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Selectivity Study on Silver Hake in Divisions 4VW, May 1982

by

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Abstract

Mesh selection data for silver hake in kapron codends of trawl nets were collected on board a Cuban commercial vessel fishing on the Scotian Shelf. The results obtained are presented and compared with previous studies in the area, including a girth-total length relationship. The "alternate haul" method was used with a 60-mm mesh codend and a 60-mm mesh codend containing a 30-mm mesh liner.

Introduction

The fishery for silver hake is one of the most important bottom-trawl fisheries on the Scotian Shelf (NAFO Divisions 4VWX). It began during the early 1960's, and nominal catches increased rapidly to about 300,000 tons in 1973. Since its beginning, the silver hake fishery has been mainly conducted by the USSR fleet, but Cuban vessels have participated in the fishery in recent years using trawls with kapron codends. The USSR fleet operated historically with 40-mm mesn codends (Anon, MS 1976), and the length compositions of the commercial catches typically had modes around 28-30 cm (Clay, 1978). At the June 1976 Annual Meeting of ICNAF, a proposal was adopted which established 60 mm as the minimum mesh size for trawls used in the silver hake fishery (ICNAF, 1977a), and at the December 1976 Special Meeting of ICNAF the use of trawls with the minimum 60-mm mesh size was restricted to an area along the slope of the Scotian Shelf south of the "small-mesh gear line" (ICNAF, 1977b).

Considering the proposed regulations which affected the silver hake fishery, some

countries agreed to carry out selectivity experiments on the Scotian Shelf north and south of the "small-mesh gear line". Consequently, new information on mesh selection of silver hake by Clay (1978), Mari (1978) and Motuzenko and Kashin (1978) was presented at the June 1978 Annual Meeting of ICNAF. However, the results from these studies were slightly different due to the methods employed. A joint Canada-USSR study on mesh selection of silver hake, using 60-mm and 90-mm mesh codends, was conducted in July 1980 on the Scotian Shelf by two USSR commercial trawlers, but the results of that experiment are not yet available.

Following the June 1981 recommendation of the Scientific Council of NAFO "that further selection studies on silver hake under commercial conditions should be undertaken as soon as possible so that sufficient data will be available to describe accurately the selectivity of 60-mm and 90-mm mesh codends" (NAFO, 1981), an experiment was carried out on board a Cuban commercial vessel in May 1982. The objective of the present study involved the use of kapron codends to increase the available information on selectivity parameters for this type of material.

Materials and Methods

This study was carried out during 20-29 May 1982 on board the Cuban commercial trawler *Rio Jibacoa*. Technical data of the vessel and fishing gear are presented in Table 1. This vessel used a kapron bottom trawl model 32.5M.

The experiment was conducted by applying the "alternate haul" method. According to Pope *et al.* (1975), for this method, "the length distribution of the fishes over the total or major part of the selection range in the area where fishing takes place may be obtained by estimating the size distribution of the fish on the grounds from hauls using a codend of much smaller mesh size than that of the codend whose length selection curve is to be determined". Thus, a direct comparison of the size distributions of catches by both codends provides an estimate of the percentage retained at each length group by the experimental codend.

During the experiment, two kapron codends with 60-mm mesh size (commercial rated) were used, but one had a 30-mm mesh liner, which was sufficient to obtain fish sizes below the selection range of the experimental codend.

Codend mesh-size measurements were made with a Canadian flat wedge-shaped gauge inserted into the mesh with a pressure of 5 kg. The measurements were made along rows of meshes running parallel to the long axis of the codend. The mean mesh sizes and standard deviations are given in Table 2.

After each commercial haul, all relevant details were recorded and a random sample of about 500 silver hake were taken and measured as total length to the nearest centimeter. The experiment was carried out south of the "small-mesh gear line" in the same areas along the edge of the Scotian Shelf where the commercial fleet operates during the fishing season. Figure 1 indicates the areas where the selection study was conducted.

A total of 40 commercial hauls were made in depths between 115 and 260 m (Table 3). The series of data obtained from the 60-mm codend and the 60-mm codend with 30-mm liner were analyzed according to the methodology proposed by Pope *et al.* (1975) to obtain the selection curve. The curve was fitted by eye, taking into account the fact that this method provides an unbiased estimate of the 50% retention length, which is very closer to that obtained by the maximum likelihood method (Pope *et al.*, 1975). The length composition of each haul was adjusted to a one-hour trawl haul, and these were then summed to provide a single selection ogive. Finally, the percentage retention value for each length group was adjusted by a factor estimated from the average of the catches above the selection range.

The ability of a fish to escape through or be held by the mesh during fishing depends on its dimension in relation to the opening of the mesh. Because of the ease of measuring the length of fish, it is customary to relate selection directly to length rather than to other dimensions. However, considering the importance of girth measurements in mesh selection studies, a stratified sample of 216 silver hake (18-48 cm total length) was taken and their girths measured with a flexible measuring-tape. The same sample was used to determine the relationship between total length and fork length.

During the experiment, the catches consisted mainly of silver hake with small by-catches of other species.

Results and Discussion

The unadjusted length frequencies are given in Tables 4A and 4B and the length frequencies adjusted to removals at length per one-hour trawl set are given in Table 5A and 5B. The combined length frequencies and selection calculations are given in Table 6.

The selection curve, fitted by eye for the 60-mm mesh codend, indicated a 50% retention length of 26.50 cm (Fig. 2). The 50% retention length, obtained by moving average of 3 points, was 26.77 cm. These values are somewhat higher than those presented in some previous studies; e.g. Clay (1979), from mesh selection studies on the Scotian Shelf in 1977, using the covered-codend method and adjusting the curves by eye, reported 50% retention lengths in the range of 216-225 mm. The retention percentages were greater than 100% for the largest fish, as is usual for alternate haul experiments

(Pope *et al.*, 1975). The selection factor for the 60-mm mesh codend (average 63.3 mm measured) was found to be 4.23, and the 25-75% selection range was 4.75 cm (23.0-27.75 cm). Comparison of the results from the present experiment with those reported by other authors for silver hake (*Merluccius bilinearis*) and European hake (*M. merluccius*) is given in Table 7. Variability in the selection factor may be due to different methods and materials used.

The length frequency distributions (adjusted to catch per hour) for silver hake sampled during the experiment, together with the 50% retention length and the selection range, are shown in Fig. 3. The length range of silver hake taken in the 30-mm lined codend was 11-51 cm, whereas the length range for the 60-mm codend was 15-55 cm. The length frequencies were dominated by 30-40 cm fish, and the 50% retention length was considerably below the 32-cm mode of the dominant group.

The girth-total length relationship derived from the length-stratified sample of 216 silver hake is shown in Fig. 4. This relationship is very similar to those reported by other authors (Table 8). The relationship between fork length and total length measurements of the sample of silver hake is shown in Fig. 5.

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Table 1. Specifications of Cuban commercial vessel used in silver hake selection experiment on the Scotian Shelf in May 1982.

Vessel characteristics	
Name	*Rio Jibacoa*
Model	TACSA 95 TF
Length overall (m)	106.70
Beam (m)	14.50
Draft (m)	6.01
Gross register (mt)	2034.87
Net register (mt)	1160.21
Power	16 knots
Type of ship	Stern trawler/freezer
Gear characteristics	
Trawl type	Bottom
Footrope length (m)	63.6
Headrope length (m)	32.0
Headrope height (m)	12.0
Wing spread (m)	32.0
Length of bridles (m)	100.0
Type of doors	Bottom (Matrosov)
Door weight (kg)	1350
Door area (m^2)	5.5
Mesh size (mm) - wings	160
- body	120-60
- Codend	60
Footrope rollers (mm)	300 and 400

Table 2. Summary of mesh measurements obtained in the silver hake mesh selection experiment on the Scotian Shelf.

Parameter	Liner	Codend
Commercial-rated mesh size (mm)	30	60
Number of sets	5	5
Number of meshes	100 (dry)	120 (wet)
Mean ± stand. dev. (mm)	30.72 ± 1.48	63.33 ± 2.10

TABLE 3. SILVER HAKE MESH SELECTION STUDY CATCH AND SAMPLE WT DATA

SET #	MESH SIZE	CATCH WT	SAMPLE WT
1.0	60	13000.0	137.0
2.0	60	25000.0	117.0
3.0	30	500.0	155.0
4.0	60	14900.0	111.0
5.0	30	2855.0	121.0
6.0	60	970.0	93.6
7.0	60	425.0	101.0
8.0	30	610.0	144.0
9.0	30	835.0	101.0
10.0	60	7935.0	92.3
11.0	30	5900.0	73.2
12.0	60	37965.0	149.0
13.0	60	6900.0	115.0
14.0	30	8700.0	122.0
15.0	60	5990.0	108.0
16.0	30	5500.0	87.6
17.0	60	7000.0	143.0
18.0	30	3680.0	82.7
19.0	60	3330.0	124.0
20.0	60	15950.0	114.0
21.0	60	4960.0	103.0
22.0	30	7000.0	84.1
23.0	60	7000.0	103.0
24.0	30	3980.0	88.6
25.0	60	1575.0	106.0
26.0	30	34750.0	109.0
27.0	30	6000.0	105.0
28.0	60	4450.0	107.0
29.0	30	6940.0	109.0
30.0	30	4000.0	104.0
31.0	30	16985.0	106.0
32.0	60	26910.0	125.0
33.0	60	3000.0	104.0
34.0	60	11900.0	101.0
35.0	30	17910.0	89.6
36.0	30	4970.0	110.0
37.0	30	15900.0	97.7
38.0	60	10000.0	176.0
39.0	30	14950.0	89.1
40.0	30	7050.0	95.5
TOTAL		378175.0	4404.0

Table 4A. Silver hake unadjusted length frequencies collected from the 30/60 mm combination (set numbers are indiated by col, headers).

LENGTH	3	5	8	9	11	14	16	18	22	24	26	27	29	30	31	35	36	37	39	40
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	16	6	2	0
13	0	0	33	0	0	0	2	0	0	0	0	0	0	0	0	0	52	7	9	6
14	0	0	1	5	0	0	6	1	3	0	0	0	0	0	5	0	63	9	24	9
15	2	0	7	14	2	0	6	1	1	0	0	0	0	0	6	21	44	8	22	9
16	7	0	10	18	5	1	17	1	3	0	0	0	0	1	20	4	24	2	17	8
17	8	0	13	50	20	3	15	5	3	0	1	1	1	1	22	8	9	2	21	7
18	8	4	18	59	43	4	13	3	2	0	3	6	1	1	25	12	5	1	18	6
19	10	4	10	108	58	13	15	2	6	0	2	13	1	2	27	11	5	3	25	5
20	6	1	15	134	86	8	15	3	22	0	4	22	4	2	29	10	3	5	18	3
21	7	2	23	121	86	3	23	5	24	7	12	16	4	3	14	12	7	6	23	14
22	9	1	20	55	32	2	7	6	16	6	17	7	6	9	10	6	6	9	14	13
23	6	0	20	25	9	6	7	4	13	4	11	4	6	8	13	2	4	6	8	17
24	9	10	27	24	9	7	3	2	6	3	6	2	16	8	13	7	3	4	8	18
25	16	32	45	61	9	9	6	7	7	7	7	7	26	19	13	23	6	9	12	16
26	17	87	63	78	19	13	10	8	9	23	10	16	37	25	18	25	16	19	18	21
27	51	103	68	89	22	21	25	18	18	23	14	18	41	37	17	28	13	24	28	25
28	45	106	69	76	31	36	25	33	37	28	32	31	57	41	22	18	13	31	22	40
29	62	65	84	43	30	44	33	24	45	32	61	62	58	46	33	28	17	23	22	27
30	72	49	80	34	29	61	35	47	60	42	91	69	67	35	33	32	16	31	15	26
31	94	55	67	17	33	86	42	72	63	69	107	103	62	47	37	62	24	40	29	30
32	68	48	50	13	29	77	39	72	41	78	82	86	50	40	36	38	27	51	33	42
33	55	38	32	15	24	63	38	58	42	58	78	60	26	25	44	26	34	36	38	36
34	32	28	21	10	17	34	28	37	26	42	50	47	22	12	37	24	43	39	31	30
35	22	23	12	12	11	35	17	29	12	22	31	20	18	20	19	24	39	29	25	10
36	15	10	4	7	7	22	17	19	16	15	15	16	5	17	14	14	25	25	14	20
37	14	11	3	2	3	14	10	11	6	10	8	5	8	9	11	5	20	13	11	11
38	8	11	0	2	2	8	4	7	5	6	3	7	4	10	8	5	14	13	10	6
39	5	1	1	2	0	4	4	5	1	4	4	1	2	6	5	3	12	10	3	4
40	0	2	1	0	2	1	1	4	1	1	3	2	2	3	5	1	11	2	4	3
41	0	1	0	0	0	3	1	2	0	1	2	0	2	4	2	0	3	5	2	0
42	0	0	3	0	0	2	2	0	0	1	1	0	1	2	0	1	4	1	0	1
43	0	0	1	0	0	0	1	2	0	0	0	1	0	0	2	0	1	0	1	0
44	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	1	0	0
45	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
46	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1
47	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	648	694	801	1074	618	582	471	489	488	482	655	622	527	436	540	451	582	471	528	464

TABLE 4B. SILVER HAKE UNADJUSTED LENGTHS COLLECTED FROM 60 MM CODENDS (SET NUMBERS ARE INDICATED BY COL, HEADERS).

LENGTH	1	2	4	6	7	10	12	13	15	17	19	20	21	23	25	28	32	33	34	38
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	2
16	0	0	0	0	0	2	0	0	1	2	0	2	3	0	0	0	1	1	0	2
17	0	0	0	0	0	2	0	0	4	2	1	2	0	0	0	0	1	2	0	0
18	1	0	0	0	3	3	0	0	2	2	0	3	2	0	0	0	3	2	0	0
19	0	0	1	1	3	2	0	0	0	3	0	4	3	0	0	1	2	2	3	0
20	0	0	0	0	6	7	0	2	0	1	0	4	5	0	0	1	6	4	1	2
21	0	0	0	0	0	3	0	0	4	6	0	6	1	1	0	0	5	8	3	2
22	0	1	1	0	0	2	0	1	3	1	1	5	1	3	0	0	2	9	2	2
23	0	1	2	2	1	0	0	1	2	1	0	4	4	1	0	0	5	9	5	8
24	0	1	4	2	1	1	0	5	3	3	1	5	3	0	0	0	1	11	1	0
25	1	4	5	5	10	1	0	10	4	0	1	6	6	0	0	4	5	12	3	2
26	3	14	20	10	21	1	13	16	9	7	1	10	13	8	1	22	6	12	11	0
27	3	23	38	16	46	2	9	22	11	18	5	16	31	18	3	19	12	27	12	8
28	8	24	52	22	29	13	26	32	19	13	13	24	37	17	3	17	14	32	12	18
29	22	46	51	21	56	16	56	67	37	22	26	28	36	36	6	30	11	31	10	8
30	39	67	62	36	53	52	77	79	72	47	58	53	36	73	30	47	13	36	16	30
31	58	66	51	50	60	47	74	63	77	46	82	65	60	68	33	75	43	51	53	42
32	70	64	60	50	65	63	59	54	79	59	99	56	56	69	42	72	43	56	51	78
33	58	63	50	51	33	46	55	43	67	59	69	56	48	64	55	64	60	56	71	84
34	42	58	30	31	38	42	45	24	38	44	68	48	49	39	39	40	50	26	67	86
35	37	41	29	22	25	22	22	21	24	40	34	36	23	24	28	39	50	26	59	66
36	36	35	29	18	16	21	16	13	15	19	25	29	21	15	24	20	35	26	49	77
37	34	27	17	17	13	9	17	8	12	14	13	23	7	7	26	11	26	11	28	56
38	29	23	16	18	6	4	9	7	7	7	3	19	7	6	23	6	18	11	21	18
39	20	15	11	13	3	6	12	6	10	6	2	12	2	6	10	2	15	16	11	18
40	6	14	1	10	3	2	9	0	1	0	1	4	1	0	6	1	7	6	1	10
41	9	6	2	4	0	5	8	1	0	0	0	3	0	0	3	0	9	4	5	4
42	4	2	3	4	1	4	4	0	1	0	0	2	1	0	2	1	3	5	2	2
43	3	3	2	3	2	2	0	1	0	0	0	2	0	0	6	0	2	4	2	4
44	1	1	0	2	0	1	1	0	0	0	0	2	0	0	1	0	0	5	1	2
45	3	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	1	0	0	0
46	0	0	2	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	2
47	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
54	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	493	600	541	408	494	382	515	675	502	423	503	533	456	455	344	472	451	503	500	633

Table 5A. Silver hake removals-at-length adjusted to a one hour trawl length, (30-mm set are indicated as column headers)

LENGTH	3	5	8	9	11	14	16	18	22	24	26	27	29	30	31	35	36	37	39	40
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	56	0
12	0	0	0	0	0	0	31	0	0	0	0	0	0	0	0	0	723	279	112	0
13	0	0	47	0	0	0	63	0	0	0	0	0	0	0	0	0	2349	325	503	116
14	0	0	1	21	0	0	188	17	73	0	0	0	0	0	224	0	2846	418	1342	173
15	3	0	10	58	42	0	188	17	24	0	0	0	0	0	269	1363	1988	372	1230	173
16	10	0	14	74	104	36	534	17	73	0	0	0	0	46	895	260	1084	93	951	154
17	12	0	18	207	415	107	471	84	73	0	93	21	21	46	985	519	407	93	1175	135
18	12	48	25	244	893	143	408	50	49	0	280	129	21	46	1119	779	226	46	1067	116
19	15	48	14	446	1205	464	471	33	146	0	186	279	21	93	1208	714	226	139	1398	96
20	9	12	21	554	1787	285	471	50	535	0	373	473	85	93	1298	649	136	232	1007	58
21	10	24	32	500	1787	107	722	84	584	105	1119	344	85	139	627	779	316	279	1286	270
22	13	12	28	227	665	71	220	100	389	90	1585	150	127	417	448	389	271	418	783	251
23	9	0	28	103	187	214	220	67	316	60	1025	86	127	371	582	130	181	279	447	328
24	13	119	38	99	187	250	94	33	146	45	559	43	340	371	582	454	136	186	447	347
25	24	381	64	252	187	321	188	117	170	105	653	150	552	880	582	1493	271	418	671	308
26	25	1037	89	322	395	464	314	134	219	344	932	344	785	1158	806	1622	723	883	1007	405
27	76	1227	96	368	457	749	785	301	438	344	1305	387	870	1715	761	1817	587	1116	1566	482
28	67	1263	97	314	644	1284	785	552	900	419	2983	666	1210	1900	985	1168	587	1441	1230	771
29	92	775	119	178	623	1569	1036	401	1095	479	5686	1332	1231	2132	1477	1817	768	1069	1230	520
30	107	584	113	141	602	2175	1099	786	1460	629	8483	1482	1422	1622	1477	2077	723	1441	839	501
31	140	655	95	70	686	3066	1318	1204	1533	1033	9974	2213	1316	2178	1656	4024	1084	1860	1622	578
32	101	572	71	54	602	2745	1224	1204	998	1168	7644	1847	1061	1854	1611	2466	1220	2371	1846	810
33	82	453	45	62	499	2246	1193	970	1022	968	7271	1289	552	1158	1969	1687	1536	1674	2125	694
34	48	334	30	41	353	1212	879	619	633	629	4661	1010	467	556	1656	1558	1943	1813	1734	578
35	33	274	17	50	229	1248	534	485	292	329	2890	430	382	927	850	1558	1762	1348	1398	193
36	22	119	6	29	145	784	534	318	389	225	1398	344	106	788	627	909	1130	1162	783	385
37	21	131	4	8	62	499	314	184	146	150	746	107	170	417	492	324	904	604	615	212
38	12	131	0	8	42	285	126	117	122	90	280	150	85	463	358	324	633	604	559	116
39	7	12	1	8	0	143	126	84	24	60	373	21	42	278	224	195	542	465	168	77
40	0	24	1	0	42	36	31	67	24	15	280	43	42	139	224	65	497	93	224	58
41	0	12	0	0	0	107	31	33	0	15	186	0	42	185	90	0	136	232	112	0
42	0	0	4	0	0	71	63	0	0	15	93	0	21	93	0	65	181	46	0	19
43	0	0	1	0	0	0	31	33	0	0	0	21	0	0	90	0	45	0	56	0
44	0	0	0	0	0	36	0	0	0	0	0	0	0	93	0	0	0	46	0	0
45	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	45	0	0	0
46	0	0	0	0	0	36	0	17	0	0	0	0	0	0	0	65	0	46	0	19
47	0	12	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	963	8270	1131	4440	12938	20752	14786	8180	11677	7217	61058	13362	11185	20204	24170	29269	26296	21901	29531	8943

TABLE 5B. SILVER HAKE REMOVALS-AT-LENGTH ADJUSTED TO A ONE HOUR TRAWL (60 MM SET NUMBERS ARE INDICATED AS COLUMN HEADERS).

LENGTH	1	2	4	6	7	10	12	13	15	17	19	20	21	23	25	28	32	33	34	38
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	33	0	0	0	22	0	70	0	0	0	0	0	16	0	44
16	0	0	0	0	0	67	0	0	28	44	0	140	56	0	0	0	103	16	0	44
17	0	0	0	0	0	67	0	0	111	44	13	140	0	0	0	0	103	33	0	0
18	40	0	0	0	5	100	0	0	55	44	0	210	37	0	0	0	310	33	0	0
19	0	0	73	5	5	67	0	0	0	65	0	280	56	0	0	14	207	33	137	0
20	0	0	0	0	10	233	0	6590	0	22	0	280	93	0	0	14	621	66	46	44
21	0	0	0	0	0	100	0	0	111	131	0	420	19	25	0	0	517	132	137	44
22	0	85	73	0	0	67	0	33	83	22	13	350	19	74	0	0	207	148	91	44
23	0	85	147	10	2	0	0	33	55	22	0	280	75	25	0	0	517	148	228	176
24	0	85	293	10	2	33	0	164	83	65	13	350	56	0	0	0	103	181	46	0
25	40	342	367	26	17	33	0	328	111	0	13	420	112	0	0	54	517	198	137	44
26	120	1197	1467	52	35	33	2208	525	250	152	13	700	243	198	7	297	621	198	502	0
27	120	1966	2787	83	77	67	1529	721	305	392	65	1119	579	445	21	257	1242	445	548	176
28	319	2051	3814	114	49	433	4417	1049	527	283	168	1679	691	420	21	230	1449	527	548	396
29	877	3932	3741	109	94	533	9512	2197	1026	479	336	1959	672	890	43	405	1138	511	457	176
30	1555	5726	4548	187	89	1733	12080	2590	1997	1023	749	3708	672	1804	214	635	1345	593	731	661
31	2312	5641	3741	259	101	1566	12570	2066	2135	1001	1059	4547	1120	1680	236	1013	4450	841	2420	925
32	2791	5470	4401	259	109	2099	10022	1770	2191	1284	1278	3918	1045	1705	300	972	4450	923	2329	1718
33	3312	5385	3668	264	56	1533	9343	1410	1858	1284	891	3918	896	1582	393	864	6210	923	3242	1850
34	1675	4957	2201	161	64	1400	7644	787	1054	957	878	3358	915	964	279	540	5175	429	3060	1894
35	1475	3504	2127	114	42	733	3737	689	666	870	439	2518	429	593	200	527	5175	429	2694	1453
36	1435	2991	2127	93	27	700	2718	426	416	413	323	2029	392	371	171	270	3622	429	2238	1696
37	1356	2308	1247	88	22	300	2888	262	333	305	168	1609	131	173	186	149	2691	181	1279	1233
38	1156	1966	1174	93	10	133	1529	230	194	152	39	1329	131	148	164	81	1863	181	959	396
39	797	1282	807	67	5	200	2038	197	277	131	26	839	37	148	71	27	1552	264	502	396
40	239	1197	73	52	5	67	1529	0	28	0	13	280	19	0	43	14	724	99	46	220
41	359	513	147	21	0	167	1359	33	0	0	0	210	0	0	21	0	931	66	228	88
42	159	171	220	21	2	133	679	0	28	0	0	140	19	0	14	14	310	82	91	44
43	120	256	147	16	3	67	0	33	0	0	0	140	0	0	43	0	207	66	91	88
44	40	85	0	10	0	33	170	0	0	0	0	140	0	0	7	0	0	82	46	44
45	120	0	0	0	0	0	0	0	0	0	0	140	0	0	7	0	103	0	0	0
46	0	0	147	0	0	0	170	0	0	0	0	0	0	0	7	0	103	16	0	44
47	120	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	80	0	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	170	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	40	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0
54	0	0	73	0	0	0	170	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	19656	51282	39683	2114	831	12729	87481	22131	13921	9203	6494	37287	8511	11244	2457	6373	46678	8291	22834	13940

TABLE 6. ADJUSTED LENGTHS AND SELECTION CALCULATIONS FOR THE 1982 CUBAN MESH SELECTION STUDY FOR SILVER HAKE.

LENGTH	60	30	60/30	60/(30×1.6)
1.0	0.0	0.0	0.0	0.0
2.0	0.0	0.0	0.0	0.0
3.0	0.0	0.0	0.0	0.0
4.0	0.0	0.0	0.0	0.0
5.0	0.0	0.0	0.0	0.0
6.0	0.0	0.0	0.0	0.0
7.0	0.0	0.0	0.0	0.0
8.0	0.0	0.0	0.0	0.0
9.0	0.0	0.0	0.0	0.0
10.0	0.0	0.0	0.0	0.0
11.0	102.1	0.0	0.0	0.0
12.0	1146.1	0.0	0.0	0.0
13.0	3404.3	0.0	0.0	0.0
14.0	5305.7	0.0	0.0	0.0
15.0	5738.0	185.6	0.0	0.0
16.0	4346.3	497.8	0.1	0.1
17.0	4883.1	510.4	0.1	0.1
18.0	5641.4	834.5	0.1	0.1
19.0	7204.8	941.8	0.1	0.1
20.0	8127.8	8018.6	1.0	0.6
21.0	9199.1	1635.0	0.2	0.1
22.0	6656.9	1309.4	0.2	0.1
23.0	4761.2	1803.8	0.4	0.2
24.0	4490.6	1485.8	0.3	0.2
25.0	7789.1	2758.4	0.4	0.2
26.0	12009.5	8816.6	0.7	0.5
27.0	15448.1	12943.1	0.8	0.5
28.0	19268.5	19185.3	1.0	0.6
29.0	23631.4	29086.2	1.2	0.8
30.0	27764.2	43638.5	1.6	1.0
31.0	36307.5	49683.5	1.4	0.9
32.0	31471.0	49035.6	1.6	1.0
33.0	27397.8	47879.7	1.7	1.1
34.0	20753.8	38388.5	1.8	1.2
35.0	15228.8	28415.1	1.9	1.2
36.0	10204.0	22887.5	2.2	1.4
37.0	6112.8	16906.5	2.8	1.7
38.0	4506.1	11928.9	2.6	1.7
39.0	2851.5	9666.0	3.4	2.1
40.0	1905.4	4646.2	2.4	1.5
41.0	1183.4	4142.6	3.5	2.2
42.0	672.8	2128.0	3.2	2.0
43.0	279.4	1276.2	4.6	2.9
44.0	175.8	658.1	3.7	2.3
45.0	109.0	370.2	3.4	2.1
46.0	184.1	487.7	2.6	1.7
47.0	44.3	205.1	4.6	2.9
48.0	47.3	153.1	3.2	2.0
49.0	0.0	0.0	0.0	0.0
50.0	0.0	169.9	0.0	0.0
51.0	58.1	103.5	1.8	1.1
52.0	0.0	0.0	0.0	0.0
53.0	0.0	47.0	0.0	0.0
54.0	0.0	243.2	0.0	0.0
55.0	0.0	70.0	0.0	0.0
56.0	0.0	0.0	0.0	0.0
57.0	0.0	0.0	0.0	0.0
58.0	0.0	0.0	0.0	0.0
59.0	0.0	0.0	0.0	0.0
60.0	0.0	0.0	0.0	0.0
61.0	0.0	0.0	0.0	0.0
62.0	0.0	0.0	0.0	0.0
63.0	0.0	0.0	0.0	0.0
64.0	0.0	0.0	0.0	0.0
65.0	0.0	0.0	0.0	0.0
66.0	0.0	0.0	0.0	0.0
67.0	0.0	0.0	0.0	0.0
68.0	0.0	0.0	0.0	0.0
69.0	0.0	0.0	0.0	0.0
70.0	0.0	0.0	0.0	0.0
TOTAL	336411.4	423142.7	60.9	38.1

TABLE 7. Summary of selection factors in some previous studies of hake selection in trawls compared with the present study.

Species (Source)	Codend mesh (mm)	Selection factor (SF)	Codend material
SILVER HAKE	52	5.08	Nylon
(Jensen and Hennemuth, 1966)	73	4.16	"
EUROPEAN HAKE	48	3.46	Polyethylene
(Vazquez *et al.*, 1975)	53	2.42	"
	67	2.64	"
	74	3.27	"
EUROPEAN HAKE	51	3.48	Polyamide
(Alonso-Allende *et al.*, 1976)	61	3.97	"
SILVER HAKE	40	4.5	Polyamide
(Mari, 1978)	60	3.2	"
	90	3.0	"
SILVER HAKE	CC 40	4.4	Polyamide
(Clay, 1978)	60 CR	3.8	"
	CC 60	3.6	"
	70 CR	2.9	"
	CC 90	2.9	"
	120 CR	3.4	"
SILVER HAKE	60	3.95	Polyamide
(Motuzenko and Kashin, 1978)	70	2.88	"
	120	3.24	"
SILVER HAKE	60	4.23	Polyamide
(This study)			

Table 8. Comparison of reported girth-length relationships for hake. (G = girth, FL = fork length, TL = total length; all measurements in centimeters.)

Species	Source	Relationship
European hake	Gulland (1956)	G = 0.47 TL - 1.10
Silver hake	Hennemuth (1964)	G = 0.44 FL - 0.31
Silver hake	Clay (1978)	G = 0.48 TL - 1.99
Silver hake	Present study	G = 0.443 TL = 0.661

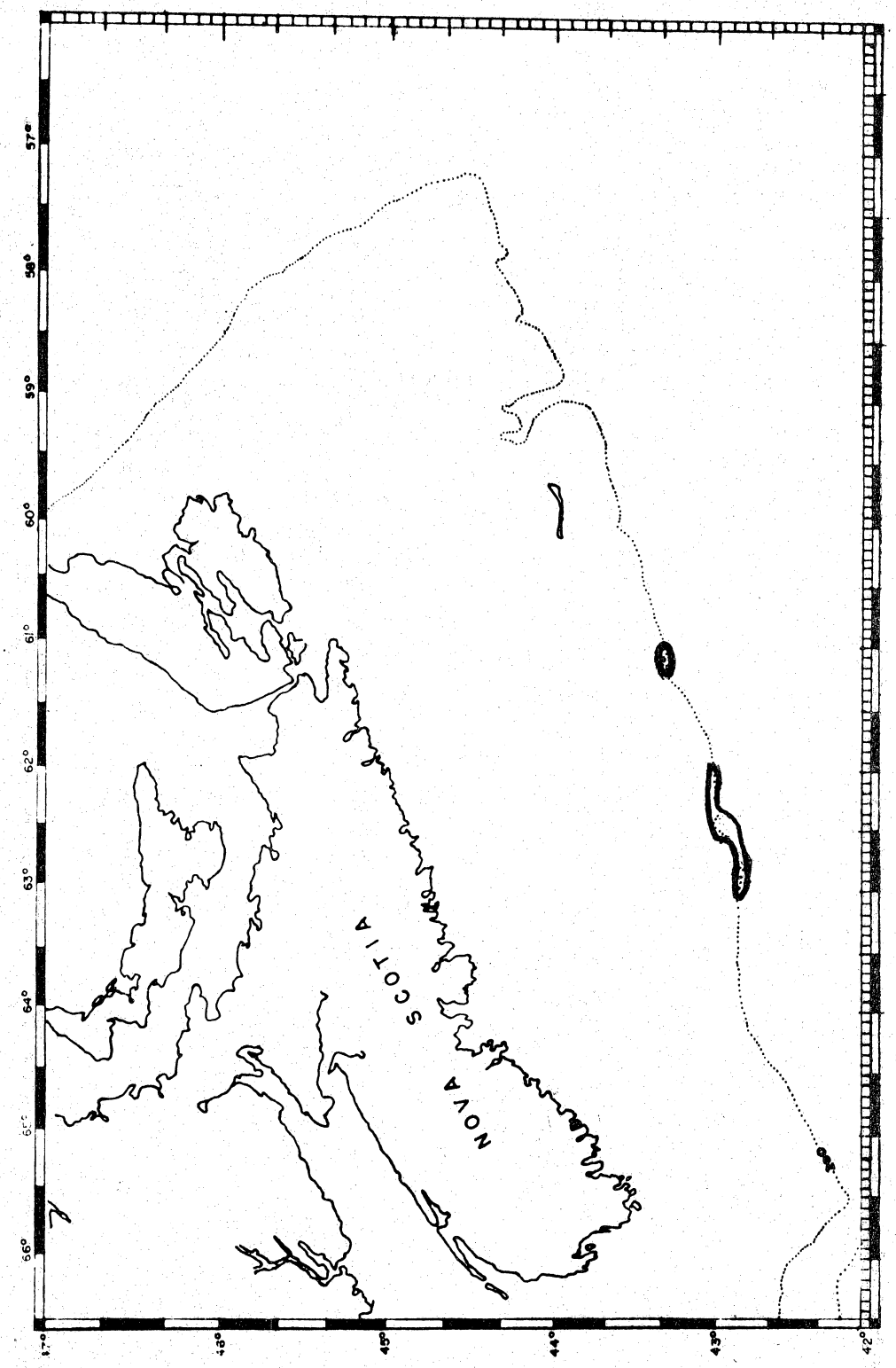

Fig. 1. Map showing the "small mesh gear line" and the approximate area of the mesh selection study, May 1982.

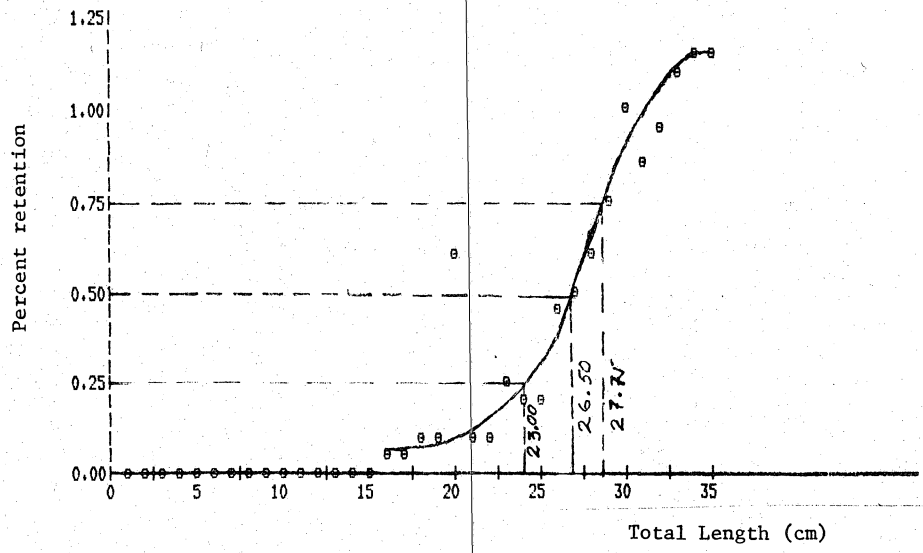

FIG 2 : SELECTION OGIVE FOR SILVER HAKE FROM DATA COLLECTED IN THE 1982 CUBAN MESH SELCETION STUDY.

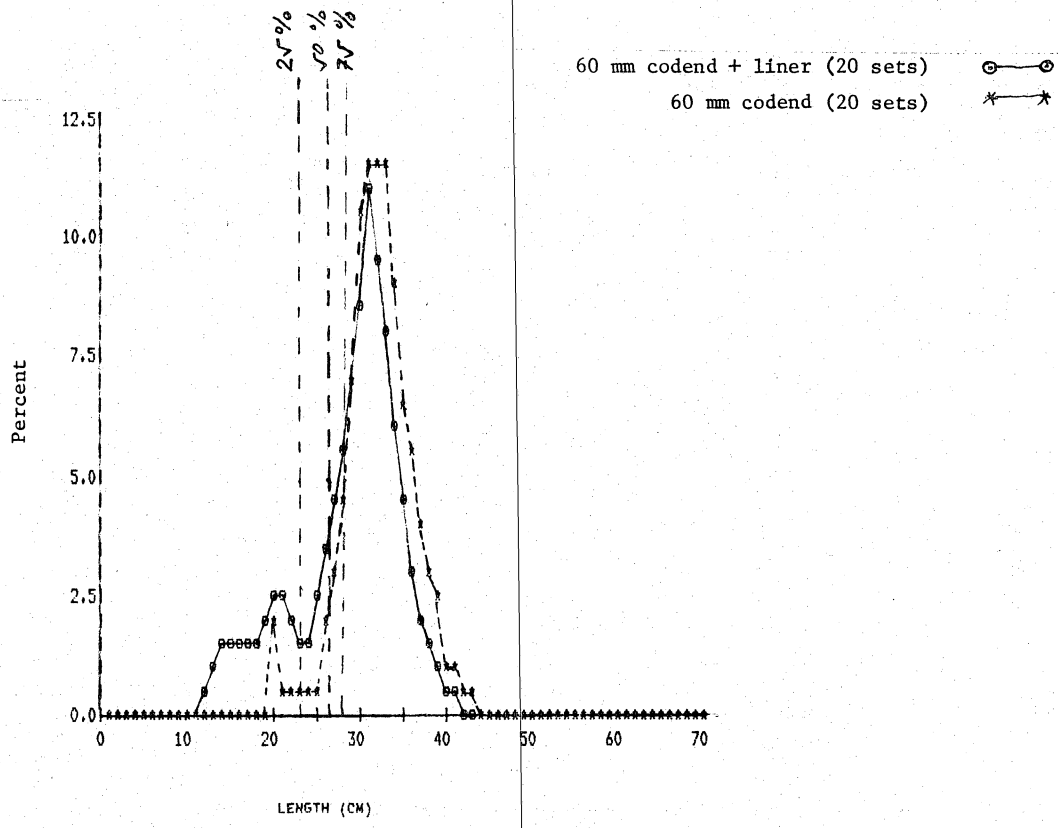

FIG 3 : PERCENT-AT-LENGTH ADJUSTED TO 1 HOUR TRAWLS FOR SILVER HAKE.

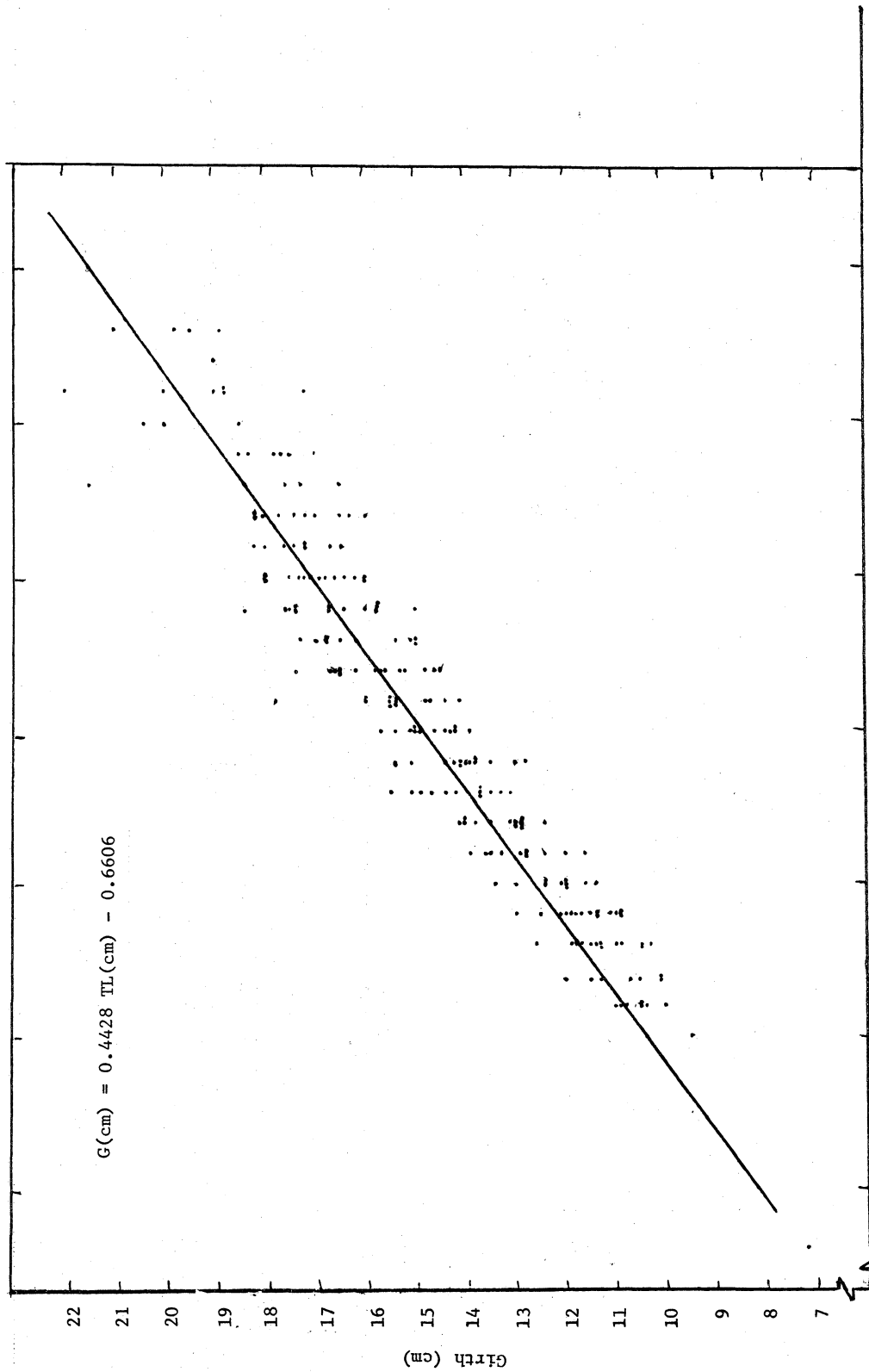

Fig. 4. Total length-girth relationship for silver hake in Division 4W, May 1982.

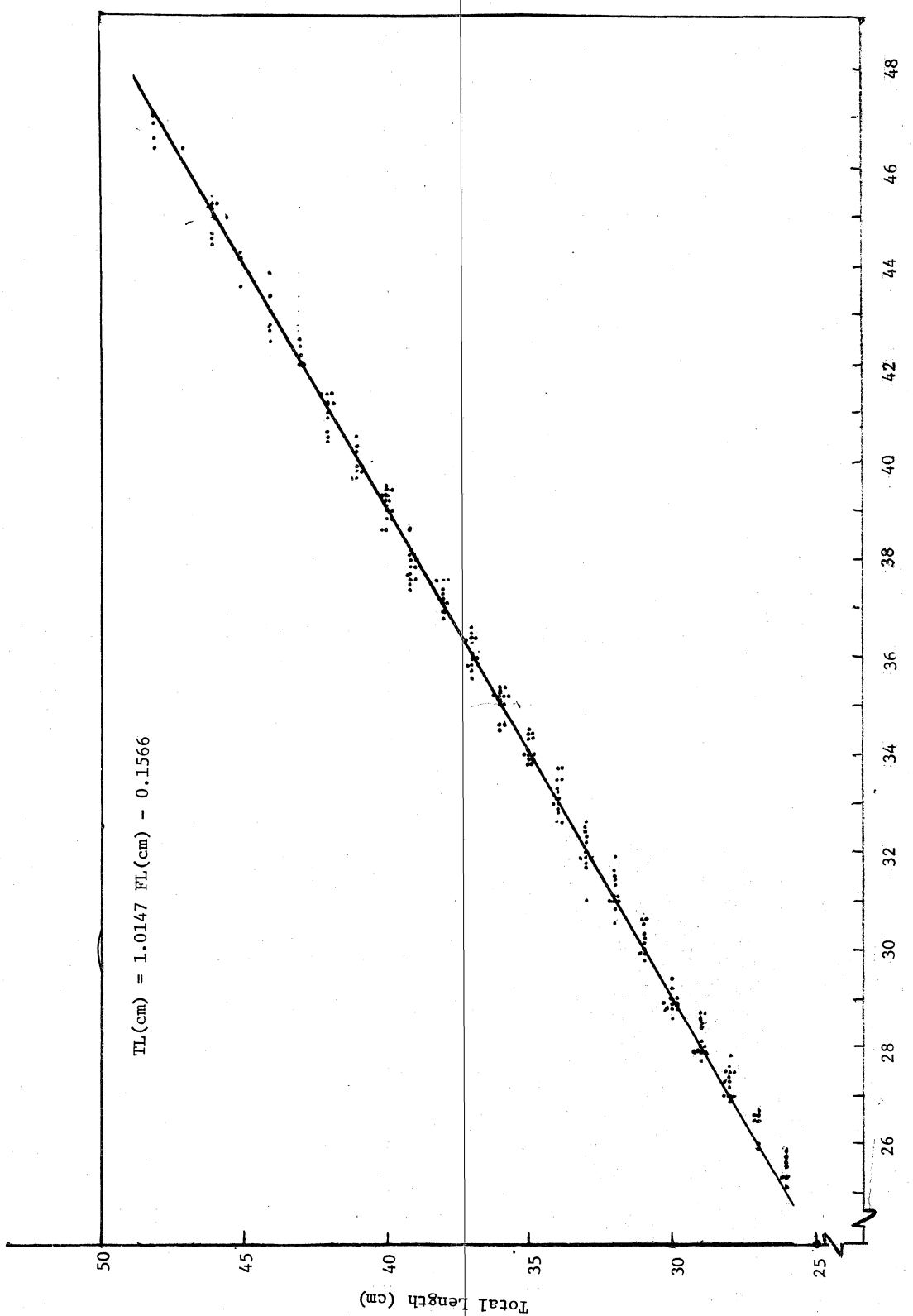

Fig. 5. Fork-total length relationship for silver hake in Division 4W, May 1982.