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On Inshore Distribution and Abundance of the
West Greenland Cod Stock, Autumn 1986

by

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1. Abstract.

A long-line investigation on cod distribution and relative abundance in inshore areas of NAFO Div. 1C and 1D was carried out in October-November, 1986. Considerable numbers of cod were found in Div. 1D whereas catches were lower in 1C. In both divisions densities were higher in the coastal area compared to the fiords.

Recent assessments of the West Greenland cod stock are based on estimated abundance from the offshore trawlable area. If assuming similar densities in the inshore areas important stock parameters as stock size, fishing mortality and migration will be significantly changed.

2. Introduction

In recent years the assessment of cod stocks off East and West Greenland has been based on a combination of catch statistics and estimates of trawlable stock size derived from the trawl surveys carried out by the Federal Republic of Germany. This assessment procedure has several advantages compared to the cohort analysis previously used, one being that it has been possible to give annual estimates of migration coefficients (Anon. 1986 ; Cornus et al. 1986). This is of quite some importance for the assessment of cod stock off West Greenland, as migration is large (sometimes exceeding the effects of the fisheries) and shows considerable year-to-year variations.

However, a face-value use of survey abundance estimates will produce bias in most stock parameters if the survey estimates deviates systematically from the true stock size (Anon. 1986). One source of error in using the survey estimates is that the survey does not include the area within the 3 nautical mile coastal line, and a proportion of the stock is therefore not covered.

For that reason the Greenland Fisheries and Environment Research Institute carried out a small inshore survey after cod concurrently with the offshore trawl survey by the Federal Republic of Germany during late fall 1986.

3. Material and Methods

3.1. The inshore area.

The inshore area is here defined as the area inside the 3nm line (from the base line) from 67.00 northern latitude to Kap Farvel, i.e. covering a part of Div.1B and all inshore areas in Div.1C-1F.

The size of the area was recorded by planimeter measurements (map scale 1:400.000), and subjectively divided in coastal and fiord subareas by straight lines at the entrance to the fiords. Each subarea was then divided into depth strata of 0-100m, 100-200m and >200m depth.

In most coastal areas depth information was available, and the area within each depth stratum could therefore be measured. In fiord areas depth information was generally poor on the maps used. However, for parts of 4 fiords, where adequate bathygraphic informations were available, depth distribution could be measured. The distribution found was then raised to cover the total fiord area. Areas are given in table 1.

3.2. Fishing gear and stations.

The coastal and fiord areas of West Greenland are generally unsuitable for demersal trawling, and other gears had therefore to be used. During a small pilot study on the banks off Nuuk (Div.1D) in July 86 long lines and links of gill nett with different mesh sizes were tried. Catches in the gill nets were extremely poor and it was therefore decided to use long lines during the inshore survey in the fall. During the pilot study some trawl hauls were also made in order to get an idea of the selection pattern of the different gears.

Initially, three inshore areas (Manitsoq, Div.1C; Nuuk, Div.1D and Qaqortoq, Div. 1F) and one offshore area (Paamiut, Div.1E) were selected for the survey (Fig. 1). The offshore area was included to enable a comparison between catch rates from inshore and offshore areas and to compare catches by long lines and trawling on the same locations. However, due to technical break downs on our main research vessel, the offshore area as well as the inshore area around Qaqortoq was not included in the survey.

Fishing was carried out around Nuuk and Manitsoq by R/V Misiliisoq in the periods 16-25/10 and 29/10-7/11, respectively. Fishing stations within each area were selected to give a reasonable coverage of both coastal and fiord habitats (Fig. 2). Stations were randomly selected in the subareas at localities where the depth ranged from 0 to >200m. Stations exposed more or less directly to the sea are considered coastal, and the rest considered as fiord stations. According to this, stations 1-5 in the Nuuk area and 11,12,13,16,19,20 in the Manitsoq area are coastal, whereas stations 6-10 and 14,15,17,18 are classified as fiord stations.

On each station fishing was carried out in three depth strata: 0-100m, 100-200m and 200-300 m. Each long-line contained 400 hooks baited with capelin. Average time on the bottom was 4.3 hours (range 3.7 to 5.7 hours). The results are expressed as catch in number per 100 hooks disregarding any difference in time on bottom. Temperature was recorded by CTD on all stations and depths.

4. Results.

4.1 Size selection.

The length frequencies of cod in trawl and long-line catches from Div. 1D in July are shown in Fig.3. The length distributions are fundamentally different between gears as 95% of the trawl catches are between 20 and 35 cm whereas 90% of the line catches are above 55 cm.

From the age-length composition of the long-line catches (Table 2) it can be seen that few fish of an age less than 6 years were caught by the lines. The scarcity of the 3 and 4-year old cod may be explained by the poor size of these year-classes, but the relative lack of 5-year old cod cannot be explained in this way, as this year-class (1981) is relatively abundant at West Greenland (Anon. 1986).

It is assumed in the following that the long-line only catches cod of 6 years and older (≥ 55 cm c.f. Table 2) in reasonable proportion to their abundance in the sea.

4.2. Length distribution.

The length distributions of the line catches in autumn are shown for each area in Figur 4 and the number of cod larger and smaller than 55cm is given by subarea and depth in Table 3.

The length distribution differs between the two areas with 89% of the cod in Div.1D being above 55cm, whereas in Div.1C only 36% exceeds this value. Within each area little difference in length distribution is found between coastal and fiord stations.

Length distribution differs for the three depth strata as larger cod are caught in all strata, whereas most of the smaller cod are from the 0-100m stratum (Table 3.). This pattern is found in both divisions.

4.3. CPUE

CPUE for large cod (≥ 55 cm.) is shown by division, subarea and depth in Table 4. Mean CPUE-figures are proportional to standard deviation indicating some log-normal like distribution. However, with the relatively small amount of data available no transformations or strict statistical testing will be made.

The CPUE from the Nuuk area (Div.1D) far exceeds the values from Manitsoq (Div.1C) for coastal as well as for fiord stations. In both areas catches are higher at coastal stations than at fiord stations.

Catch distribution between the different depth strata are similar for the two areas. In the coastal subarea most cod were caught in the two upper strata (0-200m), whereas for the fiord stations practically all cod were from the upper stratum (0-100m).

CPUE for cod above 55 cm is plotted against temperature in Fig.5. From this it seems that high CPUE-values are associated with temperatures above 3°C.

CPUE for small cod (< 55 cm) by division, subarea and depth is given in Table 5.

In contrast to what is seen for larger cod the overall CPUE for small cod does not differ between divisions. Coastal catches were a little higher than fiord catches but the difference is not pronounced. Highest CPUE-values are found in the 0-100m stratum, and in the coastal area some cod were caught in the 100-200m depth stratum. Below 100m in the fiords and 200m in the coastal areas catches were practically nil.

CPUE plotted against temperature (Fig.6) again shows that higher CPUE-values are associated with high temperatures.

5. Discussion.

The trends in spatial distribution of cod found in the coastal area is generally quite similar to what is found in the offshore area by the FRG survey in okt./nov. 86, i.e. an increase in the number of large cod from Div. 1C to 1D and little difference in abundance of small cod between the two divisions (Table 6). In both investigations cod are found primarily in the upper 200m, but unlike the coastal area small cod from the offshore area seems to be most abundant in the 100-200 m depth stratum.

So far, in the assessments of the West Greenland cod stock, cod outside the survey area have not been included in the biomass and abundance estimates of the stock. Even if the present long-line survey is rather limited it does show, that cod is found in the inshore area in some quantities. Unfortunately, comparable data from the offshore area could not be obtained in 1986, and direct comparison of densities is, therefore, not possible. However, as a mere illustration it could be mentioned, that a line setting of 4 km (2000 hooks) in the coastal area catches around 3 to 4 times as many large cod as does the trawl in the offshore area during a standard tow (approximately 4km).

In an assessment context one might choose to change the "cod outside the survey area disregarded" approach with an equal simple "same densities of cod outside as inside survey area" hypothesis. This would have quite some effect as the inclusion of the inshore area would enlarge the total area by approximately 50 % (Table 7).

The effect on stock-parameters by assuming the same densities of cod inshore as found offshore by the trawl survey would be :

Stock size would increase by 50 %.

Total mortality (Z) will remain unchanged

Fishing mortality (F) would decrease to 2/3 of the previous assumed values as

$$F = \frac{\text{Catch } Z}{1.5 (N\text{-dif})}$$

where N-dif is the difference in cod abundance found between two successive trawl surveys.

Migration coefficient (E) would increase as

$$E = Z - M - F / 1.5$$

6. Future work

A survey should be carried out on a larger scale covering offshore as well as inshore areas as proposed in the original scheme i.e. including concurrent fishing with line and trawl on the same localities. Furthermore, more detailed measurements of the inshore depth distribution should be carried out and the distribution and relative densities of cod between inshore localities should be explored.

7. References

Anon., 1986 : Report of the Working Group on Cod Stocks off East Greenland. ICES C.M. 1986 / Assess:11.

Cornus H.P., J. Messtorff, A. Schumacher, H. Hovgård Hansen, Sv. Aa. Horsted, J. Møller Jensen and K. Meyer Lehmann : Status of the West Greenland Cod Stock and Management Considerations. NAFO Scr.Doc. 85/63.

Table 3. Proportion of cod below and above 55 cm by area , subarea and depth strata

Area :Manitsoq (Div.1C.)

Subarea	coast		fiord					
	<55cm		>55cm					
	%	(n)	%	(n)				
0-100m	77	(17)	36	(5)	100	(7)	100	(2)
100-200m	23	(5)	64	(9)	0	(0)	0	(0)
>200m	0	(0)	0	(0)	0	(0)	0	(0)
total	61	(22)	39	(14)	78	(7)	22	(2)

Area :Nuuk (Div.1D)

Subarea	coast		fiord					
	<55cm		>55cm					
	%	(n)	%	(n)				
0-100m	75	(12)	29	(48)	83	(5)	93	(13)
100-200m	25	(4)	49	(82)	0	(0)	0	(0)
>200m	0	(0)	22	(36)	17	(1)	7	(1)
total	9	(16)	91	(166)	30	(6)	70	(14)

Table 4. Mean CPUE for cod \geq 55cm, (standard deviation in brackets). Unit of effort = 100 hooks.

Area	<u>Manitsoq (Div.1C)</u>		<u>Nuuk (Div.1D)</u>	
	coast	fiord	coast	fiord
0-100m	0.21 (0.19)	0.13 (0.15)	2.44 (2.62)	0.66 (0.67)
100-200m	0.38 (0.41)	0.00 (-)	4.10 (6.36)	0.00 (-)
>200m	0.00 (-)	0.00 (-)	1.96 (3.42)	0.05 (0.11)
mean	0.21 (0.30)	0.04 (0.10)	2.83 (4.21)	0.24 (0.48)

Table 5. Mean CPUE for cod < 55cm (standard deviation in brackets).
Unit of effort = 100 hooks.

Area	<u>Manitsoq (Div.1C)</u>		<u>Nuuk (Div.1D)</u>	
	coast	fiord	coast	fiord
0-100m	0.71 (0.66)	0.46 (0.40)	0.60 (0.72)	0.26 (0.30)
100-200m	0.21 (0.33)	0.00 (-)	0.20 (0.33)	0.00 (-)
>200m	0.00 (-)	0.00 (-)	0.00 (-)	0.05 (0.11)
mean	0.32 (0.51)	0.15 (0.30)	0.26 (0.50)	0.10 (0.21)

Table 6. CPUE (numbers per 30 min) from the groundfish trawl survey
carried out by the Federal Republic of Germany okt./nov. 86.

Size Group : Cod < 54cm.

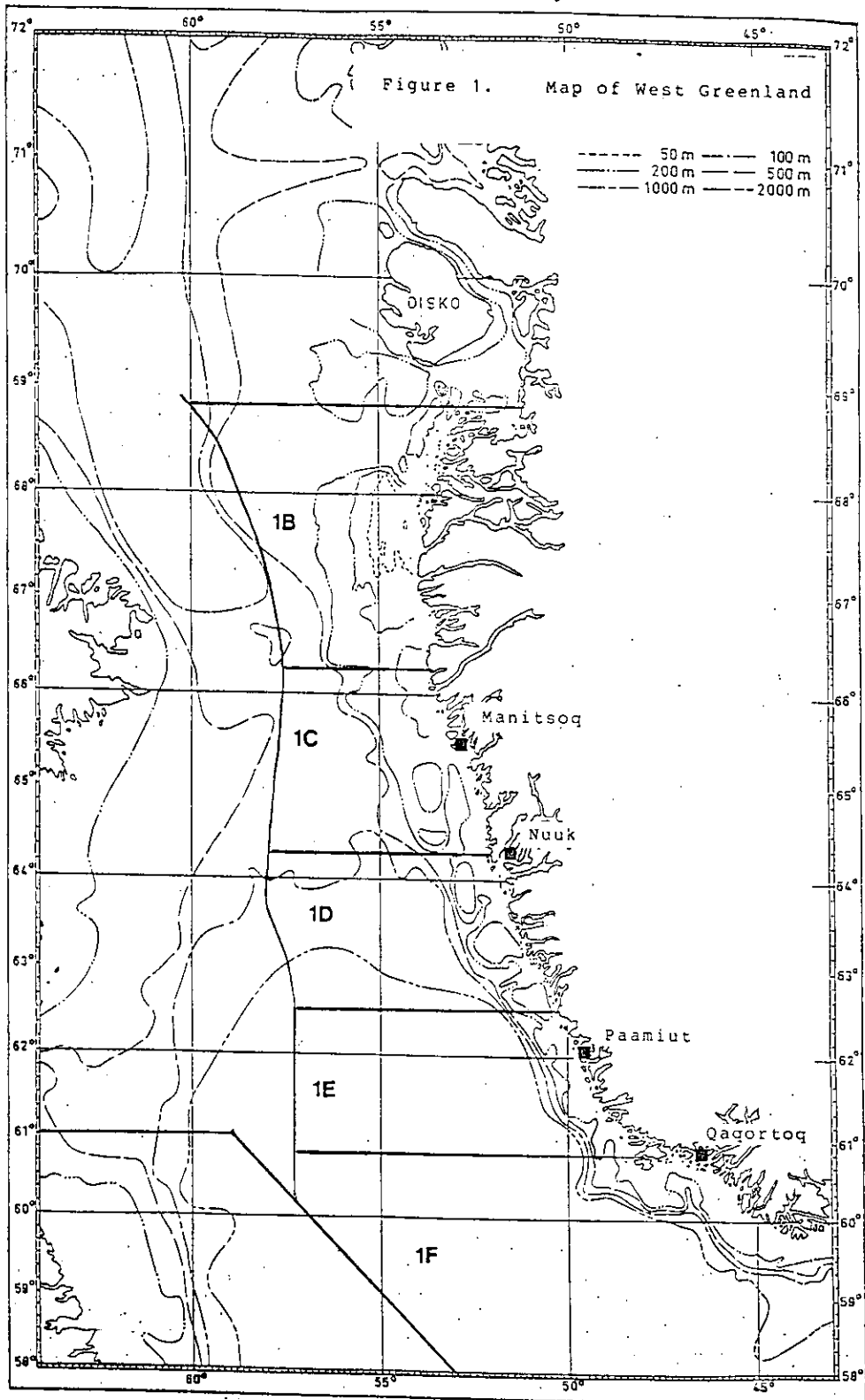
NAFO Div.	<u>1C</u>			<u>1D</u>		
	n	mean	S.D.	n	mean	S.D.
0-100m	6	181.8	326.9	12	255.4	433.8
100-200m	16	202.7	498.2	14	734.0	737.1
200-300m	5	12.4	24.4	8	12.0	15.9

Size Group : Cod > 54cm.

NAFO Div	<u>1C</u>			<u>1D</u>		
	n	mean	S.D.	n	mean	S.D.
0-100m	6	1.5	3.7	12	3.6	3.9
100-200m	16	0.5	1.5	14	31.7	52.9
200-300m	5	0.2	0.4	8	0.4	0.7

Table 7. Relation between inshore area and offshore survey area from FRG groundfish survey (square nautical miles).
 Inshore area from table 1, offshore from NAFO Scr.Doc.85/63.
 (c=coastal area, f=fiord area, o=offshore area.)

	Depth	Offshore survey stratum	area	(c+o)/o	(c+f+o)/o
Div.1B	<200m	1	2121	1.25	1.28
	>200m		870	1.20	1.38
Div.1C	<200m	2+3	4667	1.24	1.27
	>200m		1950	1.01	1.22
Div.1D	<200m	4+5	2367	1.50	1.63
	>200m		1529	1.06	1.24
Div.1E	<200m	6	1938	1.59	1.67
	>200m		799	1.03	1.45
Div.1F	<200m	7	2568	1.62	1.76
	>200m		1324	1.04	1.68
Total	<200m		13661	1.40	1.48
	>200m		6472	1.05	1.45



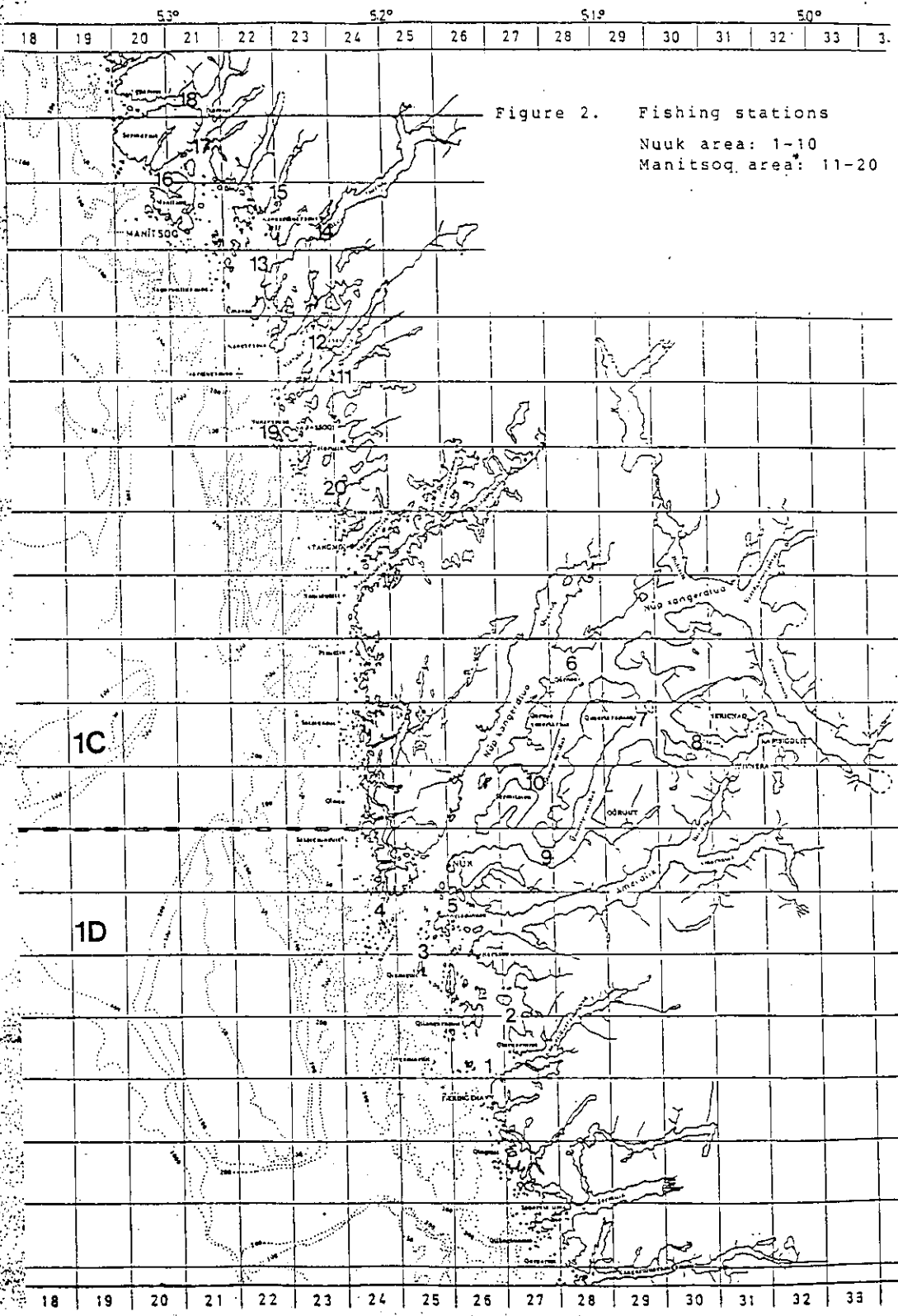
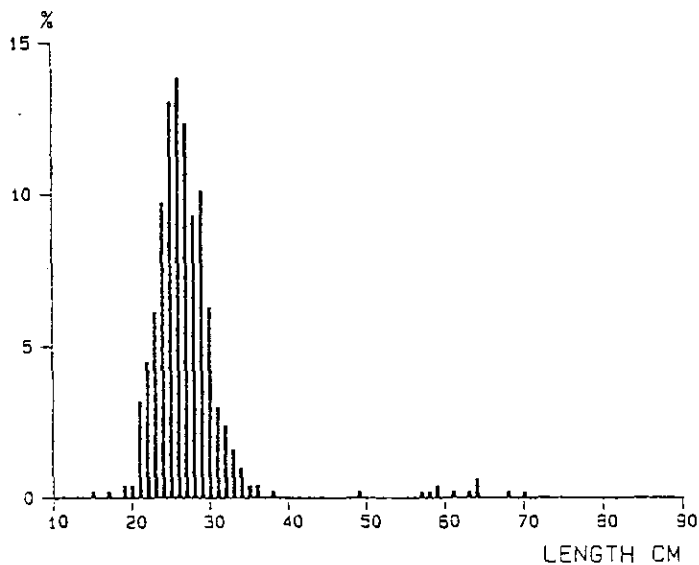


Figure 2. Fishing stations
Nuuk area: 1-10
Manitsog area: 11-20

LENGTH FREQUENCY DISTRIBUTION
TRAWL CATCHES (N=494)



LENGTH FREQUENCY DISTRIBUTION
LINE CATCHES (N=321)

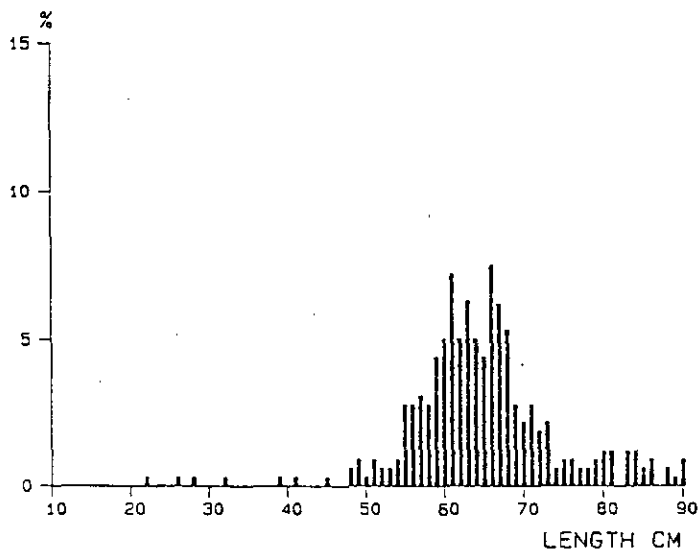


Figure 3. Length distribution of cod from pilot study in Div.1D, July 1986.

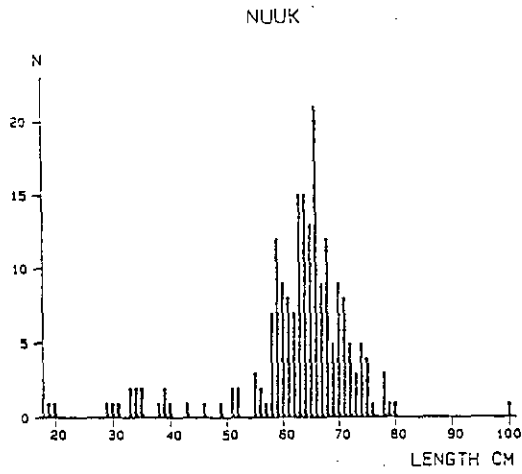
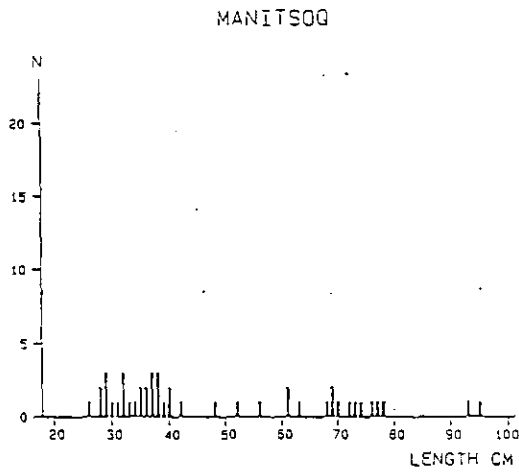
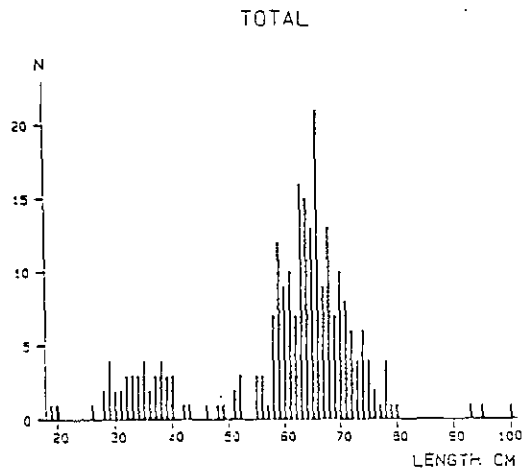


Figure 4. Length distribution of cod from long line survey in Div.1C

CPUE AND TEMPERATURE
COD \geq 55CM

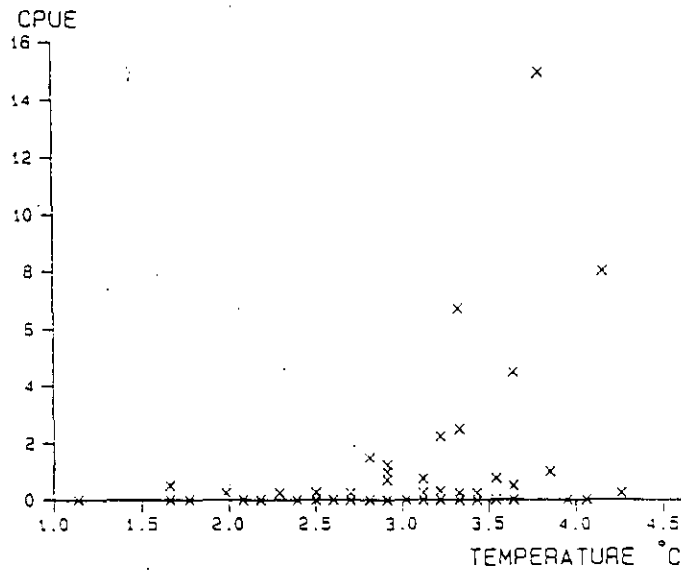


Figure 5. CPUE of large cod and temperature from all stations.

CPUE AND TEMPERATURE
COD < 55CM

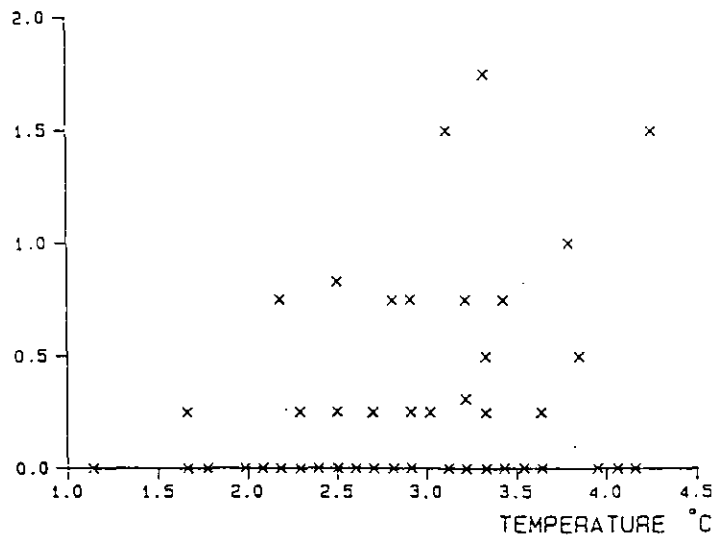


Figure 6. CPUE of small cod and temperature from all stations.