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. 88-02
Shelikof Strait Acoustic/Midwater Trawl Survey of Walleye Pollock

CRUISE PERIOD, AREA, AND SCHEDULE

From March 6 to March 28, 1988, Resource Assessment and Conservation Engineering Division scientists aboard the NOAA ship Miller Freeman conducted an acoustic/midwater trawl survey of walleye pollock (Theragra chalcogramma) in Shelikof Strait, Alaska. The vessel's itinerary was as follows:

March 6	Departure from Dutch Harbor delayed because of bad weather.
March 7-10	Transit to survey start; two hauls in Unimak Pass area en route.
March 11-19	Survey 1.
March 19	Standard target calibration 1.
March 20-27	Survey 2.
March 27	Standard target calibration 2.
March 28	Arrive Kodiak.

OBJECTIVES

Echo integrator-midwater trawl surveys have been conducted annually (with the exception of 1982) in Shelikof Strait since 1980. The principal objectives of this cruise were to:

1. Collect echo integrator and midwater trawl data necessary to determine the distribution, biomass, and biological composition of the walleye pollock stock at the time of spawning in Shelikof Strait.

2. Collect pollock target strength data 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 a real-time calibration of the acoustic system and to detect changes in system performance with changes in transducer depth.

4. Collect biological samples of pollock for reproduction and stock structure studies.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

Research was conducted aboard the Miller Freeman, a 215 ft, 1,900 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 multibeam transducer. The transducer was mounted in a deadweight body towed behind the stern of the vessel at a depth of approximately 18 m. 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 phase channels for split beam target strength collection. The sounder transmitted at a pulse repetition rate of 1 per second with nominal pulse length of 0.6 milliseconds. Echo data were processed using a Hewlett Packard 1000 computer.[1]

Echo sign was sampled using a modified midwater rope trawl #864 from NET Systems, Inc. The trawl was outfitted with 45 fm bridles, 5 m^2 doors, 600/1,200 lb tom weights, and 1 1/4 inch mesh cod end liner. Trawl mouth opening and depth were estimated from cable netsounder echograms. The vertical mouth opening ranged from 12 to 18 fm.

Water temperature/depth profile data were collected at each trawl station using an expendable bathythermograph (XBT). Surface temperatures were measured with a bucket thermometer. Conductivity, temperature, and depth (CTD) data were also collected at two trawl sites and at the site of the second standard target calibration in Malina Bay.

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

SURVEY METHODS

Survey work began between the Semidi Islands and Chirikof Island (56°00'N) and proceeded northward to Paramanof Bay (58°30'N). The survey trackline consisted of parallel transects traversing the Strait between the 50 fm bottom depth contours. The distance between transects was 7.5 nmi. Vessel speed varied between 7 and 12 knots depending upon weather conditions. Upon completion of the first pass through the Strait, a second was made from south to north with transects offset 3.75 nmi north of the first set of tracklines.

Survey operations were conducted both day and night, 24 hours a day. Echo integrator density estimates were computed at 1 minute intervals (60 pings) for each 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 then multiplied by the total survey area to yield an estimate of biomass.

Midwater trawl hauls were made at selected locations to identify echo sign and 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 knots. 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; and individual weight measurements, maturity readings, and otolith samples for walleye pollock.

Target strength measurements were obtained only at night when pollock were more dispersed and the occurrence of single echoes was more likely. For target strength data collection, the acoustic fin was towed at an average speed of about 3 knots. Trawl sampling at appropriate depths was carried out just before and after each period of data collection to provide species composition and biological data.

The standard target calibrations were conducted with the vessel at anchor in approximately 100 m of water in Malina Bay. The work consisted of split beam and dual beam measurements of a copper sphere with known acoustic properties. The sphere 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 60 m.

PRELIMINARY RESULTS

The first two midwater trawl hauls were made near Unimak Pass while in transit to the survey area. From these catches,

pollock tissue samples and whole fish were collected for stock structure studies.

Two surveys of Shelikof Strait were completed during the cruise. Survey 1 (March 11-19) consisted of 26 transects totalling 813 nmi, with 11 midwater trawl hauls completed (Fig. 1). Survey 2 (March 20-27) consisted of 26 transects totalling 868 nmi, with 15 hauls completed (Fig. 2). Of the 26 midwater trawl hauls made in the survey area (Table 1), 8 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. Walleye pollock was the predominant species in the trawl catches, accounting for 93% of the total catch by weight and 79% by numbers. Eulachon was a distant second, making up 4% of the total catch by weight and 20% by numbers. A tally of the biological data collected for pollock is presented in Table 3. Temperature profile data from bucket thermometer readings and XBT casts indicate that surface temperatures varied between 3.5 and 4.6°C while bottom temperatures remained relatively constant at about 5.5°C. A typical temperature-depth profile is shown in Figure 3.

Pollock were distributed throughout the Strait with the highest densities in an area off Kupreanof Strait and another southwest of Kodiak Island (Fig. 4). The areal distribution of pollock was very similar for the two surveys. Fish were concentrated in layers in the water column (Fig. 5). The upper layer at approximately 125 m consisted primarily of 3- and 4-year-old (27-40 cm) fish (Fig. 6).[2] The near bottom layer was also dominated by the 1985 and 1984 year classes, but contained some 1-year-old (11-14 cm) and 2-year-old (19-25 cm) fish, as well as fish > 40 cm (Fig. 6). Sex composition information indicate that on average the upper layer was 53% female and the near bottom layer was 47% female. However, statistically, neither one of these percentages differs significantly from a 1:1 sex ratio. Maturity data revealed that male pollock were in a spawning condition as early as March 16; whereas, no female pollock were found with hydrated eggs by survey end on March 27. Length-maturity relationship for female fish implies that < 20% of the 1985 year class and < 30% of the 1984 year class would spawn in the spring (Fig. 7).

Target strength data were collected successfully on four nights at three different locations (Table 4). Each collection yielded a set of dual beam and 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.

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[2] Year class discussions are based on observations of this year's size composition and historic length-at-age information and must be considered preliminary.

Two standard target calibrations were conducted during the cruise --the first at the completion of survey 1 and the second at the end of survey 2, both in Malina Bay. Approximately 14 hours of data were collected on the copper calibration sphere. There was an observed increase in total system sensitivity with increasing transducer depth, but quantification of this effect must await analysis of the data.

SCIENTIFIC PERSONNEL

Name	Nation	Position	Organization
Neal Williamson	USA	Chief Scientist	NWAFC
Daniel Twohig	USA	Electronics Tech	NWAFC
John Garrison	USA	Electronics Tech	NWAFC
Doug Smith	USA	Fishery Biologist	NWAFC
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Antonio Carmelo	Italy	Electrical Engineer	ICRAP[3]

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[3] Istituto Centrale per la Ricera Scientifica e Tecnologica Applicata alla Pesca Marittima

Table 1. Midwater trawl haul station and catch data, MF88-2

HAUL NO.	DATE (1988)	TIME (AST)	START POSITTITION LAT. (N)	LONG. (W)	AVE. DEPTH (FM) FOOTROPE/BOTTOM	CATCH (lbs/nos.) WALLEYE POLLOCK	EULACHON	OTHER
1	7 MAR	2054-2134	54 51.6	165 52.0	53/84	-	-	-
2	7 MAR	2220-2311	54 51.6	165 51.6	50/82	-	-	-
3	11 MAR	1027-1140	56 08.7	156 04.9	127/134	1719/3646	15/167	49/36
4	13 MAR	1205-1301	56 31.7	155 57.4	141/143	365/616	25/328	9/58
5	16 MAR	1746-1923	57 07.3	155 28.6	96/148	134/251	1/9	.1/2
6	16 MAR	1940-2042	57 07.5	155 31.8	135/149	1083/1940	103/958	525/7
7	17 MAR	1206-1318	57 37.4	155 11.9	79/153	806/1783	-	4/1
8	18 MAR	1212-1325	58 08.0	153 53.8	103/114	737/1286	-	6/12
9	18 MAR	2220-2322	58 13.3	153 21.6	105/115	587/1177	42/617	6/297
10	20 MAR	0019-0034	57 42.3	154 24.3	77/120	2082/3844	7/104	23/114
11	20 MAR	0520-0602	57 21.4	155 24.9	82/146	390/838	1/23	-
12	20 MAR	0610-0657	57 20.2	155 26.0	126/146	824/1725	12/130	24/9
13	20 MAR	0952-1047	56 46.4	155 43.0	136/158	540/1097	401/3404	13/16
14	21 MAR	0252-0403	56 23.2	156 03.3	131/148	605/1232	63/685	47/16
15	21 MAR	1407-1529	56 35.4	155 48.0	80/142	464/981	65/859	7/3
16	22 MAR	0327-0415	56 58.7	155 30.2	146/152	1672/3225	290/2566	14/3
17	22 MAR	1934-2030	57 12.4	155 27.9	136/148	659/1337	19/177	3/2
18*	22 MAR	2054-2200	57 10.9	155 27.7	55/146	951/2080	-	3/4
19*	23 MAR	0350-0437	57 10.7	155 26.1	55/144	1338/3011	1/11	-
20	23 MAR	1327-1440	57 31.0	155 11.4	128/141	1327/1661	85/1009	33/12
21*	23 MAR	2058-2216	57 38.0	155 04.2	56/145	659/1294	-	-
22*	24 MAR	0355-0456	57 38.7	155 04.7	66/147	562/1070	6/145	4/6
23	24 MAR	1535-1658	57 48.9	154 44.8	127/139	774/778	55/552	5/5
24	24 MAR	2123-2231	57 43.1	154 34.8	64/121	554/1164	46/527	15/8
25*	26 MAR	0106-0154	58 21.6	153 07.8	45/129	2948/4099	1/9	21/35
26*	26 MAR	0524-0558	58 22.3	153 07.8	45/118	905/1430	-	.5/2
27*	26 MAR	2315-2359	58 19.4	153 15.0	48/107	1977/3996	-	.2/1
28*	27 MAR	0400-0437	58 19.8	153 12.4	45/111	2185/4119	-	.5/2
					Totals	26847/49680	1238/12280	812.3/651

* Hauls made in conjunction with the collection of walleye pollock target strength data.

Table 2. Frequency of occurence and total catch by species in the 26 midwater trawl hauls in Shelikof Strait, MF88-2.

Species	Frequency		Total Catch	
	Number	Percent	Pounds	Percent
Walleye Pollock (Theragra chalcogramma)	26	100.0%	26902	92.60%
Eulachon (Thaleichthys pacificus)	19	73.1%	1237	4.26%
Pacific Herring (Clupea pallasii)	11	42.3%	19	07%
Smooth Lumpsucker (Aptocyclus ventricosus)	9	34.6%	50	.17%
Squid (Unidentified)	9	34.6%	17	.06%
Chinook Salmon (Oncorhynchus tshawytscha)	9	34.6%	51	.18%
Arrowtooth Flounder (Atheresthes stomias)	8	30.8%	43	.15%
Pacific Cod (Gadus macrocephalus)	7	26.9%	89	.30%
Flathead Sole (Hippoglossiodes elassodon)	5	19.2%	5	.02%
Jellyfish (Unidentified)	5	19.2%	9	.03%
Rougheye Rockfish (Sebastes aleutianus)	2	7.7%	18	.06%
Shrimp (Unidentified)	2	7.7%	3	<.01%
Pink Salmon (Oncorhynchus gorbuscha)	1	3.8%	2	<.01%
Salmon Shark (Lamna ditropis)	1	3.8%	500	1.72%
Big Skate (Raja binoculata)	1	3.8%	103	.35%
Starry Flounder (Platichthys stellatus)	1	3.8%	1	<.01%
Rock Sole (Lepidopsetta bilineata)	1	3.8%	1	<.01%
Salmon (Unidentified)	1	3.8%	3	<.01%
		Total	29053	

Table 3. Summary of the biological samples and measurements collected, MF88-2.

Haul No.	Lengths	Matur.	Otoliths	Weights	Stomach Scans	Stock Structure Samples			Reproduction Samples	
						Mt DNA	Electro-phoresis	Whole Fish	Atresia	Fecundity
1	0	0	0	0	0	15	50	21	0	0
2	159	158	0	0	0	10	50	20	0	0
3	331	99	99	0	0	0	0	0	0	17
4	207	82	82	82	0	0	0	0	0	11
5	251	211	0	0	0	0	0	0	0	0
6	232	79	70	79	0	30	0	38	0	0
7	324	59	59	59	0	0	0	0	0	0
8	371	100	100	100	25	0	0	37	16	2
9	363	71	71	71	31	0	0	0	0	21
10	265	0	0	0	0	0	0	0	0	0
11	318	0	0	0	0	0	0	0	0	0
12	287	60	60	60	0	0	0	0	3	7
13	252	88	88	0	0	0	0	0	0	0
14	278	96	96	96	11	0	0	0	0	0
15	272	64	64	0	0	0	0	0	0	0
16	246	45	45	45	0	0	0	0	0	1
17	288	180	33	33	0	0	0	0	0	0
18	315	150	0	150	0	0	0	0	0	0
19	279	0	0	0	0	0	0	0	0	0
20	365	78	78	78	0	0	0	51	3	2
21	268	132	0	132	0	0	0	0	0	0
22	252	0	0	0	0	0	0	0	0	0
23	213	90	90	90	20	0	0	0	0	0
24	252	0	0	0	0	0	0	0	0	0
25	214	106	0	106	0	0	0	0	0	0
26	260	0	0	0	0	0	0	0	0	0
27	283	144	0	144	0	0	0	0	0	0
28	264	0	0	0	0	0	0	0	0	0
TOTAL	7409	2092	1035	1325	87	55	100	167	22	61

Table 4. Target strength data collection for walleye pollock, MF88-2

Date (1988)	Time (AST)	Location Lat (N)	Location Long (W)	Associated Hauls	Pollock (Nos.)	Mean Length
22-23 Mar	2246-0317	57° 11'	155° 27'	18, 19	100%	31 cm
23-24 Mar	2334-0309	57° 38'	155° 04'	21, 22	94%	32 cm
26 Mar	0234-0454	58° 22'	153° 08'	25, 26	100%	34 cm
27 Mar	0034-0334	58° 20'	153° 14'	27, 28	100%	32 cm

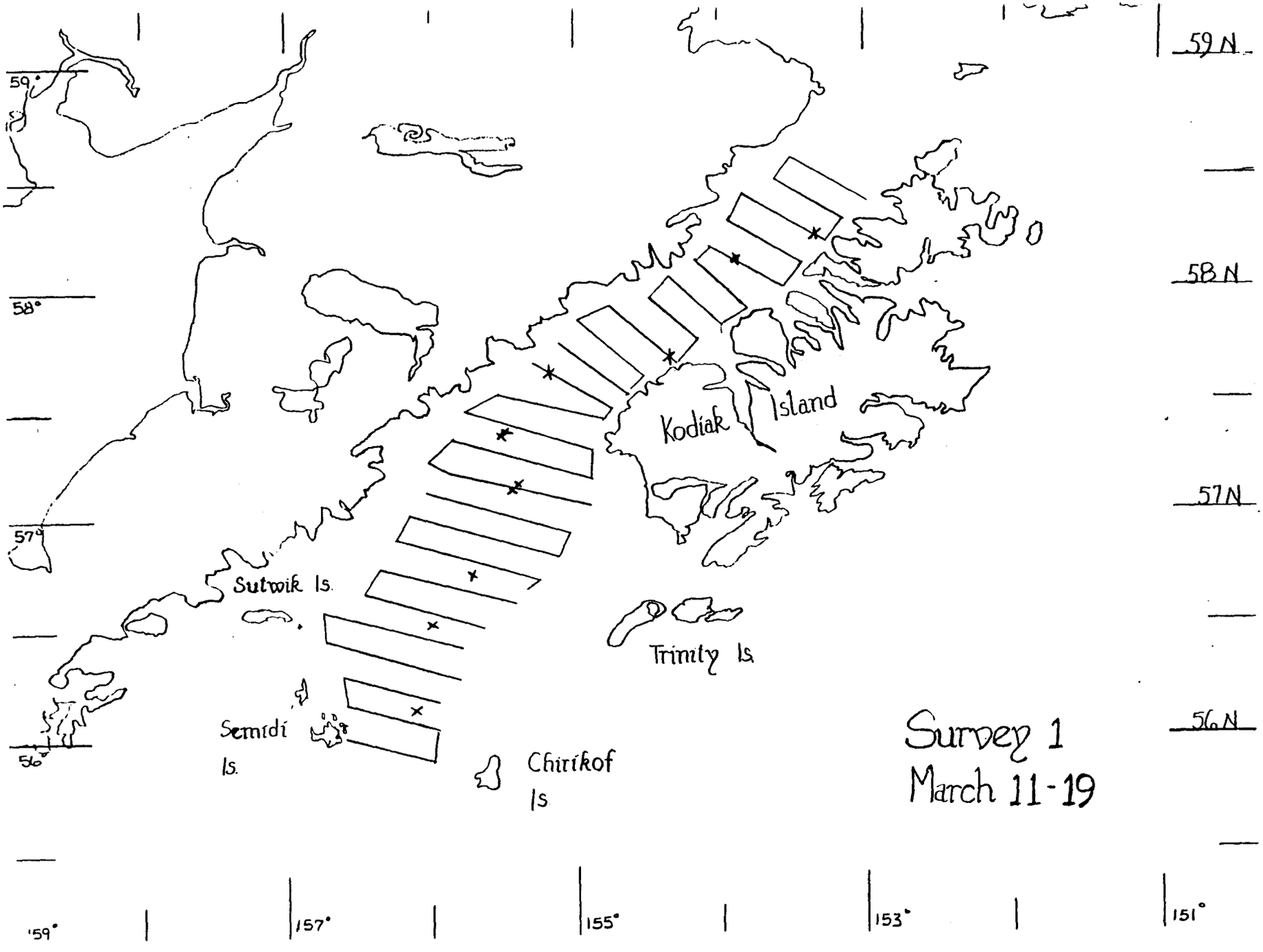

Figure 1. Survey 1 trackline and midwater trawl stations (x), MF88-2.

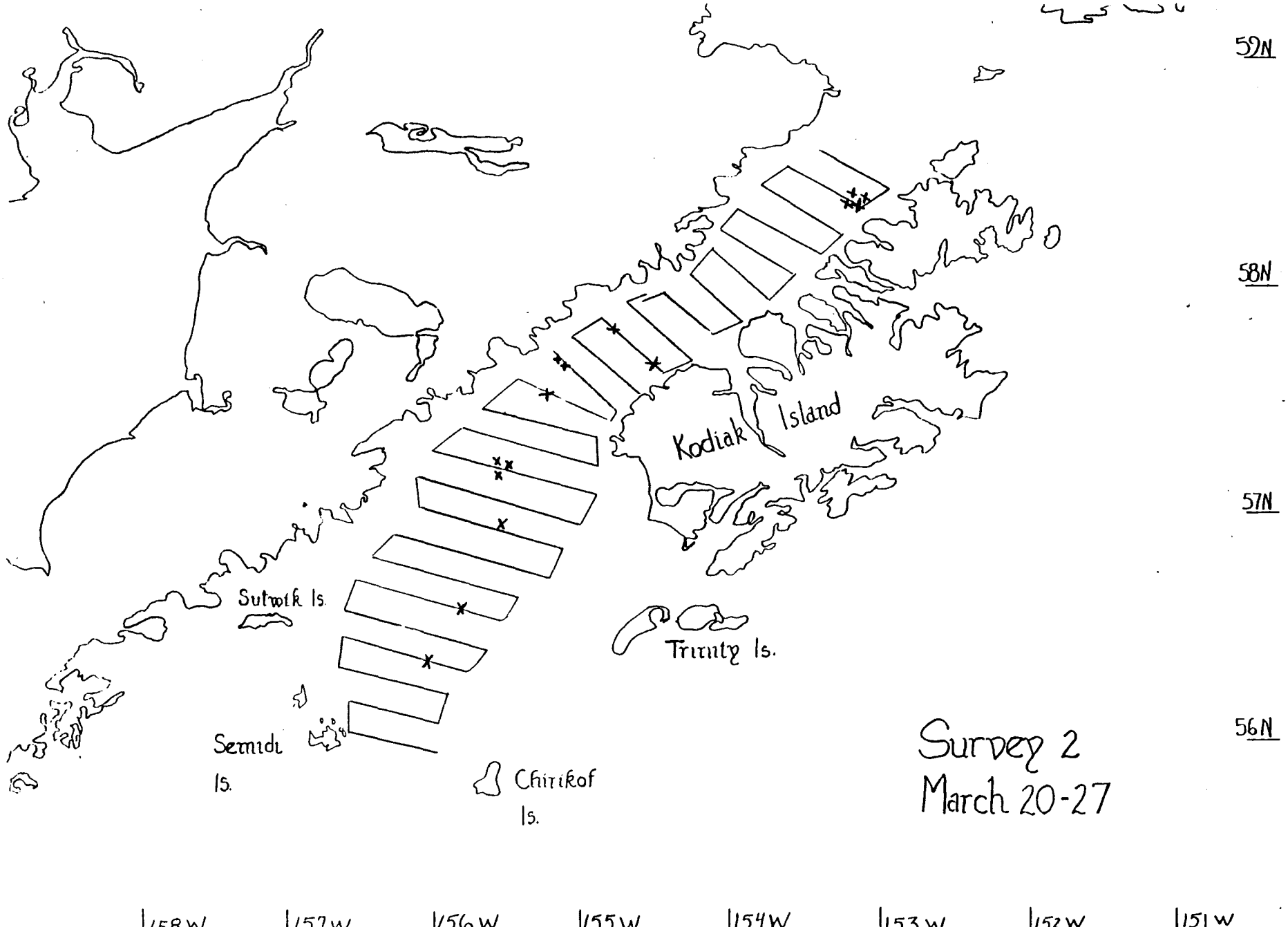

Figure 2. Survey 2 trackline and midwater trawl stations (x), MF88-2.

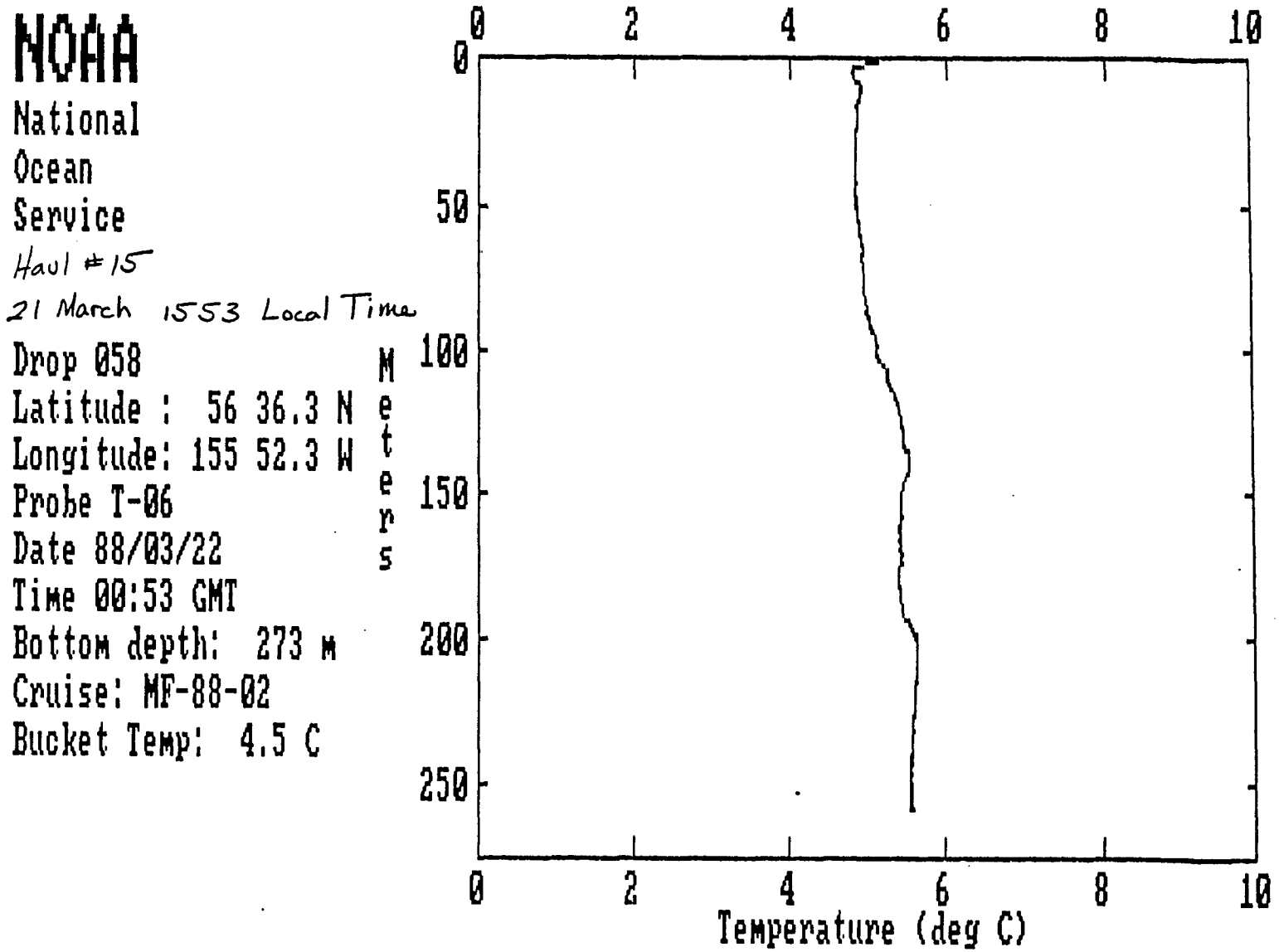

Figure 3. Typical temperature/depth profile from an XBT cast, MF88-2.

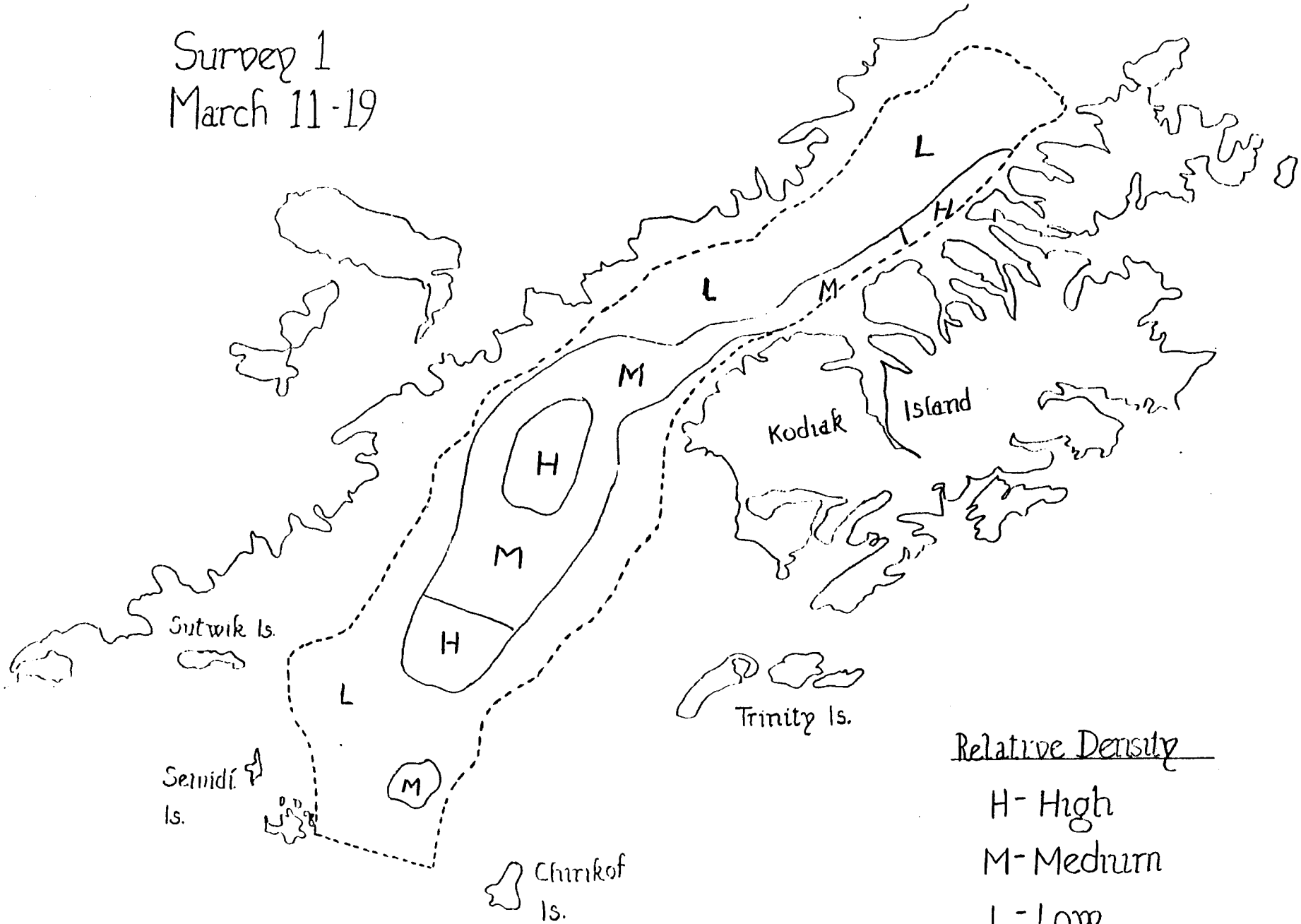

Figure 4. Areal distribution of relative surface densities of pollock from survey 1, MF88-2.

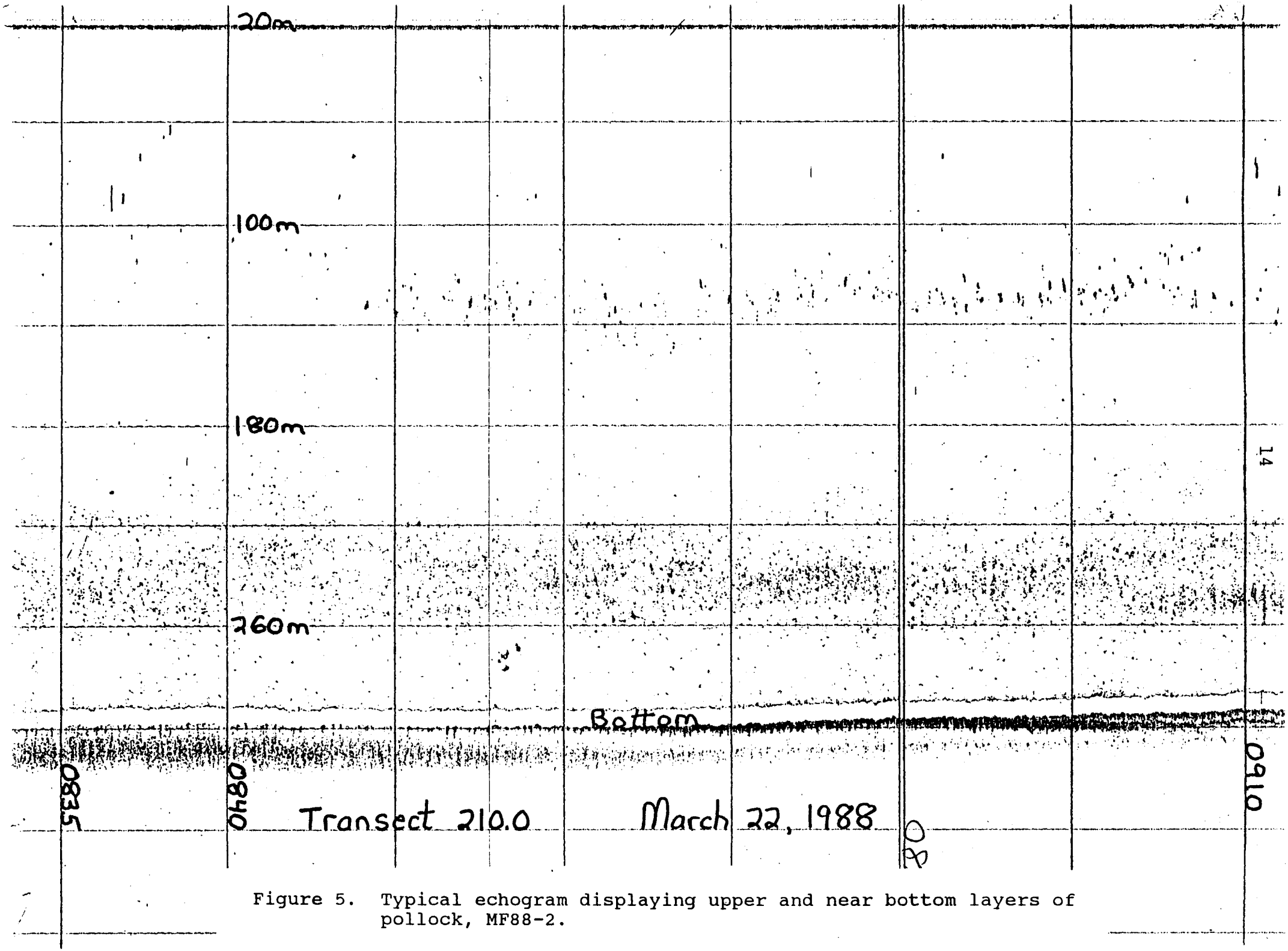

Figure 5. Typical echogram displaying upper and near bottom layers of pollock, MF88-2.

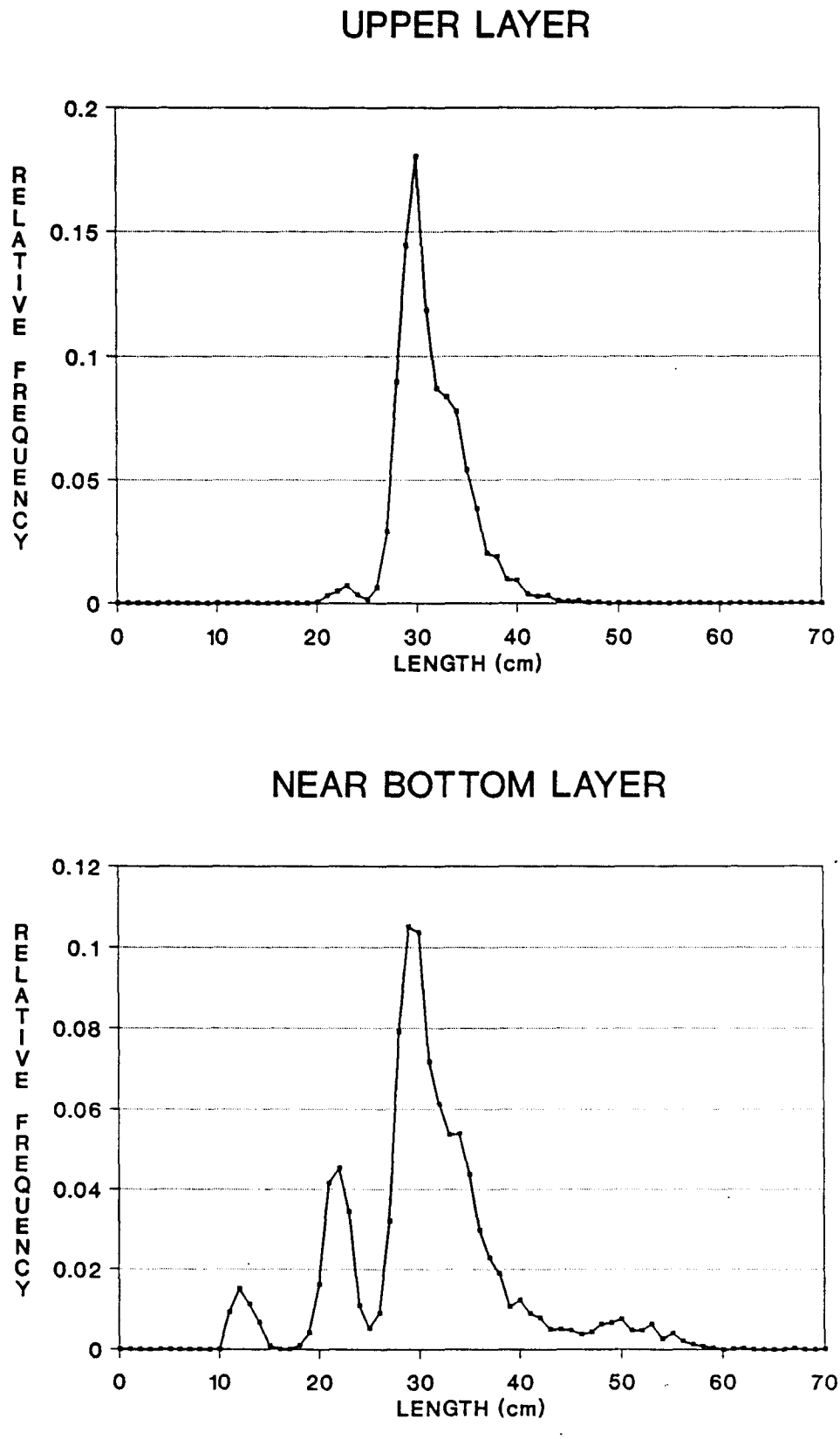

Figure 6. Pollock length distributions (unweighted by population size) for the upper and near bottom layers, MF88-2.

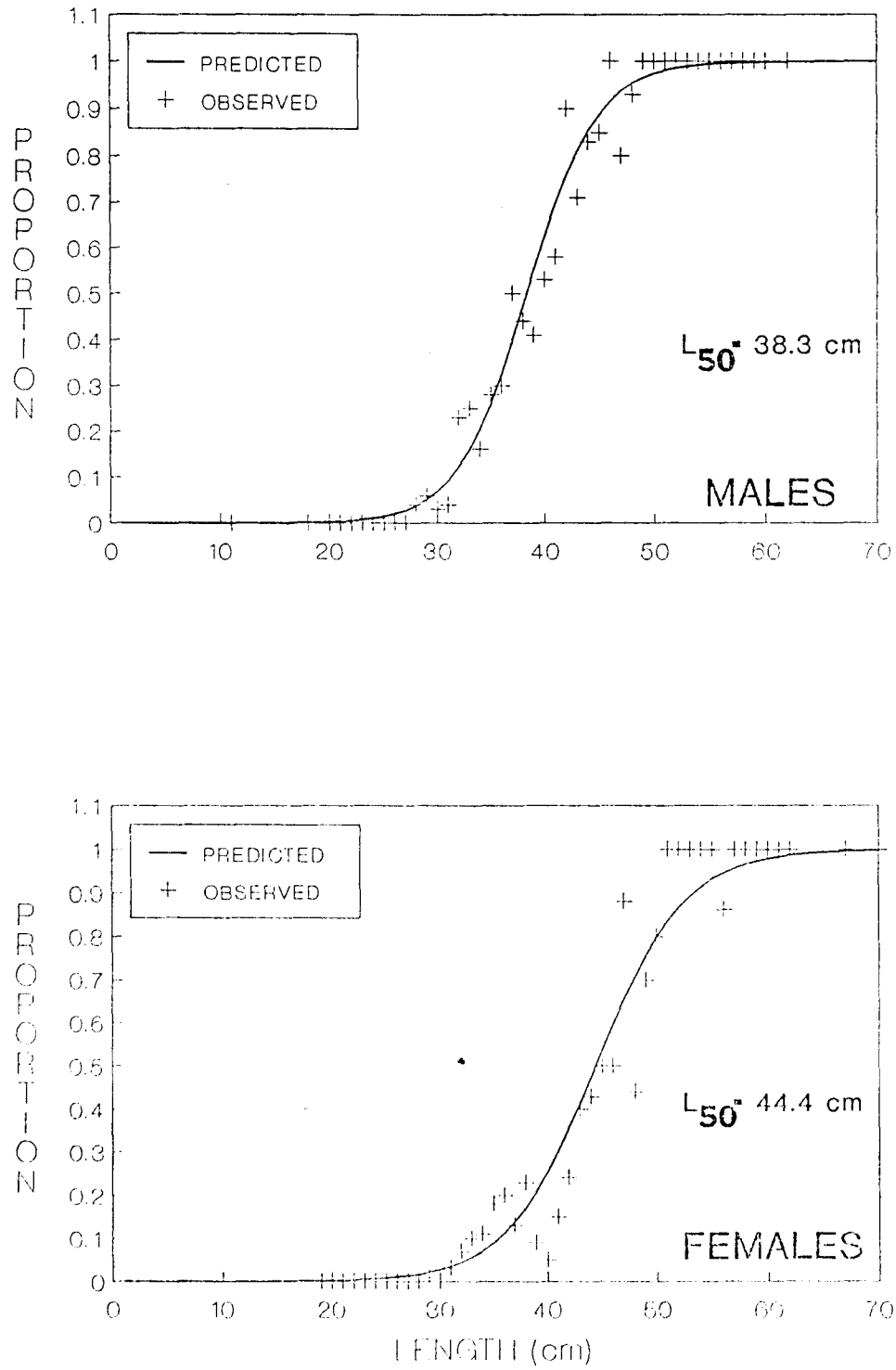

Figure 7. Pollock maturity-length plots by sex, MF88-2. Proportion mature represents the fraction of the population that will spawn in spring, 1988.