Northwest Atlantic Fisheries Organization

Serial No. N2870 NAFO SCR Doc. 97/38

SCIENTIFIC COUNCIL MEETING – JUNE 1997

An Exploratory Fishery for Greenland Halibut (*Reinhardtius hippoglossoides)* in Division 0A with Otter Trawl in 1996; Analysis of Data Collected by Observers.

by

J.A. Mathias and M. A Treble

Canada Department of Fisheries and Oceans, Central and Arctic Region
Freshwater Institute Science Laboratory
501 University Crescent, Winnipeg MB, R3T 2N6

Abstract

An exploratory fishery for Greenland halibut (Reinhardtius hippoglossoides) in NAFO Div. 0A was undertaken during September-October, 1996 by a commercial stern trawler. In 30 fishing days, 329 tonnes of Greenland halibut were caught in 122 sets. Fishing effort was distributed among 4 exploratory sub-zones within Div. 0A, and was directed at depths between 1,000 and 1300 metres. The average catch per unit of effort in 106 trawl sets analyzed was 0.603 tonnes per hour. Estimates of trawlable biomass of Greenland halibut ranged from 1.7 to 3.9 tonnes per square kilometre. The best conservative estimate of the total biomass which might lie within the 1,000-1,300 m contour in the four exploratory sub-zones in Div. 0A is 21.1 thousand tonnes. The average length of Greenland halibut caught in Div. 0A was similar to those caught by trawl in the Baffin inshore fishery, and larger than those caught further south. The discard rate of Greenland halibut was about 5% and the by-catch of other species was insignificant.

Introduction

Until now, offshore fisheries for Greenland halibut in Subarea 0 have been restricted to Div. 0B, where prior to 1984, the USSR and GDR conducted a trawl fishery in the offshore and Faroese longliners have regularly taken catches. Since 1990 trawl catches in Div. 0B have increased significantly, from 907 tonnes in 1989 to about 14,500 tonnes in 1990, but declining gradually to 4,722 tonnes by 1994 (NAFO 1995). The catch in Div. 0B was 5,880 tonnes in 1995 (NAFO 1997).

The Total Allowable Catch for Subarea 0 + Div. 1B-1F has been set at 11,000 tonnes since mid 1994. The quota for Subarea 0 from 1995 to 1996 has been set at 5,500 tons, 4,500 tons for the offshore, and 1,000 tons for the inshore fishery.

In 1993 a small test fishery took place within 200 km of Broughton Island (approx. 67° 33' N/64° 08'W). A commercial concentration of Greenland halibut was found in one gill net set in 1116 m, about 160 km southeast of Broughton Island (Hathaway, 1993). In 1994, the exploratory fishery was continued and 11 otter trawls were fished in Davis Strait off Broughton Island at depths ranging from 200 m to 900 m. Four trawl sets between depths of 200 and 500 m in the region of 65°N/61°W to 66°N/59°W produced an average trawlable biomass of 0.043 tonne/km^2, and seven trawl sets between 500 and 900 m in the region of 66°N/59°W to 67°N/59°W produced an average trawlable biomass of 0.161 tonne/km^2 (Northlands Consulting, 1994, Appendix 5).

In 1996 an exploratory fishery in NAFO Div. 0A was conducted by commercial stern trawler which fished for 30 days within the 1,000-1,300 m depth contours. This report documents the results of that fishery.

Methods

The exploratory vessel was a 65.5 ft stern trawler, 643 tons, with a crew of 35. It contained a freezer with processing capabilities. The vessel fished 30 days between September 22 and October 23, and caught a total of 329 tons of Greenland halibut in 122 trawl sets. A fishery observer was on board at all times and recorded catch rate and effort data as well as position, tow speed, tow duration and fishing depth for all sets. In addition, 20 sets were sampled to obtain biological information about the catch. In order to distribute the fishing effort, four fishing sub-zones were defined in Div. 0A (Figure 1), and the vessel was required to fish a minimum of 6 days in each zone. Fishing took place within the 1,000 m to 1,300 m depth contours because it was thought that too many sharks would be caught in deeper water. The distribution of trawl sets and sampled trawl sets is shown in Table 1.

During fishing, two trawls were used alternately, a Bacalao 630™ with a headrope length of 71.8 m, and a Startrol 630™ with a headrope length of 55.2 m. There was no sensor mounted on the net wings, so wing spread was calculated as 55% of headrope length (B. MaCallum, Gear Technologist, DFO, pers. comm.). This calculation is based on the assumption that the trawl was properly designed and rigged, and operated with the proper doors and door angle. The number of trawl sets analyzed was 106. The average towing speed was 3.5 k/h (range: 3.2-3.5 k/h) and the average duration of a set was 4.4 h (range 0.3-6.5 h). There were two mesh sizes used on the cod end during fishing, 147 mm and 148 mm.

A number of trawl sets were excluded from the analysis of the data (Table 2). These included sets less than 2.0 hours, sets in depths less than 1,000 m, and sets in which net damage was sustained with loss of fish.

The trawlable biomass was calculated from the distance the trawl was towed, the catch weight, and the assumed distance of the wing spread of the net. The total area of bottom between the 1000 and 1300 m depth contours was estimated approximately by drawing in the contours by eye from Canadian Hydrographic Service Chart No. 7010 (Davis Strait and Baffin Bay, scale 1:2,000,000), and measuring the areas with a planimeter. The mean trawlable biomass for each sub-zone was multiplied by the estimated fishable area within each sub-zone to estimate a total commercial biomass of Greenland halibut.

Results

Comparison of Trawls

During fishing two different mesh sizes were used in the codend of the net. These differences had no significant effect on the average CPUE of the trawls (t-test of means, P=0.62).

Catch per Unit Effort

The area of the fishing ground in NAFO Div. 0A which lies between the 1,000 and 1,300 m depth contours is shown in Figure 1 in relation to the four sub-zones covered by the exploratory fishery. It is noted that sub-zone 2 contains an eastern and a western component of the 1,000 - 1,300 m depth zone, whereas the other sub-zones contain only one component. Catch per unit effort (CPUE) was calculated as tonnes of Greenland halibut caught per hour of fishing effort. There was no significant difference between the CPUE of the two trawls (t-test, N=53 and 53, means=0.56 and 0.64 for the Bacalao and Startrol respectively, P>0.5), despite a difference in the length of their head ropes.

The distribution of fishing effort and the CPUE is shown by the circles in Figure 2. Although the average CPUE ranged from 0.493 tonnes/h in sub-zone 3 to 0.674 tonnes/h in sub-zone 2, the differences among zones were not statistically significant (ANOVA, P=0.094). The average CPUE for all zones was 0.603 tonnes/h, with 95% confidence limits of 0.535 and 0.671 tonnes/h. The catch rates appeared to be somewhat higher than those reported by Atkinson *et al.* (1994) from Div. 0B waters between 61°N and 65°N from 1990 to 1993. They reported average catch rates of 0.23-0.34 tonnes/h.

Figure 2 indicates that the CPUE was much higher in the eastern part of sub-zone 2 than in the western part, however there were too few trawls in the western part to make a proper statistical comparison. The few trawls taken in the western part of sub-zone 2 tended to be taken somewhat shallower than those taken from the eastern part, although still within the range of 1,000-1,300 m.

Trawlable Biomass

The estimated trawlable biomass of Greenland halibut among the four sub-zones (Table 3) ranged from a low of 1.7 tonnes/km^2 (sub-zone 3, minimum estimate) to 3.9 tonnes/km^2 (sub-zones 2 and 4, maximum estimate). When multiplied by the approximate area within the 1000 m and 1300 m depth contours, the estimated biomass of halibut, totaled over the four sub-zones, ranged from 24.4 thousand tonnes to 38 thousand tonnes, with an average estimate of 31.2 thousand tonnes. These estimates are very approximate, and depend on the following assumptions:

- that the area representing the 1,000-1,300 m depth zone (Fig. 1) is accurate, given that it was drawn by eye from a navigational chart;
- that all of the shaded area in Figure 1 is available for trawling;
- that the catches within each sub-zone are representative of the whole sub-zone.

The last point does not appear to be true for sub-zone 2, where the catch rate (Figure 2) in the western part of the sub-zone (area=3152 km^2) was lower than in the eastern part (area=923 km^2). If the western area is deleted from the calculation, the estimated biomass of Greenland halibut in the exploratory fishing area ranges between 16.5 thousand tonnes and 25.6 thousand tonnes, with an average of 21.1 thousand tonnes. Further exploratory fishing should be directed at measuring the trawlable biomass in the western portion of sub-zone 2 and in water deeper than 1,300 m throughout Div. 0A.

Biological Sampling

Length

The average total length of Greenland halibut caught in Div. 0A was 45.5 cm for males and 48.3 cm for females (Figure 3). The lengths of these fish were similar to those caught by trawl in Cumberland Sound and Davis Strait in 1994 (Northlands Consulting 1994), and considerably larger than fish caught further south in Div. 3N in 1994 (Avila de Melo *et al.*, 1995). In the latter study, the average length of Greenland halibut males was 34-35 cm and females were approximately 38 cm.

The length distribution of both male and female Greenland halibut had peaks at 40 and 50 cm. These plots were produced by combining data from the 4 sub-zones. Examination of the sub-zones separately (Figures 4 and 5), shows that the average lengths of both males and females were about 10 cm smaller in the most southerly area, sub-zone 1, than in more northerly sub-zones 3 and 4. In sub-zone 2 the length distributions were somewhat intermediate. This trend towards smaller fish sizes towards the south may be the result of higher fishing rates in more southern waters, but this needs to be investigated further.

Age

The ages of Greenland halibut have been determined for this exploratory fishery, but are not reported here pending the determination of the accuracy of age reading in the Central and Arctic Region in comparison with other laboratories in the Northwest Atlantic area measuring the age of this species.

Discards

Greenland halibut were discarded in 104 trawls. The weight of discarded fish is shown in Figure 6. A regression line forced through the graph origin had a slope of 0.056, indicating that the discard weight was 5.6% of the kept weight. This means that the discard weight was 5.3% of the weight of all Greenland halibut caught.

By-catch

Eighteen fish species, in addition to Greenland halibut, were caught by the exploratory fishery. However, as Table 4 indicates, only three of these, Greenland shark, Thorny skate and Spiny skate, made up an appreciable weight. The distribution of the weight of by-catch of these three species in the trawls is shown in Figure 7

Shark Catch

The reason given for fishing above the 1,300 m depth contour during the exploratory fishery was that a large number of sharks would be encountered in deeper waters. Most sharks were caught between the 1,100 and 1,200 m depth contours (Figure 8). Only one shark was caught deeper than 1,200 m in spite of the fact that 26 trawls were made in that depth range.

Recommendations

The exploratory survey of Div. 0A needs to be continued to answer the following questions:

1. what is the trawlable biomass of Greenland halibut in the western part of sub-zone 2?
2. what is the trawlable biomass of Greenland halibut in waters deeper than 1,300 m and shallower than 1,000 m?
3. can the exploratory fishery be extended more northerly than 71°26'N?
4. are there true differences in the lengths, ages, length-at-age and catch-at-age of Greenland halibut stock components in Div. 0A and more southern locations?
5. do such differences relate to the degree of fishing pressure on the stock components?

References

Avila de Melo, R. Alpoim, M.L. Godinho and E. Santos. 1995. Portuguese Research Report for 1994. Northwest Atlantic Fisheries Organization, SCS Doc. 95/13. Serial No. N2534. 53p.

Northlands Consulting. 1994. 1994 Exploratory fishery. A report on exploratory fishing for shrimp and groundfish in Cumberland Sound, Davis Strait, and Resolution Island survey areas. Northlands Consulting. P.O. Box 66 Iqaluit. 46 p + 1 Appendices.

NAFO. 1995. Report of Scientific Council, 7-21 June 1995 Meeting. Northwest Atlantic Fisheries Organization. NAFO SCS Doc. 95/19, Ser. No. N2599. 177 p.

NAFO. 1997. Northwest Atlantic Fisheries Organization Scientific Council Reports 1996. Northwest Atlantic Fisheries Organization. Scientific Council Reports 1996. Dartmouth. 226 pp.

Hathaway, B.L. 1993. Exploratory fishing in Davis Strait/Broughton Island Area (summer, 1993). Unpublished report to Baffin Region Sub-Committee for Fisheries, December, 1993. 29p + appendices.

Table 1. Sub-zones for Exploratory fishing, and number of trawl sets in each.

Sub-zone	Limits	No. Trawls	Sampled Trawls
Sub-zone 1	NAFO Div. 0A boundary to Broughton Island southern limit: 66°15' north latitude northern limit: 67°33' north latitude	22	3
Sub-zone 2	Broughton Island to Alexander Bank southern limit: 67°33' north latitude northern limit: 68°35' north latitude	41	7
Sub-zone 3	Alexander Bank to Clyde River southern limit: 68°35' north latitude northern limit: 70°26' north latitude	19	5
Sub-zone 4	Clyde River to Cape Adair southern limit: 70°26' north latitude northern limit: 71°26' north latitude	24	5

Table 2. Trawl sets excluded from analysis because of shallow fishing depth, short tow duration, or net damage.

Set No.	Fishing Depth (m)	Tow Duration (h)	Net Damage	Latitude	Longitude	Turbot CPUE (t/h)
11	989	0.9	no	67°35'N	58°45'W	0.02
26	647	0.4	no	67°49'N	59°09'W	0.375
27	739	0.8	no	67°53'N	59°19'W	0.300
3	1229	0.3	no	68°04'N	62°46'W	0.017
4	1262	0.3	no	68°05'N	62°59'W	0.017
16	1170	0.5	no	67°45'N	59°13'W	0.02
39	1163	1.3	no	70°28'N	65°40'W	0.246
59	1191	1.5	no	70°37'N	66°18'W	0.183
82	1097	1.0	no	67°31'N	58°44'W	0.330
20	1148	5.0	yes	67°47'N	59°17'W	0.006
23	1103	1.7	yes	67°47'N	59°17'W	0.029
67	1117	5.0	yes	70°21'N	65°29'W	0.712
83	1132	1.8	yes	67°29'N	58°37'W	0.108
100	1114	1.6	yes	67°52'N	59°26'W	0.106

Table 3. Estimate of total biomass of Greenland halibut within depth contours fished by the exploratory fishery in 1996.

Sub-zone	Area between 1000 and 1300 m (km^2)	Average Trawlable Biomass (t/km^2)	Minimum Trawlable Biomass (t/km^2)	Maximum Trawlable Biomass (t/km^2)	Average Estimated Biomass (tonnes)	Minimum Estimated Biomass (tonnes)	Maximum Estimated Biomass (tonnes)
1	3 665	2.396	2.015	2.777	8781	7385	10178
2	4 075	3.217	2.529	3.905	13109	10306	15913
3	2 511	2.428	1.705	3.151	6097	4281	7912
4	1 000	3.227	2.505	3.949	3227	2505	3949
Total	11251				31214	24477	37952

Table 4. Fish species caught as by-catch in the exploratory fishery.

Common Name	# trawls	Mean wt. per trawl (kg)		Common Name	# trawls	Mean wt. per trawl (kg)
Thorny skate	96	29.2		Black herring	3	1.0
Roughhead Grenadier	70	4.4		Large scale tapirfish	2	4.0
Threebeard rockling	65	1.0		Broadhead wolffish	1	5.0
Greenland shark	28	357.9		Smooth skate	1	3
Shrimp[a]	36	1.0		Deep sea sculpin	1	1.0
Spiny tail skate	21	35.7		Chimaera	1	1.0
Squid	10	1.0		Arctic eelpout	1	1.0
Polar sculpin	8	1.0		Viperfish	1	1.0
Redfish	3	1.0		Esmark's eelpout	1	1.0

[a] Phaiphaca tarda

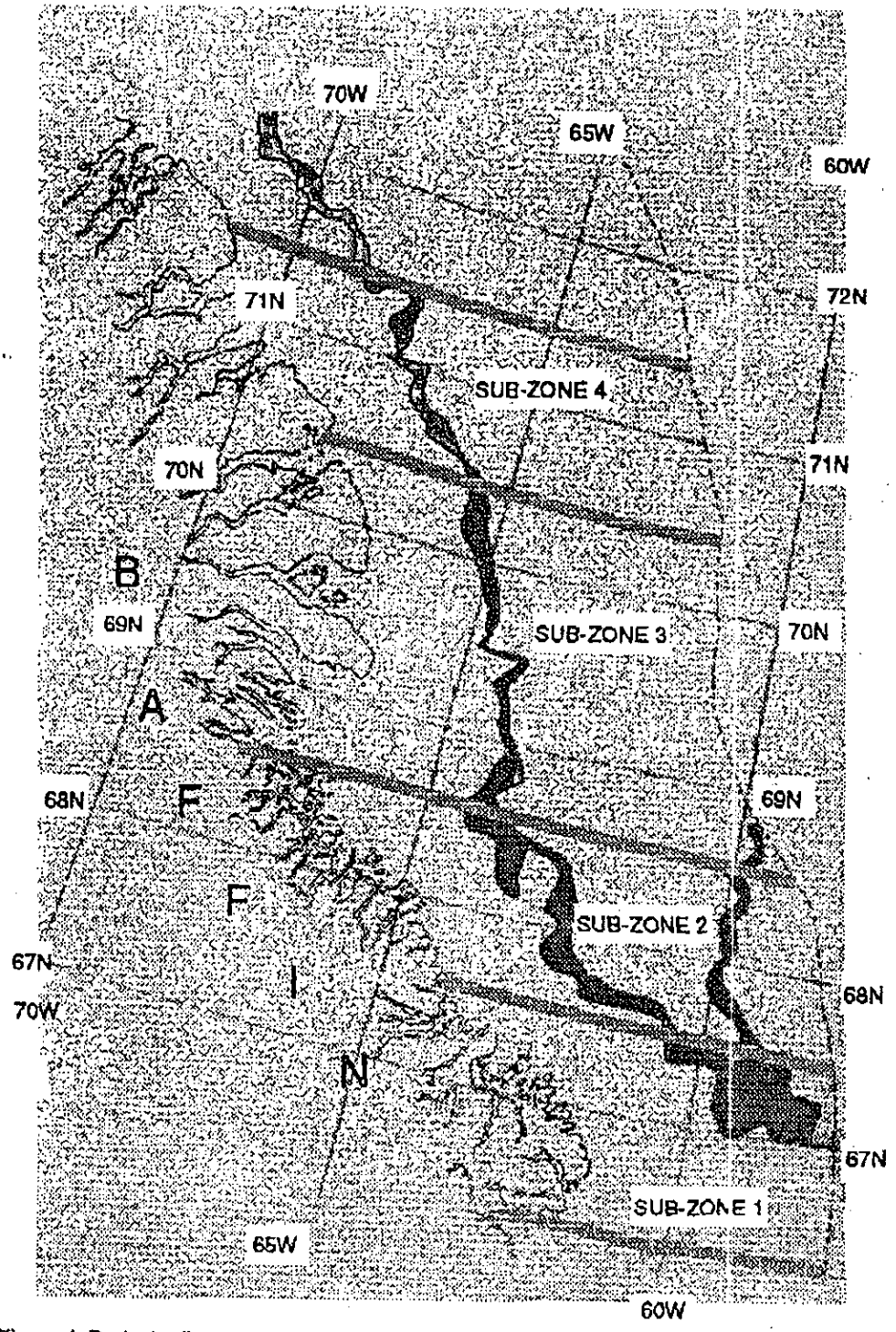

Figure 1. Dark shading represents area between 1000 and 1300 metres in NAFO Div. 0A

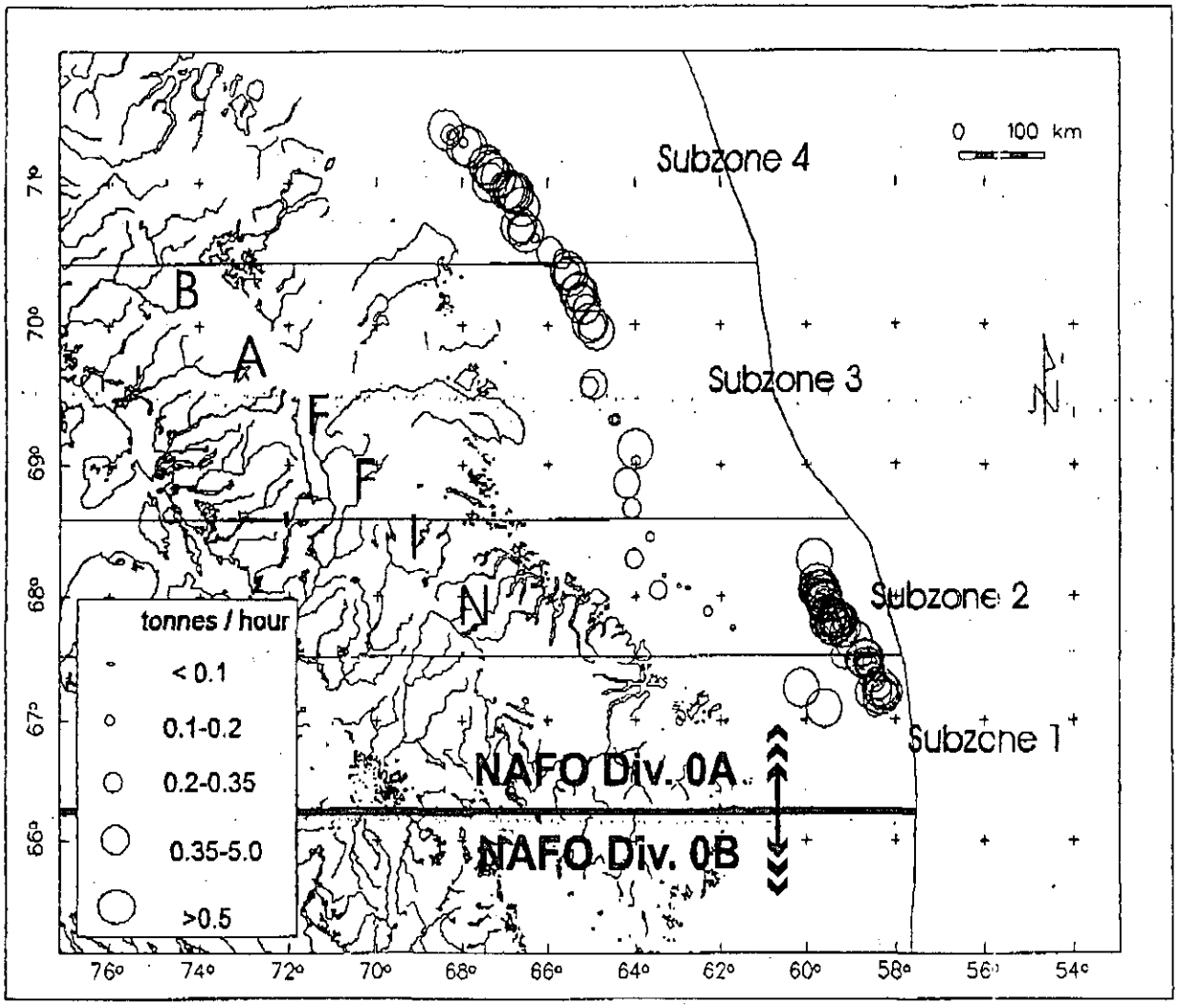

Figure 2. Map of fishing sub-zones in NAFO Div. 0A, showing the distribution of exploratory trawl sets in 1996.

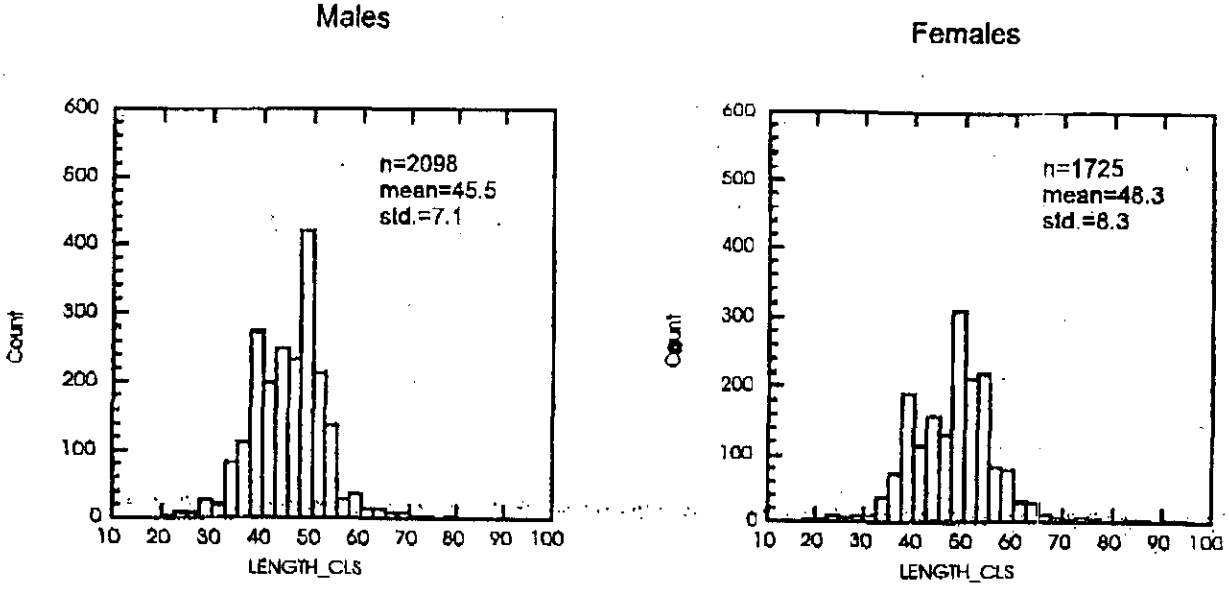

Figure 3. The length of Greenland halibut (cm) caught in Div. 0A in 1996.

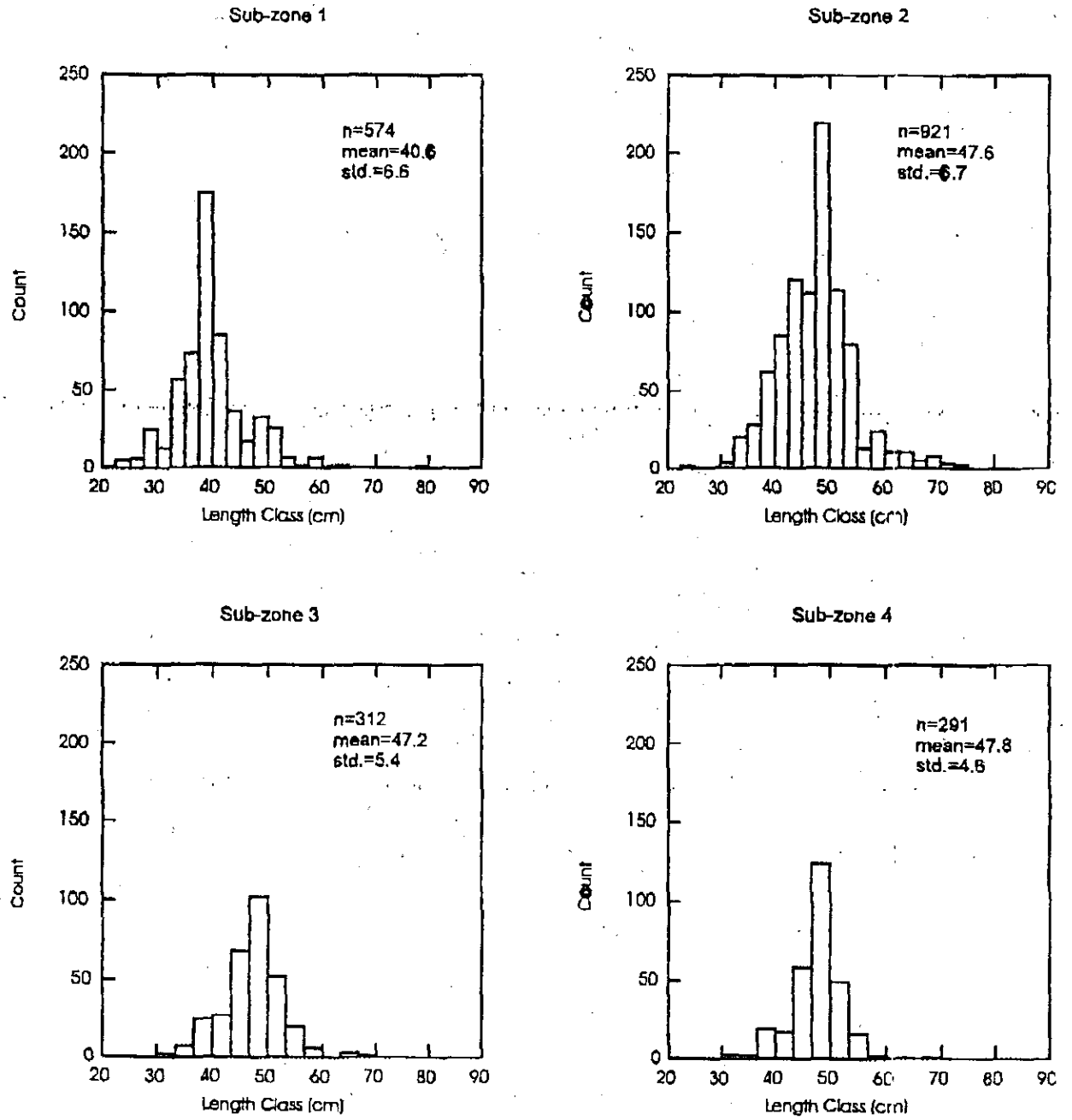

Figure 4. The length of male Greenland halibut caught in four sub-zones of Div. 0A in 1996.

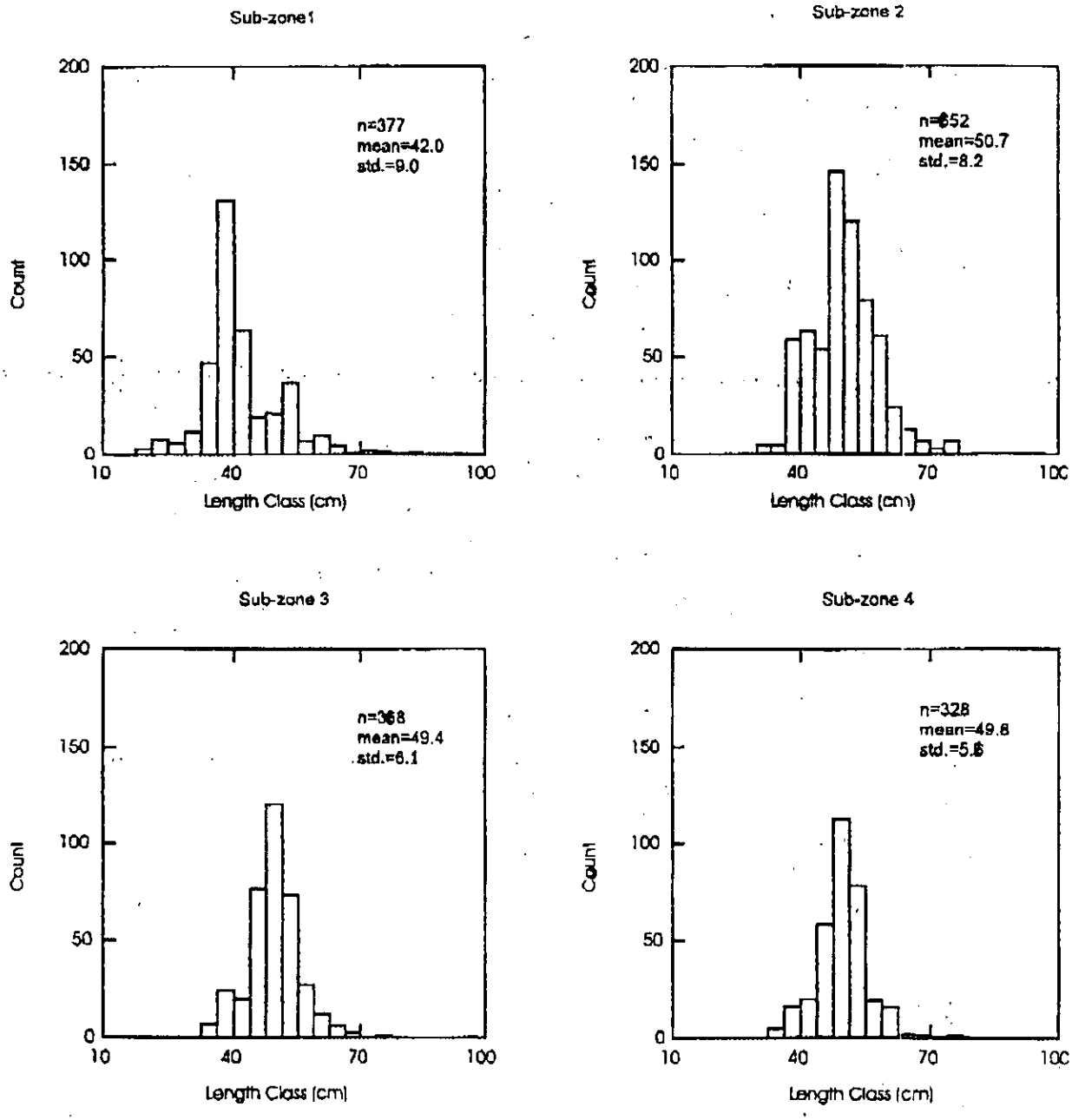

Figure 5. The length of female Greenland halibut caught in four sub-zones of Div. 0A in 1996.

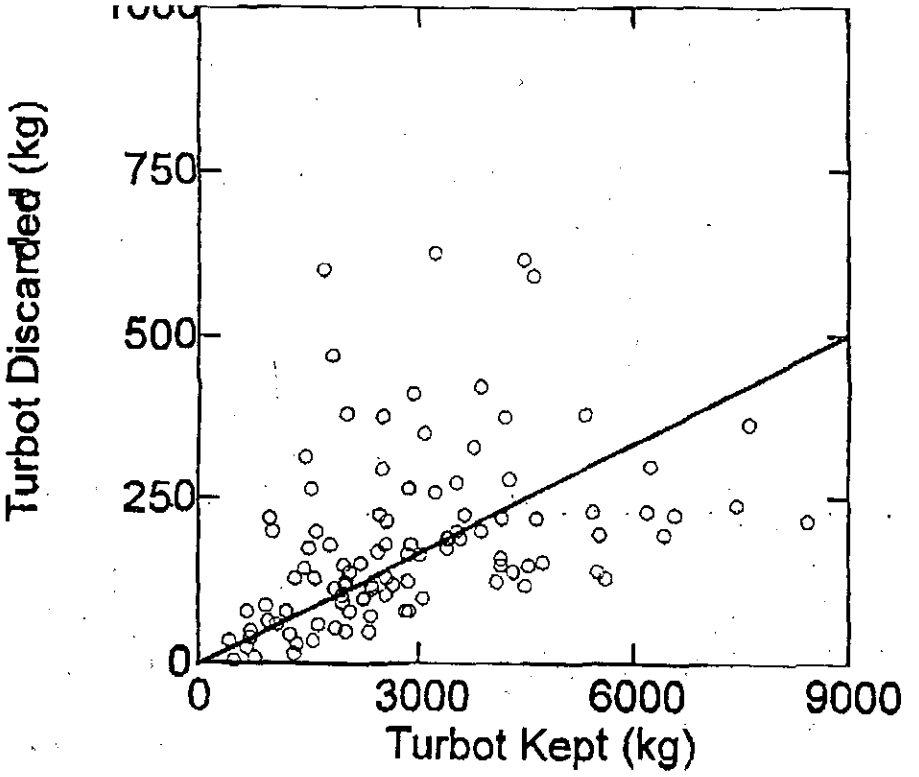

Figure 6. The weight of Greenland halibut discarded compared to the weight kept in trawls from Div. 0A in 1996. Each point represents one trawl set.

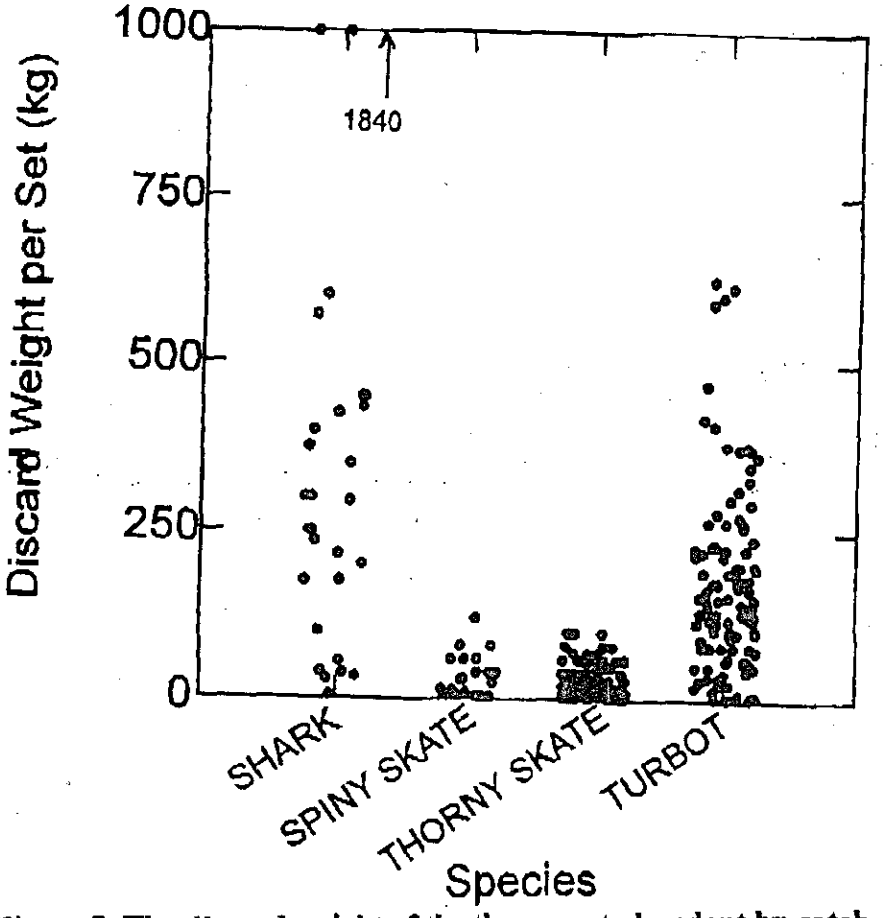

Figure 7. The discard weight of the three most abundant by-catch species compared to the discard weight of Greenland halibut in Div. 0A in 1996.

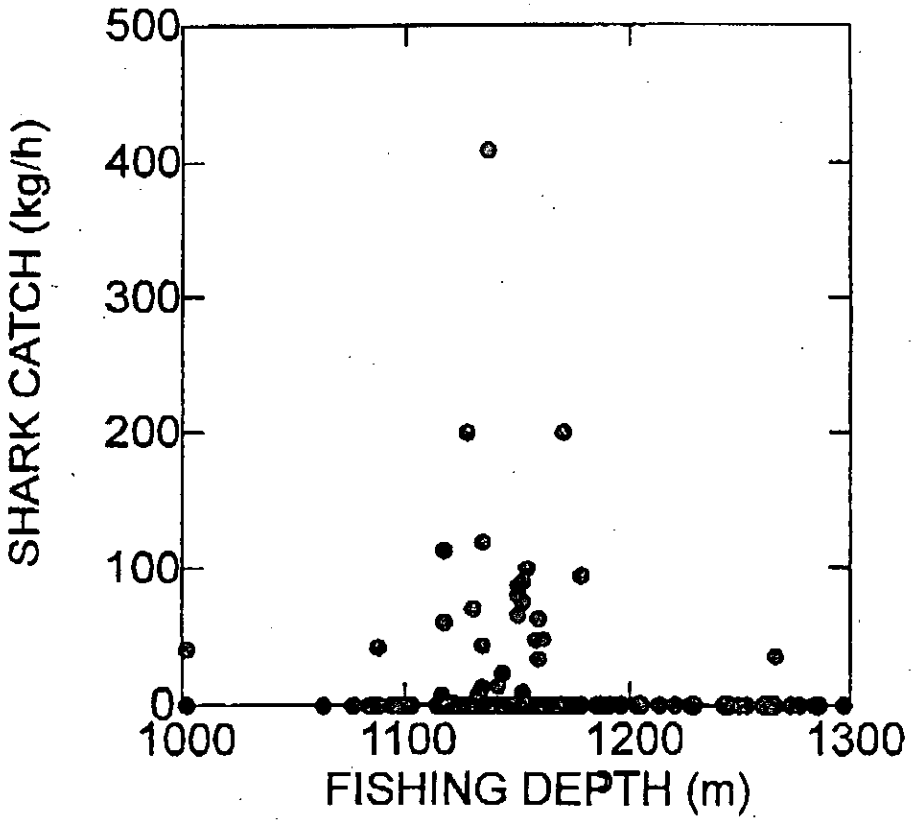

Figure 8. The weight of Greenland sharks caught at different fishing depths in Div. 0A in 1996.