UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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PRELIMINARY CRUISE RESULTS
NOAA SHIP MILLER FREEMAN
CRUISE NO. 93-02

Echo Integration-Midwater Trawl Survey of Pollock in Shelikof Strait

CRUISE PERIOD, AREA, AND SCHEDULE

Scientists from the Alaska Fisheries Science Center conducted an echo integration-midwater trawl (EIMWT) survey of walleye pollock (Theragra chalcogramma) in Shelikof Strait aboard the NOAA ship Miller Freeman from March 12-22, 1993. The cruise immediately followed the survey work in the Bering Sea (MF93-01). Thus, a brief in port at Dutch Harbor, Alaska, was required to exchange chief scientists. Researchers from Russia and China participated as guest scientists aboard the vessel.

The itinerary for the Miller Freeman was as follows:

March 12	"Touch and go" in Dutch Harbor to exchange chief scientists
March 12-14	Transit to Shelikof Strait
March 14-19	EIMWT survey of Shelikof Strait (first pass)
March 19	Malina Bay sphere calibration
March 20-22	Continue EIMWT survey of Shelikof Strait (second and third passes)
March 22	Arrive Kodiak; end of cruise

OBJECTIVES

The principal objectives of the cruise were to:

1. collect echo-integration data and midwater and demersal trawl data to determine the distribution, biomass, and biological composition of walleye pollock in Shelikof Strait;

2. collect pollock target strength data to scale echo-integration data for generating estimates of absolute abundance;

3. calibrate the acoustic system using standard sphere techniques;

4. collect pollock ovary and liver tissue samples for stock structure studies;

5. collect vertical profile data of temperature and salinity in areas of pollock abundance;

6. collect samples of cephalopods for a marine mammal prey study;

7. collect principal forage fishes [i.e., capelin (Mallotus villosus), eulachon (Thaleichthys pacificus), other smelt (Osmeridae), sandfish (Trichodon trichodon), sand lance (Ammodytes hexapterus)] of marine mammals and birds for an energetics study;

8. collect mature pollock ovaries to assess interannual variations in fecundity; and

9. collect standard, fork, and total length measurements from pollock to investigate geographical variations in body morphology.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

The survey was conducted on board the NOAA ship Miller Freeman, a 66-m (216-ft) stern trawler equipped for fisheries and oceanographic research. Acoustic data were collected with a quantitative echo-sounding system (Simrad EK500[1]). A Simrad 38-kHz split-beam transducer was mounted on the bottom of the vessel's centerboard. With the centerboard fully extended, the transducer was 9 m below the water surface. System electronics were housed in a portable laboratory mounted on the vessel's weather deck. Data from the Simrad EK500 echo sounder/receiver were processed using the Simrad BI500 echo-integration and target strength data analysis software on a SUN workstation.

Midwater echo sign was sampled using a modified Northern Gold 1200 midwater rope trawl (NET Systems, Inc., Bainbridge Island, Washington). The trawl was constructed with ropes in the forward section and stretch mesh sizes ranging from 163 cm (64 in)

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

immediately behind the rope section to 8.9 cm (3.5 in) in the codend. It was fished in a bridleless configuration and was fitted with a 3.2-cm (1.2-in) mesh codend liner. Length of the headrope was 94.5 m (310 ft) when measured between the attachment points at the breastline. Length of the footrope was 50 m (164 ft) when measured between the tom weight attachment points. The breastlines measured 79.4 m (260.5 ft). The net was fished with 1.8-m X 2.7-m (6-ft X 9-ft) steel V-doors [1,000 kg (2,200 lb)] and 340-kg (750-lb) tom weights on each side. Vertical net opening, depth, and temperature at depth were monitored with a Furuno wireless net sounder system attached to the headrope of the trawl.

The Diamond 1000 midwater trawl was used as a substitute to the Northern Gold net for hauls 12-16 because damage occurred to the latter net during haul 11. The Diamond net was constructed of 40.6-m (16-in) stretch mesh in the wings, 81.3-m (32-in) mesh in the body, and 8.9-cm (3.5-in) mesh in the codend. A 3.1-cm (1.2-in) mesh liner was fitted to the codend. The 1.8-m 2.7-m V-doors and 114-kg (250-lb) tom weights were used on each side. Vertical net opening, depth, and temperature at depth were monitored with a Furuno net sounder system.

Fish on and near bottom were sampled with an 83/112 bottom trawl without roller gear. Net mesh sizes were 10.2 cm (4 in) except for the 8.9-cm (3.5-in) net mesh codend which was fitted with a 3.2-cm (1.2-in) liner. Length of the headrope was 25.6 m (83.9 ft) and footrope was 34.1 m (111.9 ft). The breastline lengths were 3.4 and 3.2 m (11.3 and 10.5 ft). Vertical net opening, depth, and temperature at depth were monitored with a Furuno net sounder system.

Vertical profile measurements of water temperature and salinity were collected at two trawl stations and the calibration site using a Seabird conductivity/temperature/depth (CTD) system. Temperature profile data at the remaining trawl locations were collected using expendable bathythermographs (XBT).

SURVEY METHODS

Three survey passes were conducted in Shelikof Strait to assess the distribution and abundance of pollock. The survey transects were oriented parallel to one another on all surveys, spaced about 7.5 nm apart during the first pass and about 3 nm during the second and third passes (Figs. 1-2). The first and third surveys progressed northward while the second survey progressed toward the south. The latter two surveys were designed to provide greater sampling effort in the region where greatest densities of pollock were observed during the first pass.

Survey operations were conducted during the day and night. While transecting, vessel speed averaged about 11 knots, with the speed varying between 7 and 12 knots, depending upon weather conditions. The acoustic system collected echo-integration data and split-beam target strength data.

Midwater and demersal trawl hauls were made at selected locations to identify echo sign and provide biological samples (Fig. 3). The average trawling speed was about 3 knots. The vertical net opening for the midwater rope trawl averaged about 22 m (range 19-24 m) and for the Diamond trawl averaged 11.1 m (11-14 m). The 83/112 trawl vertical mouth opening was about 2 m. No trawl hauls were made during the third survey pass.

Standard catch sorting and biological sampling procedures were used to provide weight and number by species for each haul. Pollock were further sampled to determine sex, fork length (FL), body weight, age, maturity, and gonad weight. Ovary and liver tissue samples for stock structure studies and cephalopod and fishes for the marine mammal studies were frozen. Fecundity samples were simply placed in a fixative solution.

Standard sphere calibrations were conducted in Malina Bay, Kodiak Island, on March 19. Acoustic properties of a copper sphere suspended below the transducer were measured. The standard sphere (60.0 mm diameter) had a known target strength of -33.6 dB. Split-beam target strength and echo-integration data were collected with the Simrad EK500 system. The data were collected to describe transducer-beam pattern characteristics and other acoustic system parameters.

PRELIMINARY RESULTS

Biological data were collected at trawl locations throughout Shelikof Strait. Trawl station and catch data from 22 midwater (17 Northern Gold and 5 Diamond trawl hauls) and 2 demersal trawl hauls are summarized in Table 1. Pollock was the dominant fish species captured in midwater trawl hauls although substantial numbers of eulachon (*Thaleichthys pacificus*) were also caught south of Uyak Bay (Table 2). Pollock ranked third numerically and seventh by weight among fishes captured in the two demersal trawl hauls (Table 3). Biological data collected for pollock are tallied in Table 4. A total of 20 successful XBT and 3 CTD casts were made during the cruise (Tables 5-6, Fig. 4). The first survey of Shelikof Strait took place from April 14-19 and comprised about 744 nm of acoustic transects. The second and third surveys were conducted from March 20-22 and covered 195 nm and 76 nm of trackline, respectively. Preliminary acoustic results from the latter two surveys are not yet available. A distributional plot of the relative pollock densities for the first survey is presented in Fig. 5. In the southernmost portion

of the Strait, southwest of Middle Cape, some pollock echo sign was observed along a few transects immediately north of Chirikof Island and moderate levels of density were detected along several transects between Sitkinak Strait and Middle Cape (Figs. 1 and 5). Most of this echo sign was observed within about 50 m of the bottom. Midwater trawl hauls in the southern region of the Strait generally produced pollock ranging in size from about 9-66 cm with three prominent length modes around 12, 23, and 40 cm (Fig. 6). The two smaller juvenile modal lengths were largely absent in the more northerly regions of the Strait, as described below. Pollock size compositions based on the two demersal trawls taken in this region of the Strait showed similar patterns to those from midwater catches.

In the central region of the Strait, between Middle Cape and Uyak Bay, moderate fish densities were also detected (Figs. 1 and 5) primarily within 50 m of the bottom. Trawl catches through these fish aggregations produced pollock size distributions that ranged from 10-64 cm, with a predominant modal length around 41 cm (Fig. 6).

The densest pollock aggregations were observed in the northwest region of the Strait, around Cape Kuliak (Figs. 1 and 5). This area has historically contained the greatest densities of pollock during surveys conducted in March. Again, most fish were detected within 50 m of the bottom. Midwater tows within this area produced fish that ranged in size from 13-67 cm with modal lengths often 50 cm or more (Fig. 6).

A total of 1,385 male and 1,273 female Shelikof Strait pollock were randomly sampled for maturity from the demersal and midwater catches. No males less than 36 cm FL, or females less than 37 cm FL, were mature (Fig. 7). The maturity composition of females at least 37 cm FL was 48% developing, 51% mature, and 1% spent. No spawning females were observed in the catch. For males at least 36 cm FL the maturity composition was 25% developing, 32% mature, 42% ripe and running, and 1% spent. Gonado-somatic indices (GSI) exhibited a slight positive correlation with length for mature, prespawning females (Spearman $r = 0.147$, $P < 0.05$; Fig. 8). Pollock from midwater trawls were not compared with those from bottom trawls because too few specimens were taken with the latter.

Results of the standard sphere calibration work indicated that the acoustic system parameters were similar to those estimated during calibration work on earlier cruises. Additional test results aided in the interpretation of the intership calibration work conducted during the winter 1993 Bering Sea EIMWT survey (MF93-01).

SCIENTIFIC PERSONNEL

Name	Sex/ Nationality	Position	Organization
William Karp	M/USA	Chief Scientist	AFSC
Dan Twohig	M/USA	Electronics Tech.	AFSC
Chris Wilson	M/USA	Fish. Biologist	AFSC
Dennis Benjamin	M/USA	Fish. Biologist	AFSC
Stephen de Blois	M/USA	Fish. Biologist	AFSC
Lowell Fair	M/USA	Graduate Student	UAK
Mikhail Stepanenko	M/Russia	Fish. Biologist	TINRO
Vladimir Vologdin	M/Russia	Acoustician	TINRO
Xiangyong Zhao	M/China	Acoustician	YSFRI

AFSC - Alaska Fisheries Science Center, Seattle, Washington
UAK - University of Alaska, Juneau, Alaska
TINRO - Pacific Research Institute of Fisheries and Oceanography, Vladivostok, Russia
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Table 1. Summary of trawl stations and catch data from Shelikof Strait collected during the winter 1993 EIMWT pollock survey, Miller Freeman cruise 93-02.

Haul	Survey[a] Pass	Date	Time (AST)	Start Position Lat. (N)	Start Position Long. (W)	Temp (C) Gear	Temp (C) Surf	Depth (m) Gear	Depth (m) Bott	Catch (lb[b]./no.) Pollock	Catch (lb[b]./no.) Eulachon	Catch (lb[b]./no.) Other
1	1	14 Mar	0417-0422	56 2.7	156 2.9	5.0	3.5	164	202	318/2884	147/3060	289/26
2[c]	1	14 Mar	1412-1442	55 50.8	156 23.9	5.3	3.7	245	245	36/40	T/1	1163/489
3	1	15 Mar	0152-0212	56 19.1	156 7.7	5.2	3.6	240	256	2702/2791	44/467	141/128
4	1	15 Mar	1101-1125	56 33.7	156 1.3	6.4	4.0	268	288	2000/1458	6/70	45/94
5[c]	1	15 Mar	1241-1311	56 34.2	156 4.3	6.5	4.0	293	293	19/47	27/181	885/585
6	1	15 Mar	2252-2301	56 46.2	155 40.6	5.2	4.0	256	280	857/619	59/787	62/251
7	1	16 Mar	0744-0753	57 1.8	155 41.3	5.3	4.1	275	293	1231/883	390/4421	42/288
8	1	16 Mar	1438-1451	57 10.3	155 45.8	4.1	3.8	82	274	2144/1660	2/41	4/4
9	1	16 Mar	1553-1559	57 11.1	155 46.6	4.8	3.8	246	272	1126/1594	311/2691	64/540
10	1	16 Mar	2324-2343	57 19.5	155 6.9	5.4	3.6	229	243	1933/2186	408/5096	359/1159
11	1	17 Mar	0808-0822	57 27.9	154 43.6	3.7	4.2	48	79	1968/1114	17/268	26/116
12	1	17 Mar	1813-1825	57 54.3	154 47.4	4.8	3.6	218	265	1267/764	1/4	7/3
13	1	17 Mar	2328-2333	57 56.3	154 31.3	4.7	4.6	243	277	1836/1262	T/3	6/1
14	1	18 Mar	0320-0340	57 50.1	154 2.0	4.5	4.0	86	200	2404/2459	--/--	316/6
15	1	18 Mar	0729-0740	58 6.6	154 11.4	4.7	3.2	212	230	1782/932	T/1	12/4
16	1	18 Mar	1251-1321	58 8.8	153 31.6	4.8	4.5	146	214	1552/707	--/--	5/2
17	1	18 Mar	2045-2100	58 23.1	153 52.6	4.7	2.5	150	178	2495/979	T/1	188/21
18	2	19 Mar	1720-1722	58 14.4	154 2.0	4.7	3.1	204	255	13094/4806	--/--	6/7
19	2	19 Mar	2331-2332	58 9.3	154 6.1	2.8	3.2	210	301	8613/4875	T/2	37/4
20	2	20 Mar	0613-0621	58 2.0	154 21.9	4.9	4.5	197	230	2779/1315	T/6	8/10
21	2	20 Mar	1035-1037	57 57.0	154 34.2	4.8	4.5	175	250	6330/4468	--/--	--/--
22	2	20 Mar	1219-1224	57 56.4	154 34.4	5.0	4.5	236	262	1474/994	1/22	161/6
23	2	20 Mar	1933-1949	57 45.6	155 0.5	5.1	3.4	243	313	2115/1417	69/821	33/36
24	2	21 Mar	0646-0654	57 29.1	155 19.5	5.3	3.6	245	274	1848/1371	316/2424	173/182

[a]Represents the first (1) and second (2) pass through Shelikof Strait
[b]T represents catch < 0.5 lb.
[c]bottom trawl

Table 2. Summary of catch by species in 22 midwater rope trawls from Shelikof Strait during the winter 1993 EIMWT pollock survey, Miller Freeman cruise 93-02.

Species	Weight (lb.)	Percent	Numbers	Percent
Walleye Pollock (*Theragra chalcogramma*)	61,866.4	94.3	41,538	64.3
Eulachon (*Thaleichthys pacificus*)	1,771.3	2.7	20,185	31.2
Pacific Sleeper Shark (*Somniosus pacificus*)	847.0	1.3	5	<.1
Pacific Cod (*Gadus macrocephalus*)	310.6	0.5	31	<.1
Salmon Shark (*Lamna ditropis*)	285.0	0.4	1	<.1
Squid Unidentified (Teuthoidea)	214.8	0.3	2,236	3.5
Rougheye Rockfish (*Sebastes aleutianus*)	89.7	0.1	26	<.1
Smooth Lumpsucker (*Aptocyclus ventricosus*)	67.3	0.1	27	<.1
Jellyfish Unidentified (Scyphozoa)	51.5	0.1	57	0.1
Chinook Salmon (*Oncorhynchus tshawytscha*)	49.6	0.1	12	<.1
Arrowtooth Flounder (*Atheresthes stomias*)	44.7	0.1	14	<.1
Northern Smoothtongue (*Leuroglossus schmidti*)	14.2	<.1	296	0.5
Flathead Sole (*Hippoglossoides elassodon*)	6.1	<.1	8	<.1
Shrimp Undientified (Natantia)	1.1	<.1	117	0.2
Pasiphaeid Shrimp (Pasiphaeidae)	0.2	<.1	54	0.1
Capelin (*Mallotus villosus*)	0.2	<.1	2	<.1
Sidestripe Shrimp (*Pandalopsis dispar*)	0.1	<.1	1	<.1
Snailfish Unidentified (*Careproctus* sp.)	0.1	<.1	1	<.1
Totals	65,619.9	100.0	64,611	100.0

Table 3. Summary of catch by species in 2 bottom trawls from Shelikof Strait during the winter 1993 EIMWT pollock survey, Miller Freeman cruise 93-02.

Species	Weight (lb.)	Percent	Numbers	Percent
Arrowtooth Flounder (*Atheresthes stomias*)	949.0	44.6	329	24.5
Longnose Skate (*Raja rhina*)	371.5	17.4	24	1.8
Big Skate (*Raja binoculata*)	264.5	12.4	12	0.9
Dover Sole (*Microstomus pacificus*)	96.5	4.5	31	2.3
Pacific Halibut (*Hippoglossus stenolepis*)	76.6	3.6	7	0.5
Sablefish (*Anoplopoma fimbria*)	67.5	3.2	21	1.6
Walleye Pollock (*Theragra chalcogramma*)	54.5	2.6	87	6.5
Skate Unidentified (*Bathyraja* sp.)	47.0	2.2	13	1.0
Rex Sole (*Errex zachirus*)	35.0	1.6	26	1.9
Eulachon (*Thaleichthys pacificus*)	27.5	1.3	182	13.6
Miscellaneous Invertebrates	27.0	1.3	---	----
Bairdi Tanner Crab (*Chionoecetes bairdi*)	25.7	1.2	104	7.7
Flathead Sole (*Hippoglossoides elassodon*)	25.5	1.2	33	2.5
Pacific Cod (*Gadus macrocephalus*)	14.0	0.7	2	0.1
Oregon Triton (*Fusitriton oregonensis*)	11.5	0.5	65	4.8
Sidestipe Shrimp (*Pandalopsis dispar*)	7.9	0.4	227	16.9
Squid Unidentified (Teuthoidea)	7.9	0.4	7	0.5
Rougheye Rockfish (*Sebastes aleutianus*)	6.0	0.3	2	0.1
Chinook Salmon (*Oncorhynchus tshawytscha*)	4.2	0.2	1	0.1
Red King Crab (*Paralithodes camtschatica*)	3.5	0.2	1	0.1
Jellyfish Unidentified (Scyphozoa)	2.5	0.1	7	0.5
Common Mud Star (*Ctenodiscus crispatus*)	1.9	0.1	119	8.9
Scarlet Sea Star (*Pseudarchaster parelii*)	0.9	<.1	26	1.9
Spinyhead Sculpin (*Dasycottus setiger*)	0.7	<.1	4	0.3
Basket Star (*Gorgonocephalus caryi*)	0.5	<.1	4	0.3
Sea Mouse Unidentified (Aphroditidae)	0.2	<.1	6	0.4
Peachskin Snailfish (*Careproctus scottae*)	0.2	<.1	2	0.1
North Pacific Toad Crab (*Hyas lyratus*)	0.1	<.1	1	0.1
Totals	2,129.8	100.0	1,343	100.0

Table 4. Summary of pollock biological samples and measurements from Shelikof Strait collected during the winter 1993 EIMWT pollock survey, Miller Freeman cruise 93-02.

	United States								Russia[a]		China[a]
Haul No.	Length	Maturity	Otolith	Fish Wt	Ovary Wt	Fecundity	Genetic	Comparative Length	Scale	Otolith	Otolith
1	602	158	158	158	18	3	0	0	0	0	0
2	40	29	29	29	1	0	0	0	0	0	0
3	687	113	113	113	2	0	0	0	0	0	0
4	436	100	100	100	15	0	0	0	0	0	0
5	47	39	39	39	2	0	0	0	0	0	0
6	496	123	123	123	37	7	0	0	0	0	0
7	467	91	91	91	26	2	0	0	0	0	0
8	430	128	128	128	3	0	0	0	100	20	0
9	504	107	107	107	19	0	0	0	0	0	0
10	579	134	134	134	9	0	0	0	0	0	0
11	440	153	153	153	28	0	0	0	0	0	0
12	664	100	100	100	23	0	0	0	0	0	0
13	374	117	117	117	10	0	0	0	0	0	25
14	354	100	100	100	2	0	0	0	0	0	0
15	402	133	133	133	76	0	25	0	0	0	35
16	310	117	117	117	52	40	0	0	0	0	0
17	316	105	105	105	68	0	0	0	0	0	0
18	564	95	95	95	37	0	0	45	0	0	0
19	405	119	119	119	31	1	25	11	0	0	0
20	431	114	114	114	48	0	0	8	0	0	0
21	406	117	117	117	13	0	0	2	0	0	0
22	363	103	103	103	15	1	0	0	0	0	0
23	447	107	107	107	12	0	0	14	0	0	0
24	667	158	158	158	28	0	0	0	0	0	0
Total	10,431	2,660	2,660	2,660	575	54	50	80	100	20	60

[a]samples collected by foreign scientists for their use

Table 5. Inventory of CTD casts, Miller Freeman cruise 93-02.

Cast	Haul	Date (1993)	Time (AST)	Position Lat (N)	Position Long (W)	Depth (m) Cast	Depth (m) Botm	Comments[a]
1	1	Mar 14	0524	56 03.1	156 02.8	190	200	Shelikof Tr. 1.0
2	2	Mar 14	1530	55 50.7	156 21.4	229	242	Shelikof Tr. 0.2
3	-	Mar 19	0741	58 12.6	153 02.7	87	98	Malina Bay cal

[a]Tr. = Transect

Table 6. Inventory of XBT drops, Miller Freeman cruise 93-02.

Drop[a]	Probe	Haul	Date (1993)	Time (AST)	Position Lat (N)	Position Long (W)	Bottom Depth (m)	Comments[b]
91	T-4	3	Mar 15	0117	56 18.6	156 05.6	244	Shelikof Tr. 3.0
92	*** DROP NO GOOD ***							
93	T-6	5	Mar 15	1205	56 33.7	156 06.5	287	Shelikof Tr. 5.0
94	T-6	6	Mar 15	2202	56 45.2	155 35.8	255	Shelikof Tr. 7.0
95	T-4	7	Mar 16	0642	57 02.0	155 42.2	285	Shelikof Tr. 9.0
96	T-6	8,9	Mar 16	1356	57 11.4	155 51.8	238	Shelikof Tr. 10.0
97	T-6	10	Mar 16	2242	57 19.7	155 10.4	240	Shelikof Tr. 12.0
98	*** DROP NO GOOD ***							
99	T-4	11	Mar 17	0854	57 28.6	154 41.3	65	Shelikof Tr. 13.1
100	T-6	12	Mar 17	1730	57 54.8	154 46.1	257	Shelikof Tr. 17.0
101	T-4	13	Mar 17	2311	57 56.0	154 32.6	270	Shelikof Tr. 18.0
102	T-6	14	Mar 18	0400	57 51.2	154 04.0	217	Shelikof Tr. 19.0
103	T-6	15	Mar 18	0813	58 07.0	154 09.2	287	Shelikof Tr. 20.1
104	T-6	16	Mar 18	1158	58 10.3	153 36.1	194	Shelikof Tr. 22.0
105	T-4	17	Mar 18	1832	58 23.1	153 53.2	158	Shelikof Tr. 23.0
106	T-4	-	Mar 19	1541	58 15.3	154 03.8	101	Shelikof Tr. 101.0
107	T-7	18	Mar 19	1643	58 15.6	153 59.7	268	Shelikof Tr. 101.0
108	T-4	19	Mar 19	2237	58 09.3	154 06.1	272	Shelikof Tr. 103.1
109	T-6	20	Mar 20	0653	58 01.2	154 21.8	254	Shelikof Tr. 108.1
110	T-6	21,22	Mar 20	1108	57 57.4	154 35.3	225	Shelikof Tr. 110.1
111	T-4	23	Mar 20	1907	57 44.7	154 58.8	275	Shelikof Tr. 116.1
112	T-6	24	Mar 21	0559	57 27.9	155 20.1	264	Shelikof Tr. 124.1

[a]XBT drops 1-90 on MF93-1.
[b]Tr. = Transect

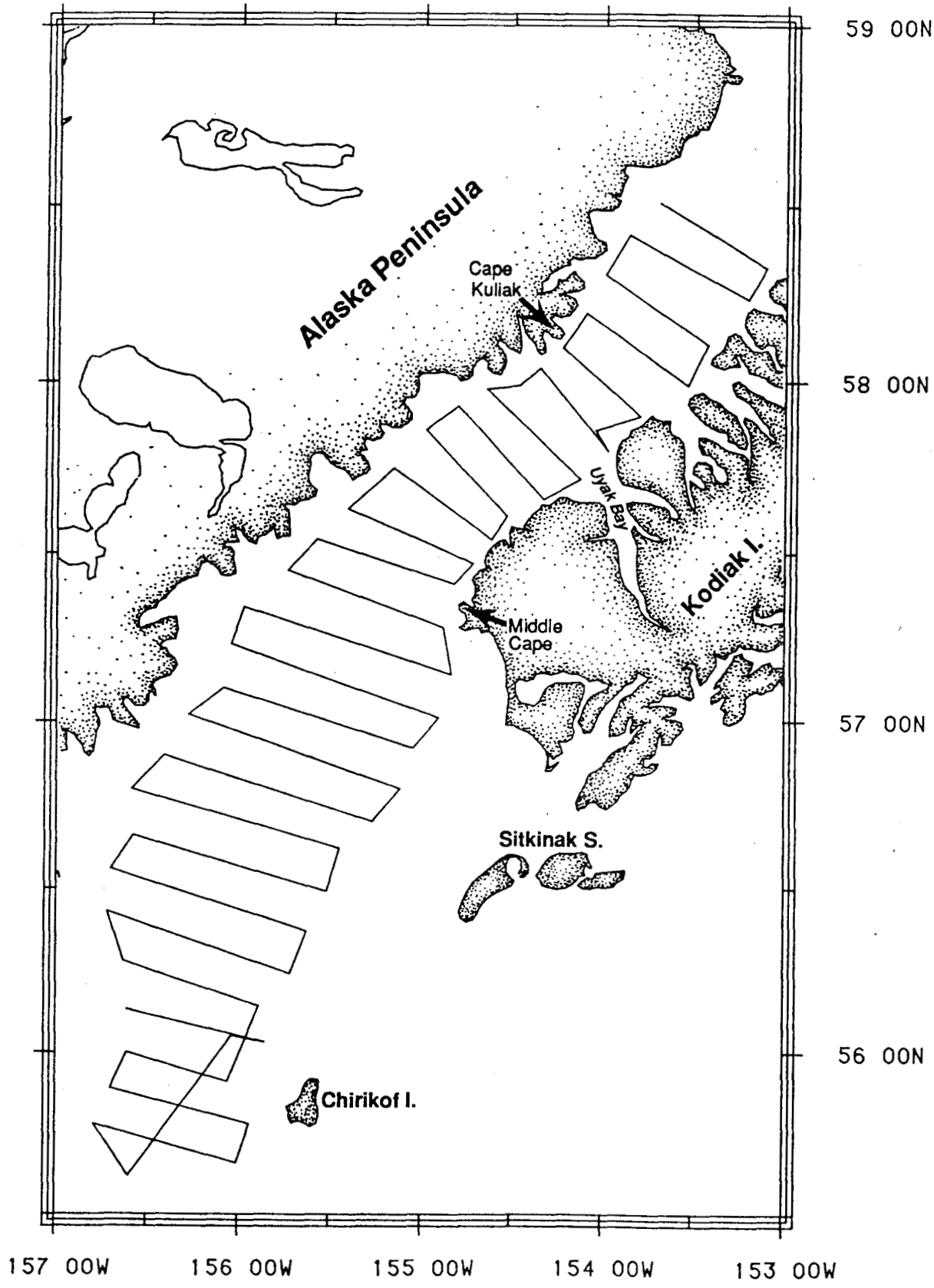


Figure 1. Survey trackline for the first pass through Shelikof Strait during the winter 1993 EIMWT survey, MF93-02.

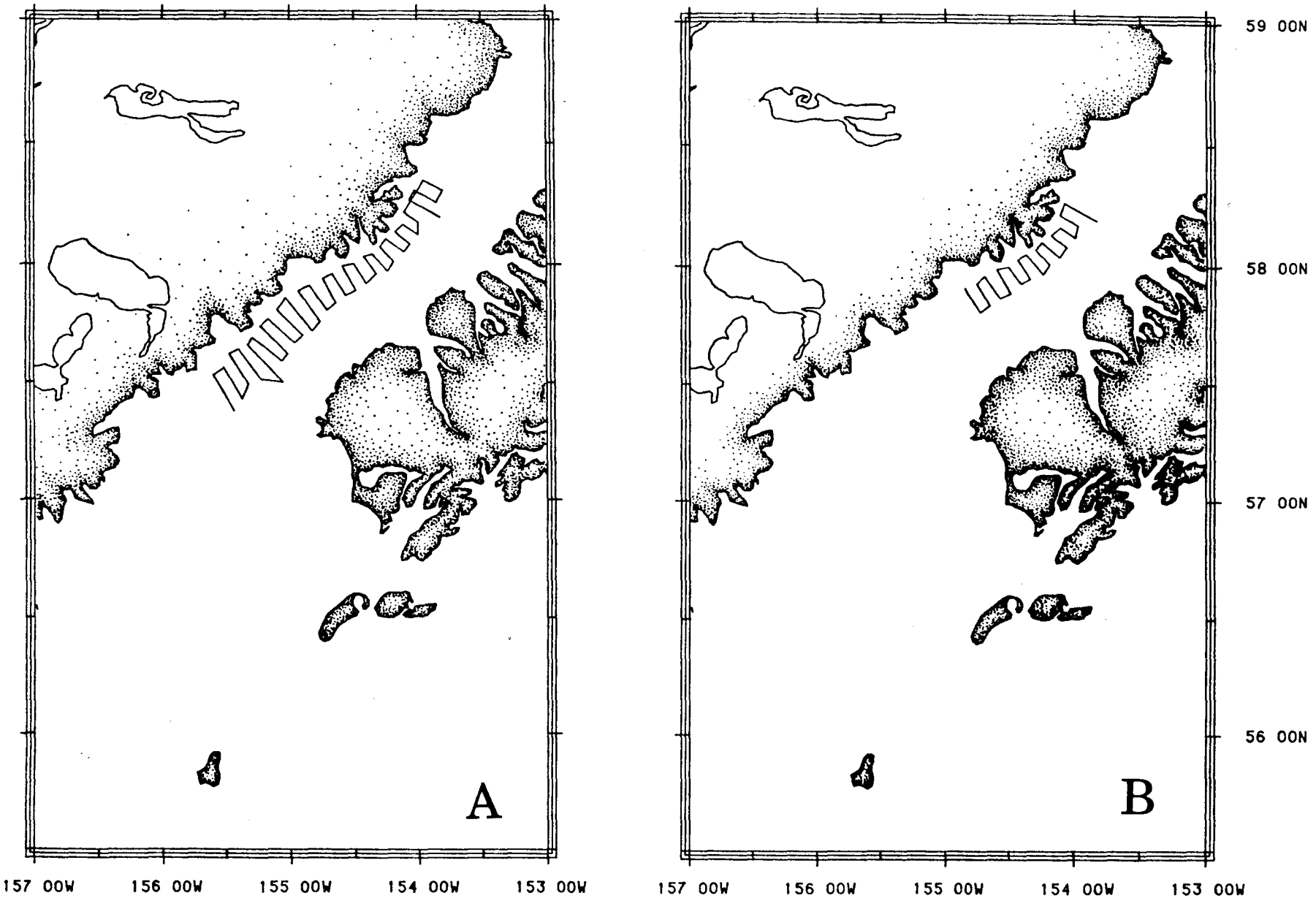


Figure 2. Survey trackline for the second (A) and third (B) pass through Shelikof Strait during the winter 1993 EIMWT survey, MF93-02.

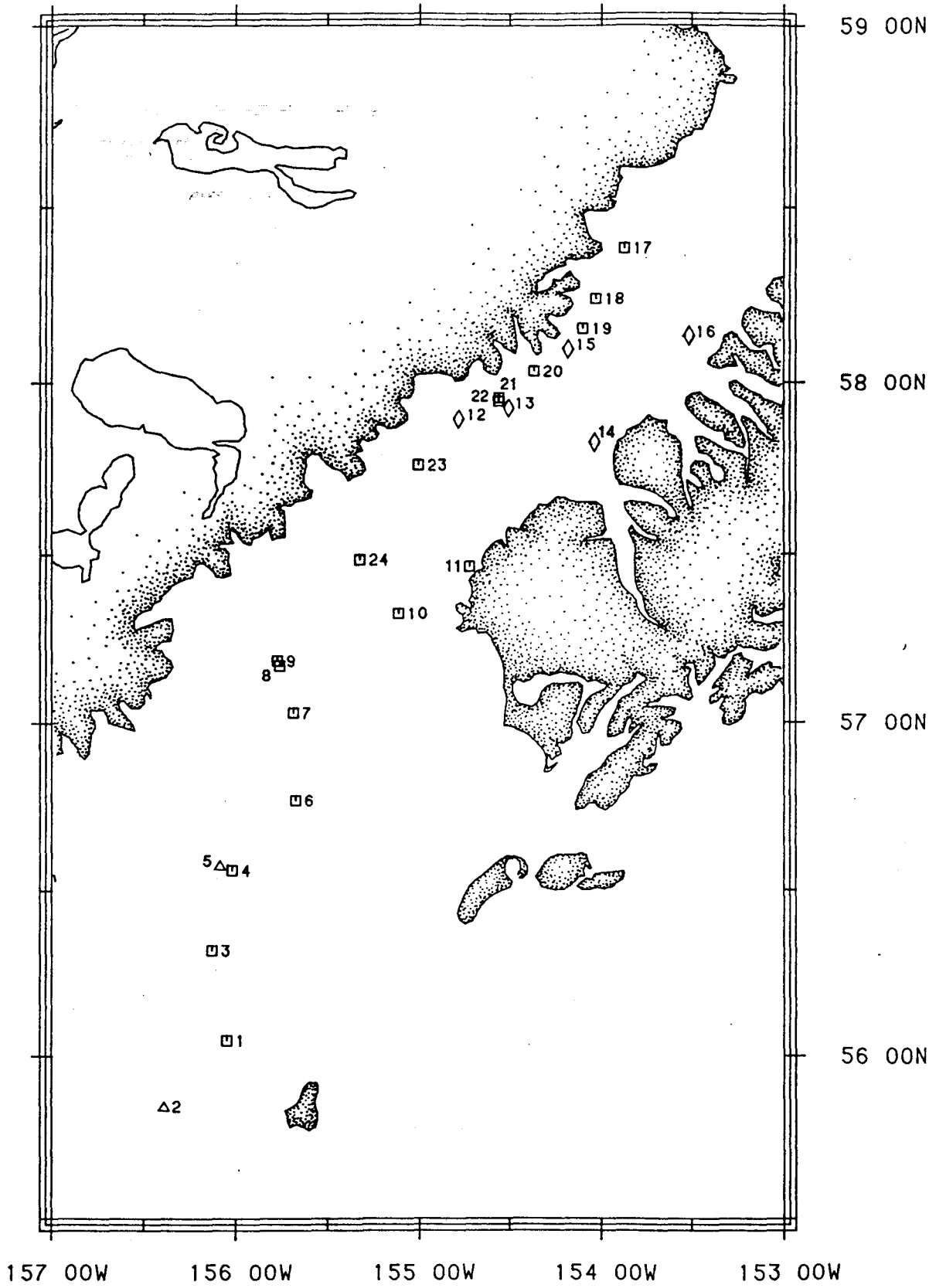


Figure 3. Trawl haul locations for the winter 1993 EIMWT survey of Shelikof Strait, MF93-02. Northern Gold trawl (□), Diamond trawl (◊), bottom trawl (△).

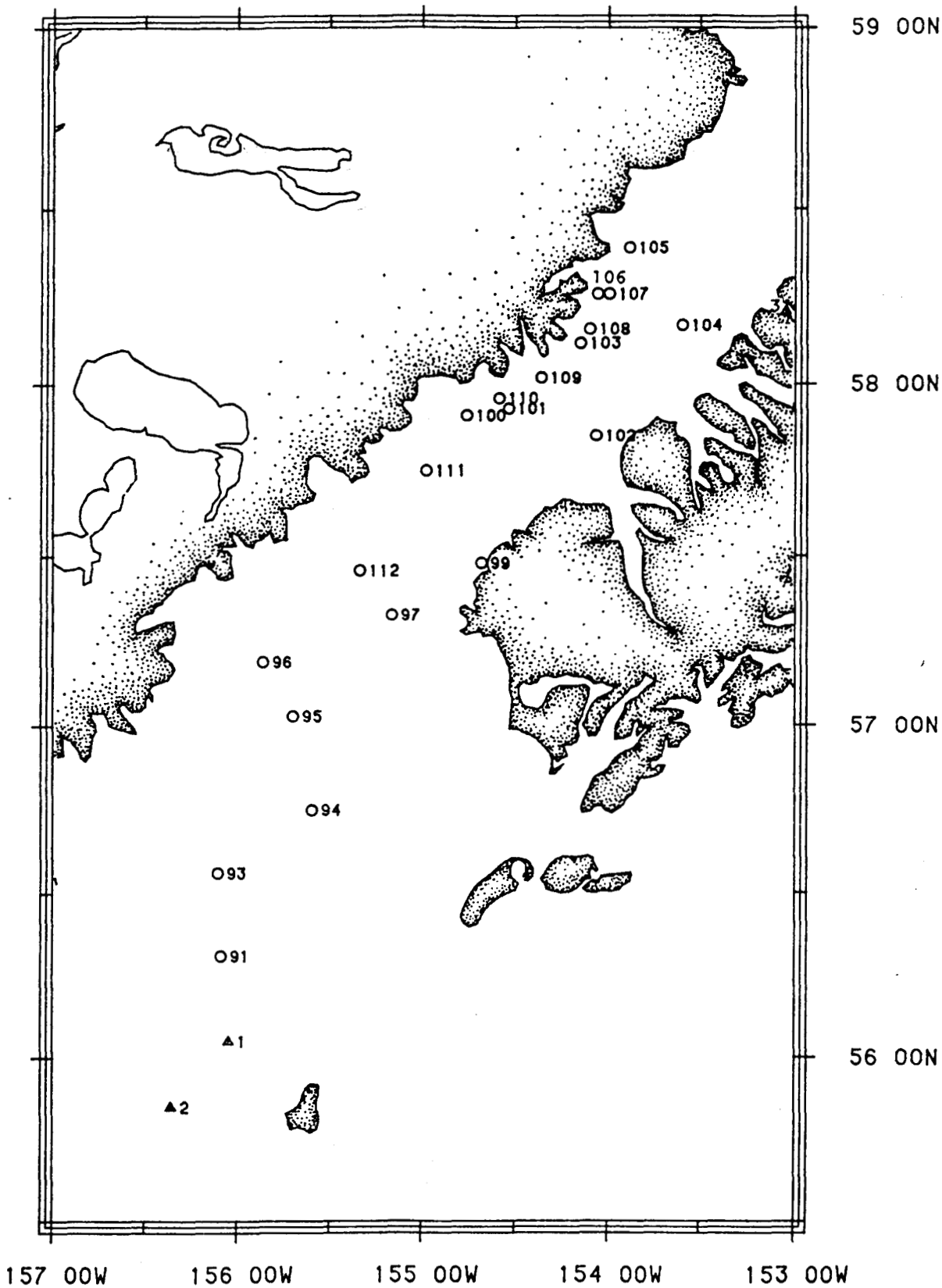


Figure 4. Locations of XBT (o) and CTD (△) casts for the winter 1993 EIMWT survey of Shelikof Strait, MF93-02.

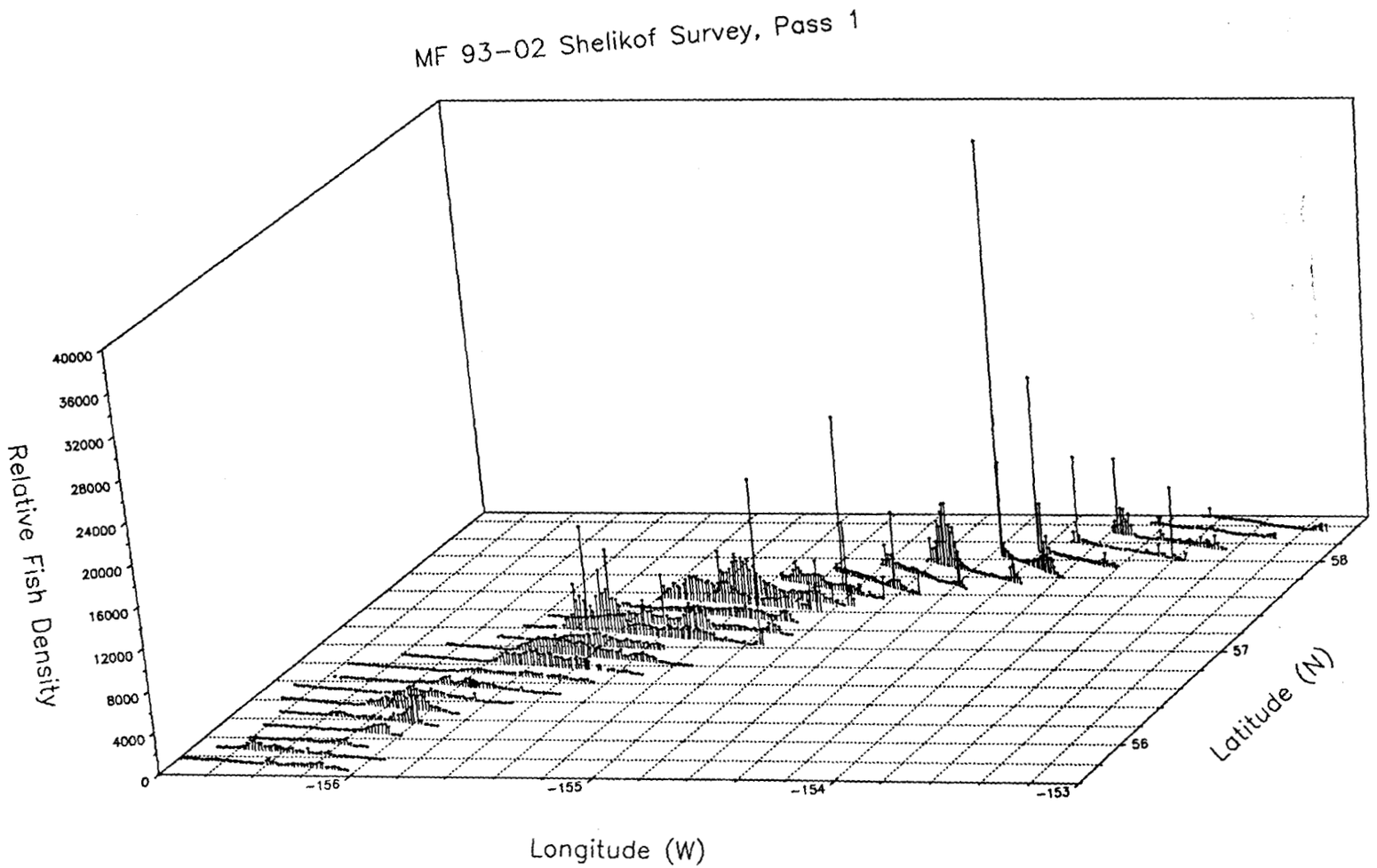
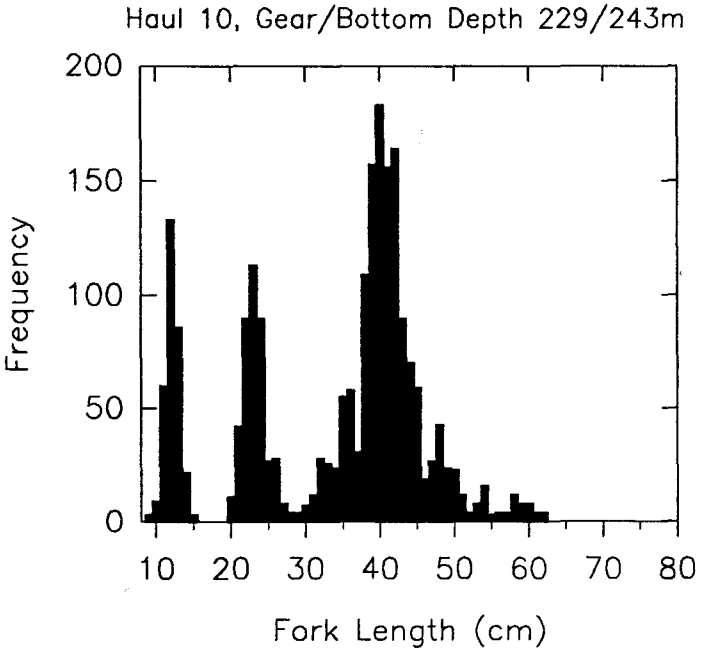
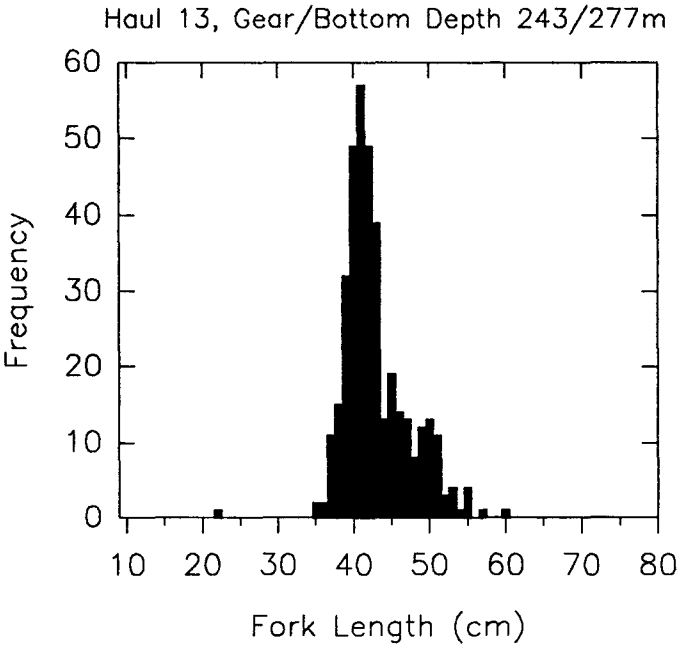


Figure 5. Relative pollock density along tracklines during the first pass through Shelikof Strait, MF93-02. Y-axis values represent an arbitrary scale of relative fish density.





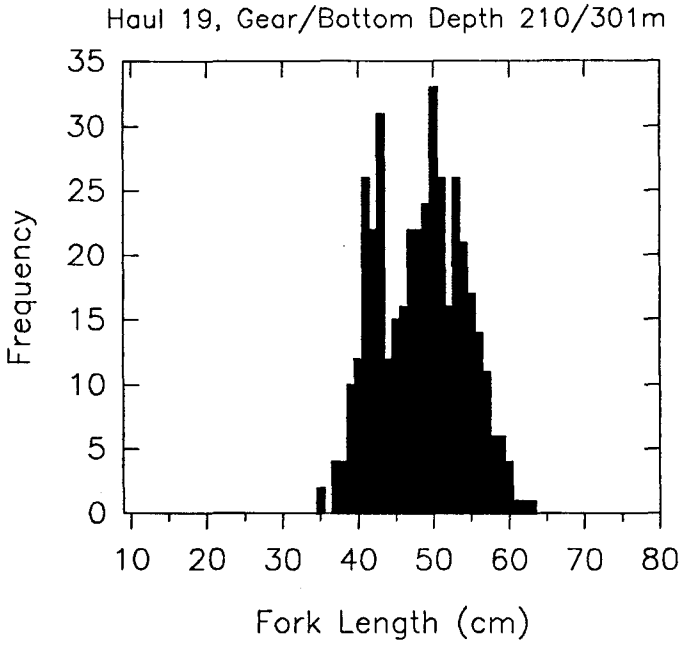


Figure 6. Pollock size compositions from selected midwater trawl samples in the southern (haul 10), central (haul 13), and northern (haul 19) regions of Shelikof Strait, MF93–02.

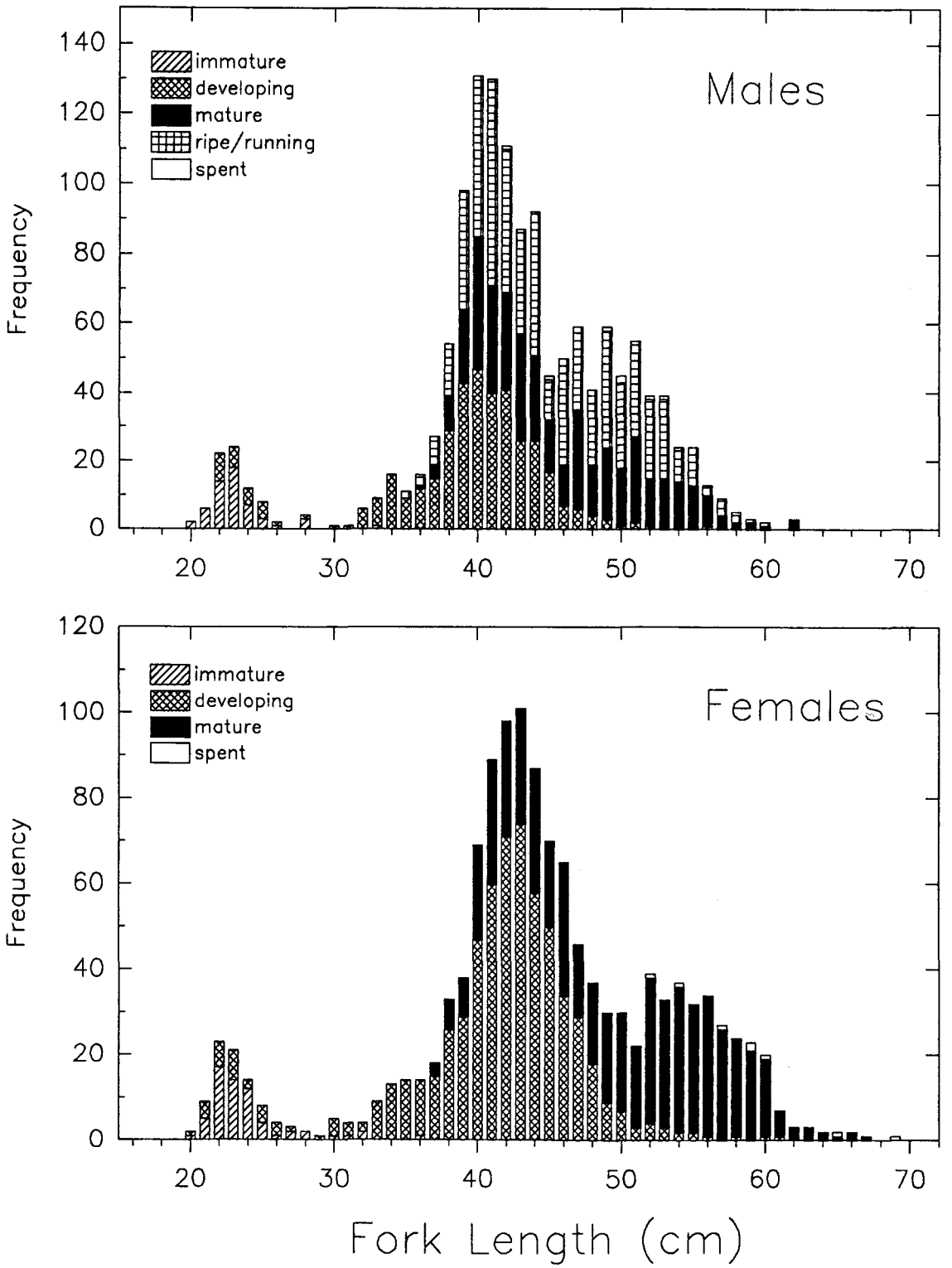


Figure 7. Maturity–length compositions for male and female pollock from Shelikof Strait, MF93–02. Relative proportion by size for the maturity–length composition reflects the number of maturity samples collected and is not indicative of the actual size composition of the population.

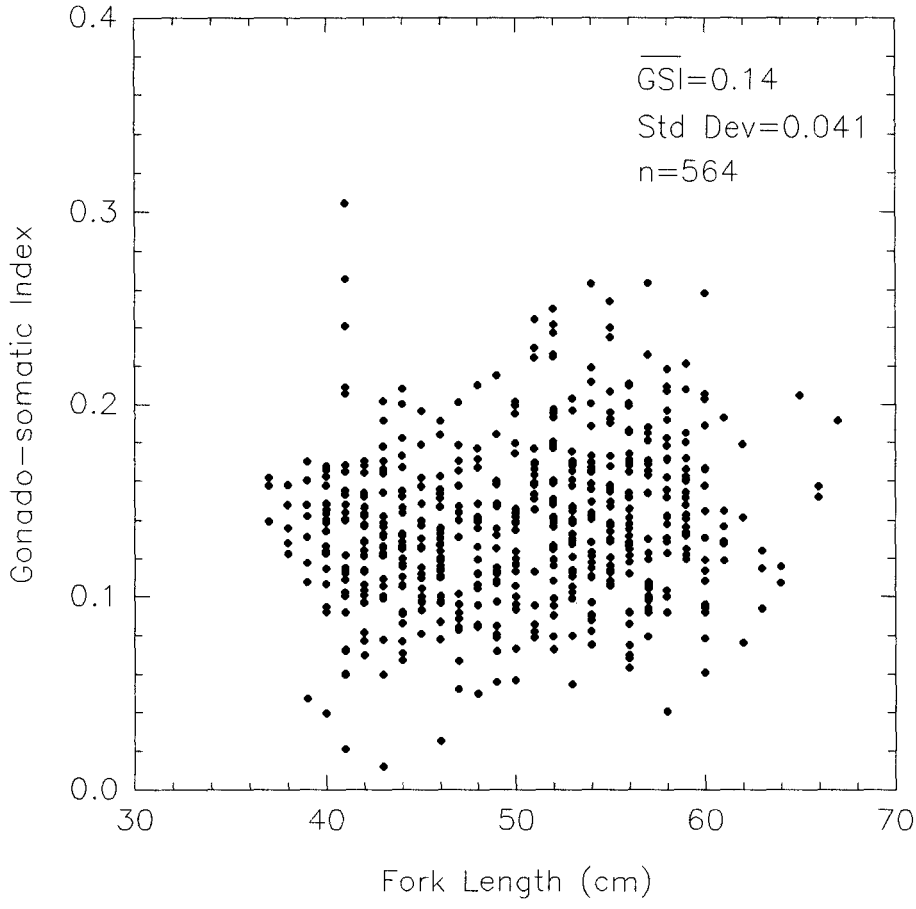


Figure 8. Pollock gonado-somatic indices plotted as a function of length for mature (pre-spawning) females from Shelikof Strait, MF93-02.