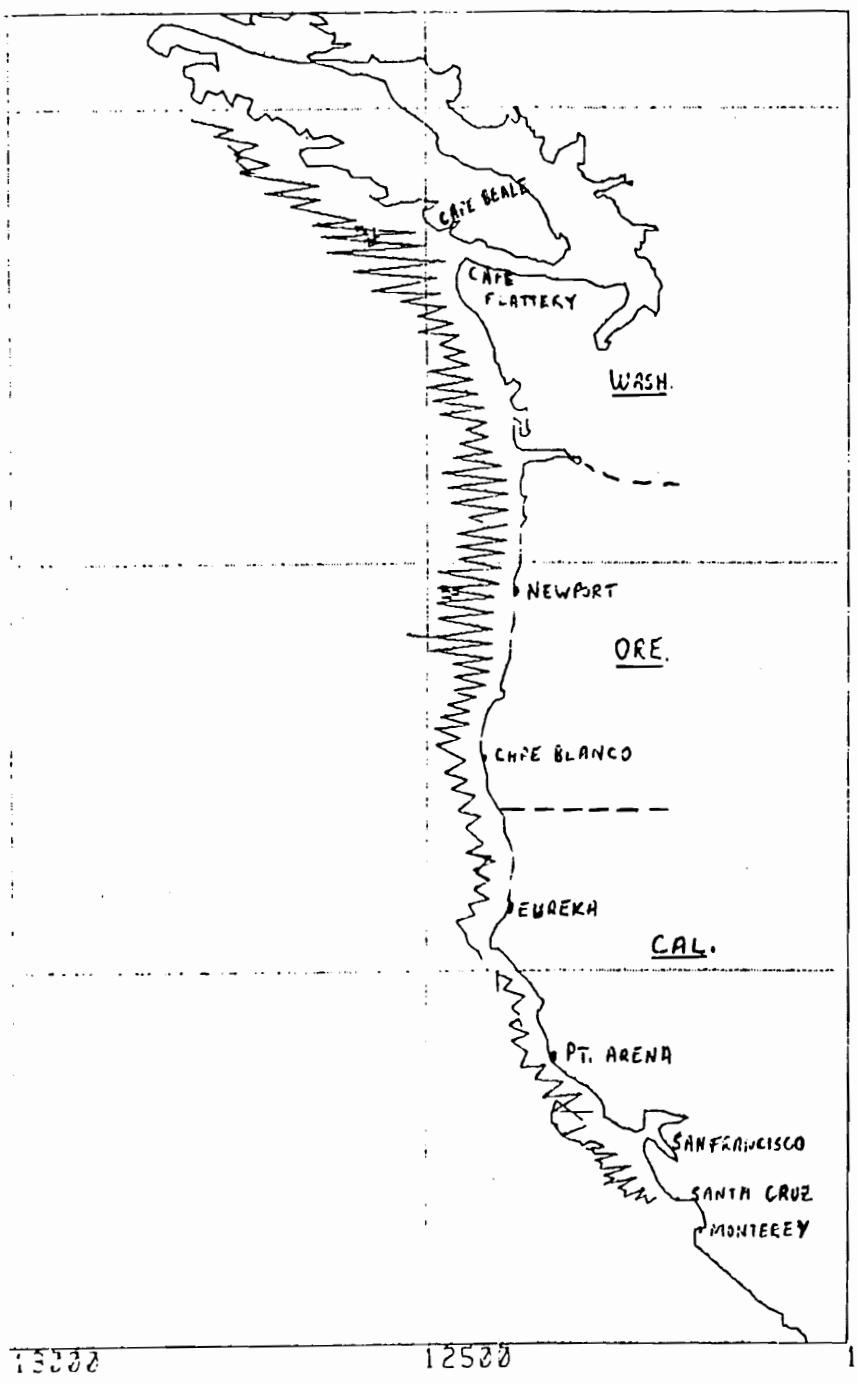

Figure 1. Daytime survey trackline, Miller Freeman Cruise 80-03.

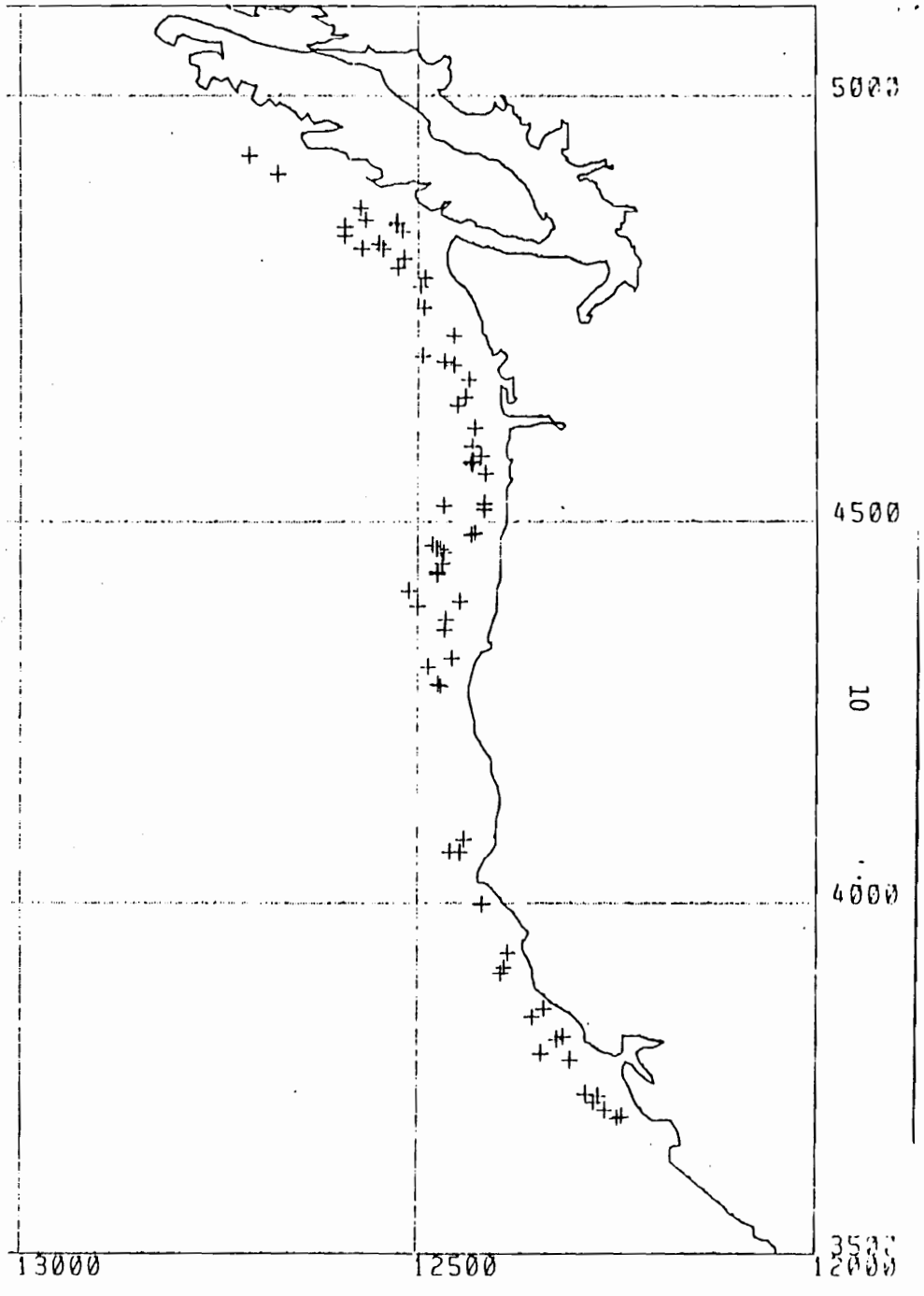

Figure 2. Geographic distribution of midwater trawl stations, Miller Freeman Cruise 80-03.

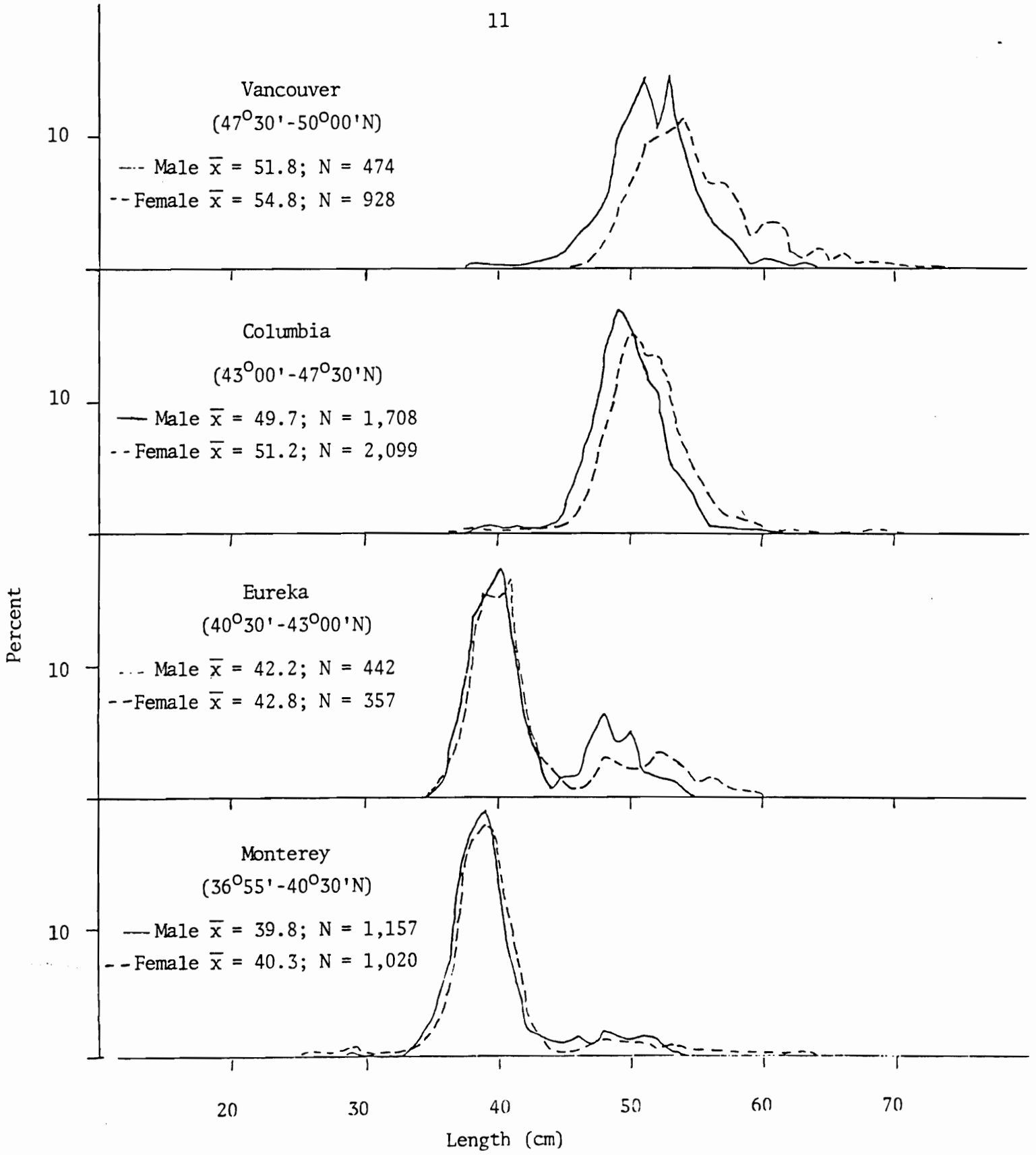

Figure 3. Percentage length distribution and mean length of Pacific Whiting, by sex and International North Pacific Fisheries Commission statistical area, as determined from midwater trawl samples obtained during Miller Freeman Cruise 80-03.

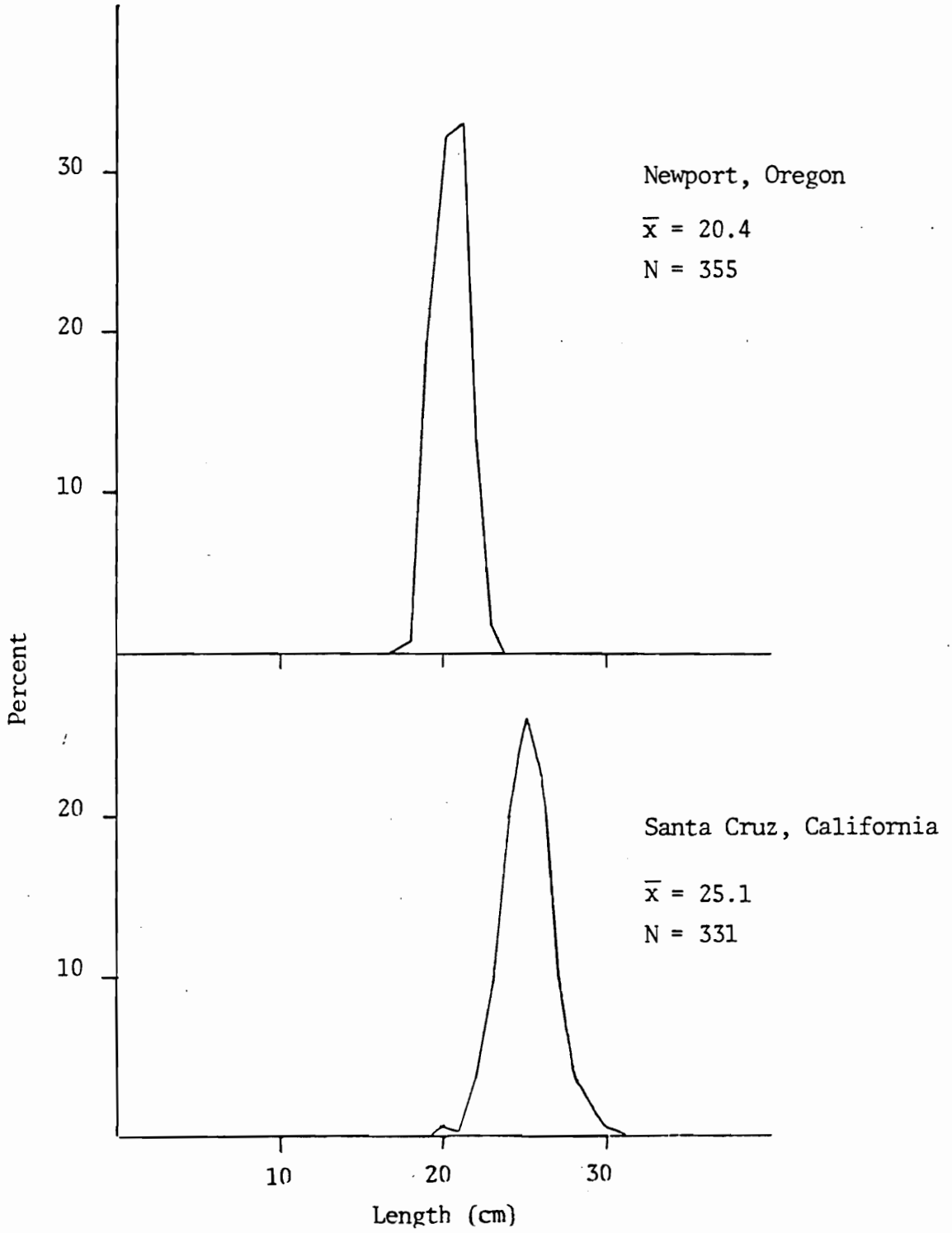

Figure 4. Percentage length distribution and mean length of shortbelly rockfish (sexes combined) in midwater trawl samples taken near Santa Cruz, California (36° 59'-37°13'N) and Newport, Oregon (44°40'N) during Miller Freeman Cruise 80-03.

Table 1. Summary of trawl station and catch data, Miller Freeman Cruise 80-03

Haul no.	Date (1980)	Start Pos. Lat (N)	Long (W)	INPFC area	Time of day (hr, PDT)	Ave depth (fm) gear/ bottom	Duration (hr)	Distance fished (n.m)	Catch (lbs) of selected species (T = catch < 1 lb)											
									Pacific whiting	Rockfish: Yellow tail	Rockfish: Widow	Rockfish: Shortbelly	Rockfish: Red Stripe	Rockfish: Canary	Rockfish: Chilipepper	Pac. Herring	Jack Mackerel	Walleye Pollock	Spiny Dogfish
1	7/14	37°06'	122°25'	Monterey	1100	64/82	1.0	2.1	-	-	-	6,821	-	-	47	-	-	-	-
2	"	36°59'	122°06'	"	1900	(Unsatisfactory haul; netsounder problem)						-	-	-	-	-	-	-	-
3	7/15	36°59'	122°06'	"	0300	69/80	0.1	0.4	156		-	3,029	-	-	-	-	-	-	-
4	"	37°06'	122°18'	"	1100	45/67	0.3	1.1	49	-	-	6	-	-	-	-	-	-	-
5	7/16	37°20'	122°32'	"	1000	110/130	0.4	1.0	4	-	-	8	-	-	2	-	4	-	-
6	"	37°13'	122°16'	"	1500	95/115	0.5	2.0	500	-	5	10,127	-	-	19	-	-	-	-
7	"	37°18'	122°43'	"	2100	40/55	0.3	0.9	13	-	-	-	-	-	-	-	-	-	-
8	7/17	37°49'	123°01'	"	2200	25/42	1.2	2.3	232	-	T	-	-	-	-	1	5	-	-
9	7/19	37°54'	123°2[illegible]'	"	1900	85/206	0.7	2.0	7,093	-	-	-	-	-	25	-	381	-	-
10	7/20	38°07'	123°[illegible]'	"	0200	35/61	1.0	2.9	3,114	-	-	-	-	-	-	-	-	-	182
11	"	38°09'	123°[illegible]	"	1100	38/53	0.5	1.0	1,151	-	-	-	-	-	-	T	7,562	-	281
12	"	38°32'	123°2[illegible]	"	2200	30/52	0.5	1.0	75	-	-	-	-	-	-	-	-	-	13
13	7/21	38°24'	123°32'	"	0300	50/111	1.0	2.5	T	-	-	-	-	-	-	-	-	-	-
14	"	39°07'	123°54'	"	1600	51/69	0.1	0.5	1,699	-	-	-	-	-	3	-	-	-	-
15	7/22	39°02'	123°5[illegible]'	"	0200	55/190	1.0	2.0	2,421	-	-	-	-	-	-	-	-	-	2
16	"	39°18'	123°5[illegible]'	"	0900	35/61	0.3	1.3	1,743	-	-	-	-	-	-	-	-	-	2,207
17	"	39°58'	124°1[illegible]'	"	1900	59/70	0.8	1.5	1,608	3	-	-	-	-	-	-	9	-	32
18	7/23	40°41'	124°07'	Eureka	1700	50/71	(Unsatisfactory haul; cod end open)					-	-	-	-	-	-	-	-
19	"	40°41'	124°28'	"	1900	70/80	0.6	1.4	2,282	-	-	-	-	-	-	-	-	-	-
20	7/24	40°41'	124°35'	"	0200	40/450	0.8	2.7	1,442	-	-	-	-	-	-	-	-	-	-
21	"	40°51'	124°25'	"	2300	65/100	0.3	1.5	2,776	-	20	1	-	-	-	-	-	-	23
22	7/30	42°54'	124°43'	"	0200	(Haul aborted; fouled headrope transducer)						-	-	-	-	-	-	-	-
23	7/31	42°55'	124°45'	"	0300	84/84	0.5	1.5	190	56	-	-	-	5	9	-	-	-	12
24	"	43°10'	124°53'	Columbia	1100	130/196	0.5	1.9	113	-	-	-	-	-	-	-	520	-	-
25	8/01	43°15'	124°34'	"	0100	37/56	0.7	2.2	65	-	-	-	4	-	-	-	-	-	4
26	"	43°3[illegible]	124°40'	"	1300	135/210	1.0	2.7	727	-	-	-	-	-	-	-	-	-	2
27	"	43°4[illegible]	124°41'	"	2100	30/185	1.5	6.0	282	-	-	-	-	-	-	-	-	-	2
28	8/02	43°[illegible]	124°59'	"	1400	40/300	0.8	2.2	82	-	-	-	-	-	-	T	26	-	-
29	"	44°[illegible]	124°28'	"	2200	30/66	1.0	5.0	707	-	-	-	-	-	-	-	4	-	27
30	8/03	44°08'	125°08'	"	1100	100/680	0.5	2.8	7	-	-	-	-	-	-	-	6	-	-
31	"	-	-	"	2300	(Haul aborted; bridles damaged)				-	-	-	-	-	-	-	-	-	-
32	8/04	43°23'	124°45'	"	0200	50/77	0.5	2.0	-	-	-	-	-	-	-	-	-	-	-

Table 1. (Continued)

Haul No.	Date (1983)	Start Pos. Lat (N)	Long (W)	INPFC area	Time of day (hr, PDT)	Ave depth (fm) gear/ bottom	Duration (hr)	Distance fished (n.m)	Catch (lbs) of selected species (T = catch < 1 lb)										
										Rockfish									
									Pacific whiting	Yellow tail	Widow	Short-belly	Red Stripe	Canary	Chili-pepper	Pac. Herring	Jack Mackerel	Walleye Pollock	Spiny Dogfish
33	8/04	44°22'	124°45'	Columbia	0600	50/74	0.3	1.1	6	4	-	-	-	-	-	-	-	-	-
34	"	44°29'	124°41'	"	1400	(Haul aborted; fouled headrope transducer)						-	-	-	-	-	-	-	-
35	8/05	44°21'	124°44'	"	0100	60/65	1.5	5.4	4	-	1	-	-	-	-	-	-	-	-
36	"	44°43'	124°47'	"	1000	125/200	1.1	2.6	8	-	2	-	-	3	-	-	4	-	-
37	"	44°52'	124°16'	"	1800	60/68	1.0	3.0	743	42	-	-	-	-	-	-	-	-	-
38	"	44°48'	124°21'	"	2200	65/70	1.0	4.0	738	40	-	-	-	-	-	-	-	-	-
39	8/06	45°13'	124°42'	"	2300	70/200	1.0	3.9	28	-	-	-	-	-	-	-	-	-	-
40	8/07	45°13'	124°08'	"	0900	50/58	0.8	3.0	3,900	-	-	-	-	-	-	-	-	-	-
41	8/08	45°11'	124°10'	"	0100	40/68	1.2	4.3	736	-	-	-	-	-	-	-	-	-	-
42	8/11	44°43'	124°46'	"	2300	75/85	0.4	0.8	98	-	-	922	-	-	-	-	-	-	3
43	8/12	44°37'	124°40'	"	0300	88/125	0.1	0.1	12	-	2,738	-	-	-	-	-	-	-	-
44	"	44°39'	124°43'	"	1000	60/75	0.7	2.5	-	-	-	-	-	-	-	-	-	-	-
45	8/13	44°40'	124°43'	"	0100	50/84	0.2	0.4	-	-	-	381	-	-	-	-	-	-	-
46	8/14	45°10'	124°09'	"	0200	40/66	1.0	2.5	947	-	-	-	-	-	-	-	4	-	T
47	"	45°35'	124°08'	"	1300	46/54	0.3	1.0	-	-	-	-	-	-	-	1	-	-	-
48	"	45°41'	124°17'	"	1900	62/75	0.9	2.0	4,269	-	-	-	-	-	-	-	-	-	-
49	8/15	45°41'	124°19'	"	0200	64/78	0.1	0.6	258	417	315	-	10	-	-	-	-	-	-
50	"	45°45'	124°13'	"	0900	50/60	0.5	1.5	4,650	-	-	-	-	-	-	-	-	-	-
51	8/16	45°56'	124°12'	"	0300	49/72	1.0	2.4	80	439	21	-	-	5	-	-	-	-	-
52	"	46°08'	124°15'	"	1200	27/51	0.5	2.0	-	-	-	-	-	-	-	-	-	-	-
53	8/17	46°30'	124°24'	"	0100	35/55	0.7	2.5	419	4	-	-	-	-	-	-	-	-	-
54	"	46°25'	124°30'	"	0300	35/74	0.5	2.0	1	-	1	-	-	-	-	-	-	-	-
55	"	46°43'	124°21'	"	1700	22/37	1.0	3.0	2,616	12	-	-	-	-	-	-	-	-	-
56	8/18	46°53'	124°32'	"	1200	40/52	0.5	1.3	7,236	468	-	-	-	-	-	4	-	-	-
57	"	46°59'	124°37'	"	0000	70/85	0.7	0.9	227	67	159	T	147	-	-	-	-	-	-
58	8/19	46°55'	124°40'	"	0500	30/64	1.0	1.4	161	51	-	-	-	17	-	-	-	-	-
59	"	47°14'	124°33'	"	1500	26/35	0.3	1.2	1,015	-	-	-	-	-	-	T	4	-	6

Table 1. (Continued)

Haul no.	Date (1986)	Start Lat N	Pos. Long (W)	Area	Time of day (hr, PST)	Ave depth (fm) gear/ bottom	Duration (hr)	Distance fished (n.mi)	Catch (lbs) of selected species (T = catch < 1 lb)										
									Pacific whiting	Rockfish: Yellowtail	Widow	Shortbelly	Red Stripe	Canary	Chilipepper	Pac. Herring	Jack Mackerel	Walleye Pollock	Spiny Logfish
60	8/30	47°34'	124°57'	Vancouver	1000	85/92	0.6	2.3	60	18	-	-	-	-	-	T	-	-	-
61	8/31	47°55'	124°55'	"	0100	46/50	0.3	1.2	1,741	-	-	-	-	-	-	T	-	-	30
62	"	48°02'	125°17'	"	1400	74/84	0.5	2.0	-	1,080	752	-	1,968	-	-	-	-	-	-
63	"	48°09'	125°03'	"	2200	60/159	1.5	3.5	483	103	-	-	-	-	-	-	-	-	2
64	8/30	45°43'	124°20'	Columbia	0200	55/79	0.1	0.1	3	-	2,022	-	-	-	-	-	-	-	-
65	8/31	47°49'	124°58'	Vancouver	0100	40/61	1.0	3.2	681	36	-	-	-	-	-	T	-	-	7
66	8/31	48°15'	125°43'	"	1200	104/163	0.7	1.7	11,996	-	-	-	-	-	-	-	-	-	-
67	"	48°18'	125°30'	"	1900	70/71	0.8	2.2	-	-	-	-	43	-	-	214	-	-	57
68	9/01	48°15'	125°27'	"	0300	45/70	1.2	2.9	36	33	-	-	-	-	-	-	-	-	530
69	"	48°27'	125°56'	"	1500	80/89	0.5	1.2	-	12	-	-	1,223	-	-	35	-	-	237
70	9/02	48°27'	125°56'	"	0300	55/90	1.0	3.2	19	47	3	-	1	-	-	T	-	-	81
71	"	48°31'	125°12'	"	1400	55/71	0.1	0.1	5,124	17	-	-	-	-	-	4	-	13	11
72	9/03	48°31'	125°17'	"	0100	30/74	0.5	1.0	1,288	3	-	-	-	-	-	-	-	101	261
73	"	48°31'	125°16'	"	0300	50/74	0.2	0.3	951	269	-	-	36	-	-	-	-	171	44
74	9/04	48°43'	125°44'	"	0100	33/95	0.5	1.4	839	-	-	-	-	-	-	3	-	64	133
75	9/05	49°26'	126°47'	"	0100	83/89	0.5	1.3	-	15	-	-	4	-	-	-	-	-	-
76	9/07	49°19'	127°00'	"	2300	99/108	1.0	2.5	2	7	-	-	1	6	-	-	-	-	-
77	9/08	48°35'	125°40'	"	1800	22/31	0.2	0.6	-	-	-	-	-	-	-	30,000	-	-	50
					No. of occurrences				61	24	13	9	10	5	6	15	12	4	27
					Percent occurence*				84.7	33.3	18.1	12.5	13.9	6.9	8.3	20.8	16.7	5.6	37.5
					Total weight				79,906	3,243	6,040	21,296	3,437	36	105	30,269	8,529	349	4,240

* In 72 useable hauls

Table 2. Species of fish captured during Miller Freeman Cruise 80-3.

Family	Common Name	Scientific Name
Alopidae	Thresher shark	Alopias vulpinus
Anoplopomatidae	Black cod	Anoplopoma fimbria
Carcharhinidae	Blue shark	Prionace glauca
Squalidae	Spiny dogfish	Squalus acanthias
Rajidae	Longnose skate	Raja rhina
Chimaeridae	Ratfish	Hydrolagus colliei
Torpedinidae	Torpedo ray	Torpedo californica
Scorpaenidae	Blackgill rockfish	Sebastes melanostomus
	Bocaccio	Sebastes paucispinus
	Chilipepper	Sebastes goodei
	Pacific ocean perch	Sebastes alutus
	Redstripe rockfish	Sebastes proriger
	Shortbelly rockfish	Sebastes jordani
	Shortspine thornyhead	Sebastolobus alascanus
	Silvergray rockfish	Sebastes brevispinus
	Widow rockfish	Sebastes entomelas
	Yellowtail rockfish	Sebastes flavidus
	Canary rockfish	Sebastes pinniger
Gadidae	Pacific whiting	Merluccius productus
	Pacific cod	Gadus macrocephalus
	Walleye pollock	Theragra chalcogramma
Salmonidae	King salmon	Oncorhynchus tshawytscha
	Silver salmon	Oncorhynchus kisutch
	Sockeye salmon	Oncorhynchus nerka
Bothidae	Pacific sanddab	Citharichthys sordidus
	Speckled sanddab	Citharichthys stigmaeus
Pleuronectidae	Arrowtooth flounder	Atheresthes stomias
	Dover sole	Microstomus pacificus
	English sole	Parophrys vetulus
	Flathead sole	Hippoglossoides elassodon
	Rex sole	Glyptocephalus zachirus
	Slender sole	Lyopsetta exilis
Carangidae	Jack mackerel	Trachurus symmetricus
Clupeidae	Pacific herring	Clupea harengus pallasi

Table 2. (Continued)

Family	Common Name	Scientific Name
Engraulidae	Northern anchovy	*Engraulis mordax*
Osmeridae	Eulachon	*Thaleichthys pacificus*
	Whitebait smelt	*Allosmerus elongatus*
Agonidae	Sturgeon poacher	*Podothecus acipenserinus*
Trachipteridae	King-of-the-salmon	*Trachipterus altivelis*
Hexagrammidae	Lingcod	*Ophiodon elongatus*
Icosteidae	Ragfish	*Icosteus aenigmaticus*
Gobiesocidae	Plainfin midshipman	*Porichthys notatus*
Centrolophidae	Medusa fish	*Icichthys lockingtoni*
Molidae	Ocean sunfish	*Mola mola*
Chauliodontidae	Pacific viperfish	*Chauliodus macouni*
Myctophidae	Lanternfish (Unid.)	
Zoarcidae	Eelpout (unid.)	

Table 3. Numbers of length measurements, length/weight measurements, age structures and stomach samples collected during Miller Freeman Cruise 80-03.

Species	No. length measurements	No. length/weight measurements	No. age structures*	No. stomachs
Pacific whiting	8,311	1,378	4,061	192
Shortbelly rockfish	686	--	402	104
Widow rockfish	567	141	489	10
Yellowtail rockfish	447	144	432	11
Chilipepper	15	--	--	15
Bocaccio	18	--	--	--
Jack mackerel	178	--	--	9
Spiny dogfish	489	--	38	--
Walleye pollock	67	--	--	--
Pacific herring	407	--	193	--
King salmon	2	--	--	2

* Otoliths, except for scales from Pacific herring.