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Distribution and Abundance of Young Greenland Halibut (Reinhardtius

hippoglossoides Walb.) in West Greenland Waters

by

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Abstract

The distribution and abundance of young Greenland halibut at West Greenland is
described on the basis of stratified-random bottom trawl surveys from 1982 to
84 and research trawling for shrimp in the period 1968-84.

The main area of distribution of young Greenland halibut is the offshore areas
north of 68°N and the Disko Bay. In the sourthern area covered by the bottom
trawl surveys (south of 67°N) the abundance increases towards the north; the
preferred depth interval is 2-400 m. High abundance of young Greenland halibut
is also found in the research trawling for shrimp in some coastal areas near
Holsteinsborg (Div. 1B) and south of Godthåb (Div. 1D). Length distributions
by quarter from shrimp trawling in the Nuuk area shows the 0-group in the catches
in 4. quarter.

The distribution pattern of young Greenland halibut is discussed in relation
to a drift pattern of larvae from an assumed spawning area in the Davis
Strait. The authors put forward the theory that young Greenland halibut in the
coastal area in south Greenland may originate from the Iceland/East Greenland
area from where they are transported by the East Greenland current to West
Greenland.

Introduction

Greenland halibut is widely distributed along the West Greenland coast. The
main fishery takes place in the fiords and the coastal areas in Umanak and
Jakobshavn districts (NAFO Div. 1A).

Little is known about the distribution and abundance of young Greenland
halibut in West Greenland. Smidt (1969) presented length frequencies from
shrimp trawling in different areas; he believed the Greenland halibut larvae
to be transported by the current northwards along the West Greenland coast
from a spawning area in the deep water between Baffin Island and West
Greenland, south of the Davis Strait ridge at 67°N.

This paper describes the distribution and abundance of young Greenland halibut
in West Greenland waters on the basis of bottom trawl surveys carried out by
the Federal Republic of Germany and research trawlings for shrimp carried out
by the Greenland Fisheries and Environment Research Institute. The results are
discussed in relation to the generally assumed pattern of recruitment of
Greenland halibut to the West Greenland area.

Materials and Methods

Catch data from bottom trawl surveys off West Greenland 1982 - 84 were kindly supplied by the Bundesforchungsanstalt für Fischerei, Hamburg.

The area covered by the stratified-random bottom trawl surveys includes the West Greenland shelf outside 3 nautical miles off the baseline and the continental slope down to 600 m depth, extending from the southern part of Div. 1B (south of 67°N) southward to Cape Farewell (NAFO Div. 1F) as illustrated in Fig.1. All surveys were conducted during autumn. The area was divided into 7 main strata equal to Div. 1B-F or parts thereof. Each main stratum was subdivided by 200 m depth zones into 3 substrata. The strata coverage is shown in Table 1. In the 1982 and 1984 surveys fish were measured to nearest cm below total length. In the 1983 no Greenland halibut were measured. Mesh size in codend was 30 mm. Further information on trawl parameters are given by Cornus et al. (1985).

Catch data were analysed after a logarithmic transformation LOG(catch in number per hour of trawling +1), with a three-way ANOVA. All effects (year, strata and depth) were regarded as deterministic:

$$Y_{ijkl} = my + A_i + B_j + C_k + E_{l(ijk)}$$

Where Y_{ijkl} = LOG(catch per hour trawling +1), my = general mean, A_i = year effect, B_j = strata effect, C_k = depth effect and $E_{l(ijk)}$ error

Catch data from a total of 643 research hauls for shrimp carried out in the period from 1968 to 1984 by the Greenland Fisheries and Environment Research Institute were analysed. The data do not justify performing an analysis of variance; however some general distributional trends can be deduced. Ten localities have been defined from the area covered by those research hauls trawlings (Fig. 2). A few research hauls were made outside these localites are included in the discussion.

At the localities in Southwest Greenland (Fig.2, loc.2,3,4,5,6,7) hauls have been made in all months of the year. At the other localities the ice situation alloved trawling only in the summer period from about April/May to September/October. Mesh sizes in the codend of 18, 20 and 21 mm were used in these hauls.

Results

Bottom trawl surveys

Fig. 3 shows the length distribution of Greenland halibut caught during the 1982 and 1984 surveys. Lengths range from 7 to 104 cm. Two minor modes in the length distribution are seen. According to Smidt (1969) these modes represent the two and three years old fish while the very small mode at 14-15 cm represent the one year old fish.

The smaller specimens (less than 40 cm) constitute the major part (83%) of the survey catch. Therefore, the results from these surveys mainly reflect the distribution and abundance of the 2 and 3 year old fish.

Table 1 shows mean numbers caught per hour of trawling by year, strata and depth. The catch rate is generally at a low level, except in stratum 1 in the 200 to 400 m depth interval, where great numbers were caugth.

An ANOVA was applied to the catch data after logaritmic transformation of the

data. The ANOVA shows significant (1%-level) effects of strata and depth but
there was no significant (p=0.09) effect of years (Table 2). The model
explains 36% of the total variation. A Newman-Keul's range test (Hicks 1982)
on mean LOG(CPUE + 1) gives significantly (5% - level) higher value for
stratum 1 than for stratum 2, which again was significantly (5% - level)
higher than for strata 3,4,5,6 and 7. Furthermore, the catch rates in strata 3
and 4 were significantly (5% - level) higher than in strata 6 and 7. This
indicates a general decrease in catch rate from north to south. For the depth
distribution the range test shows a significantly (5% - level) higher catch
rate in the 2-400 m interval than below 400 m, which again was significantly
(5% - level) higher than in the 0 - 200 m interval. This shows that Greenland
halibut prefers depths about 2-400 m.

Research trawling for shrimp

The results from the research trawling for shrimp during the period 1968-84 are
seen in Table 3. The length distribution for each locality is shown in Fig. 4.
The 1 year and older Greenland halibut are assumed to be caught in a representa-
tive way by the small-meshed shrimp trawl.

There are large variations in mean CPUE between localities, and the standard
deviations for all localities are large. The length of Greenland halibut range
from 7 cm to above 100 cm. On most of the length distributions two to three
peaks can be recognized representing the youngest year classes.

Loc.3,(4),7,9,10 (Fig. 2) show high mean CPUE and occurrence of catches above
500 in number per hour of trawling. Two of these localities (3 and 4) are coastal
localities in south West Greenland, while loc.9 is offshore and loc.10 is the
Disko Bay, both further north. The length distribution found in these
localities are dominated by the 1 year old fish (Fig. 4).

Low densities of Greenland halibut are found at loc.2 and at the two
localities in the deeps between the banks (loc.5,6) (Table 3). At these
localities there was no dominance of the 1 year class. Scattered hauls on the
banks (not shown) also gave low density figures, and the abundance west of
Store Hellefiske Bank (loc.8) was also low (Table 3). The length distribution
at loc.8 was dominated by the 1 year old fish (Fig. 4).

In order to analyse seasonal variations of length distribution, length
distributions by quarter for loc.3 and 4 are shown in Fig. 5. In the first
quarter pronounced modes occur at 10 cm and 18 cm representing the 1- and 2-
year classes. These two peaks can be followed in subsequent quarters. In the
fourth quarter a new mode at 9 cm can be recognized, representing the 0-year
class. A more detailed analysis of the length distribution within the fourth
quarter reveals that the 0- group is showing up in the December length
distribution (not illustrated).

Discussion

The smallest bottom stage of the Greenland halibut is about 7 cm in length
according to Smidt (1969). Due to the mesh size useds in the German
stratified-random bottom trawl survey (30 mm codend) it is not to be expected
that the youngest Greenland halibut (0-group and to some extent the 1 year
class) are caught. In the research trawling for shrimp a smaller mesh size
(18-21 mm codend) has been used, and only the smallest 0-group individuals can
be expected to escape through the meshes.

In south West Greenland (south of 67°N) the abundance of Greenland halibut

seem to be low outside the 3-mile limit as indicated by the low catches in the bottom trawl surveys, although generally a clear tendency of increasing abundance towards north is evident. The small Greenland halibut seem to prefer the 200-400m depth interval. Shrimp-trawl catches made in this area (loc. 5 and 6) confirm these results as do a few hauls made on the banks (these have not been included in the analyses). Furthermore, length distribution in shrimp-trawl catches showed no pronounced dominance of the 1-year group in this area.

In contrast to the low abundance in the offshore area in the southern West Greenland area high abundance were found in the research hauls for shrimp in the coastal areas at Holsteinsborg and south of Godthåb. At these localities the 1-year group is particularly abundant. Also Smidt (1969) found this year class to be very numerously represented in the area south of Godthåb. Both coastal areas are located near fiord systems where important commercial fisheries for Greenland halibut occur or have occured. Probably other areas exist along the southern coast, where young Greenland halibut are very numerous and from where recruitment to different fiord stocks takes place.

Small Greenland halibut are highly abundant in the Disko Bay and in the offshore area north of St. Hellefiske Bank. Smidt (1969) found high densities of the 1-year group in localities west of Disko (not covered by this investigation) and he regards this area as a very important nursery ground. Further north, in the offshore area west of Umanak (about 71°N), the Danish research vessel "Dana" found great numbers of smaller Greenland halibut in shrimp-trawl hauls in July 1971 (unpubl.). Likewise, in the recently developed shrimp fishery between 71°N and 73°N great numbers of small Greenland halibut are caught.

The distribution and abundance of young Greenland halibut found in this study together with the results presented by Smidt (1969) indicate, that the main area of distribution of young Greenland halibut is found from about 68°N and towards the north. In this area the young Greenland halibut are numerous in the offshore area and in the Disko Bay. The northern limit of distribution is unknown. The main area of distribution fits an assumption of a spawning area of Greenland halibut in the Davis Strait south of 67°N and the knowledge of the hydrography and the currents in the Davis Strait (e.g. Buch, 1982).

The relativly high abundance of young Greenland halibut found in some coastal areas in southernmost Greenland can, however, not be explained by a passive transport of larvae by the current from the spawning area in the Davis Strait, because it is not believed that water masses from the latter area transported by the currents are reaching the southernmost coastal areas of West Greenland (E. Buch, Greenland Fisheries Investigation, pers. comm.).

From the authors' point of view another explanation could be valid, namely that the young Greenland halibut in the coastal areas in south West Greenland do not originate from the same spawning area as the young Greenland halibut in the northern part of West Greenland. It is noteworthy that pelagic 0-group Greenland halibut are well represented in the 0-group fish survey carried out every year by Iceland (e.g. Vilhjalmsson et. al 1981). Therefore the possibility exists that young Greenland halibut to some extent are carried by the East Greenland current from the East Greenland area to the southern West Greenland area.

Further investigations must focus on whether young Greenland halibut occuring numerously in some coastal areas in south West Greenland can be looked at as isolated from the main area of distribution in the north and whether there exists an influx of young Greenland halibut from East Greenland and, if so, the importance of such an influx.

References

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  the 1970-79 Decade. NAFO Sci.Coun. Studies 5: 43-50.

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  Møller Jensen, K. Meyer Lehmann. Status of the West Greenland Cod stock and
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Vilhjalmeson, H., Magnusson J.V. 1981. Report on the 0-group fish survey in
  Icelandic and East-Greenland waters, August 1981. ICES, C.M. 1981/H : 41.

Table 1. Mean number of Greenland halibut per hour trawling by year
and stratum. n = number of hauls.

	1982		1983		1984	
Stratum 1	mean CPUE	(n)	mean CPUE	(n)	mean CPUE	(n)
0-200	19.8	(8)	12.3	(6)	11.2	(5)
2-400	47.5	(4)	440.0	(1)	589.0	(2)
>400	12.0	(1)	-	-	25.0	(2)
Stratum 2						
0-200	20.4	(5)	1.1	(7)	7.1	(9)
2-400	1.0	(2)	4.0	(2)	15.0	(2)
>400	-	-	10.0	(1)	6.0	(5)
Stratum 3						
0-200	0.4	(11)	7.9	(20)	3.3	(12)
2-400	1.5	(4)	59.3	(9)	17.1	(7)
>400	0.0	(3)	0.7	(3)	6.0	(5)
Stratum 4						
0-200	-	-	-	-	4.0	(1)
2-400	0.0	(1)	20.0	(1)	1.0	(2)
>400	-	-	0.0	(1)	5.2	(5)
Stratum 5						
0-200	0.4	(17)	0.0	(25)	0.1	(26)
2-400	8.1	(7)	9.8	(13)	18.4	(10)
>400	1.0	(2)	-	-	2.0	(2)
Stratum 6						
0-200	0.0	(10)	0.0	(19)	0.0	(19)
2-400	1.3	(6)	0.0	(7)	0.5	(7)
>400	-	-	-	-	0.0	(1)
Stratum 7						
0-200	0.3	(16)	0.0	(19)	0.0	(23)
2-400	2.0	(4)	0.2	(10)	0.5	(8)
>400	-	-	-	-	3.0	(2)

Table 2. Basic statistic information from the ANOVA on LOG transformed CPUE data;   model $LOG(CPUE+1)_{ijkl} = my + A_i + B_j + C_k + E_{l(ijk)}$

	sum of squares	degrees of freedom	mean squares	F	pr>F	R^2
Model	206.4	10	20.6	21.65		0.36
year	4.6	2	2.3	2.45	0.0877	
strata	143.1	6	23.9	25.01	0.0001	
depth	58.7	2	29.4	30.77	0.0001	
Error	367.9	386	1.0			

Table 3. Data on research trawling for shrimp. CPUE = Catch in number per hour trawling.

locality nr.	locality name	number of hauls	depth interval	mean CPUE	s.d. CPUE	number of hauls >500 CPUE
1	Julianehåb inshore	12	250-450	149	114	0
2	Frederikshåb Isblink	70	200-250	28	49	0
3	South of Godthåb	38	160-270	534	981	8 (21%)
4	Godthåb Fjord	43	150-420	180	227	1 (2%)
		20	510-620	83	56	0
5	Godthåb Depth	118	240-310	38	39	0
6	Sukkertop Depth	91	460-540	24	26	0
7	Holsteinsborg	7	300-370	522	780	2 (29%)
8	West of St. Hellefisk Bank	62	200-570	28	41	0
9	North of St. Hellefisk Bank	67	250-530	225	270	8 (12%)
10	Disko Bay	115	200-550	592	1383	36 (31%)
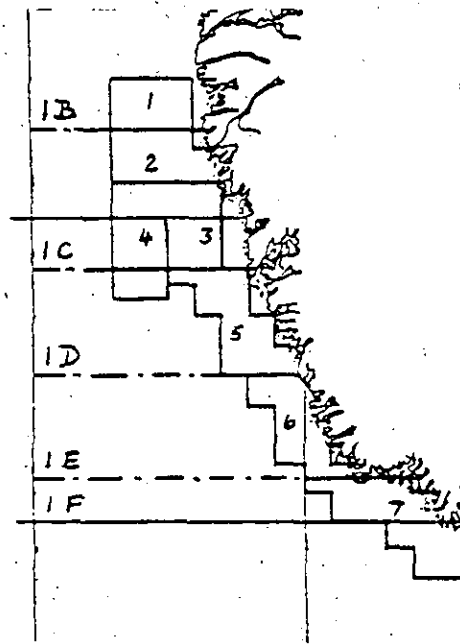
Fig 1 : Map of survey areas and stratification off West Greenland.
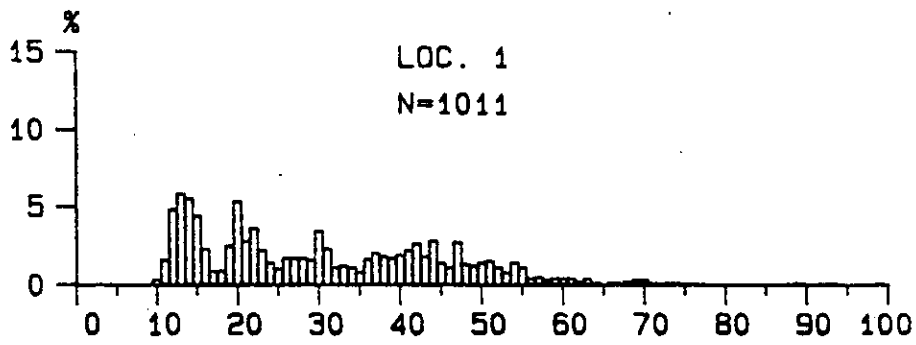Numbers indicate the stratum. (from Cornus et al., 1985)
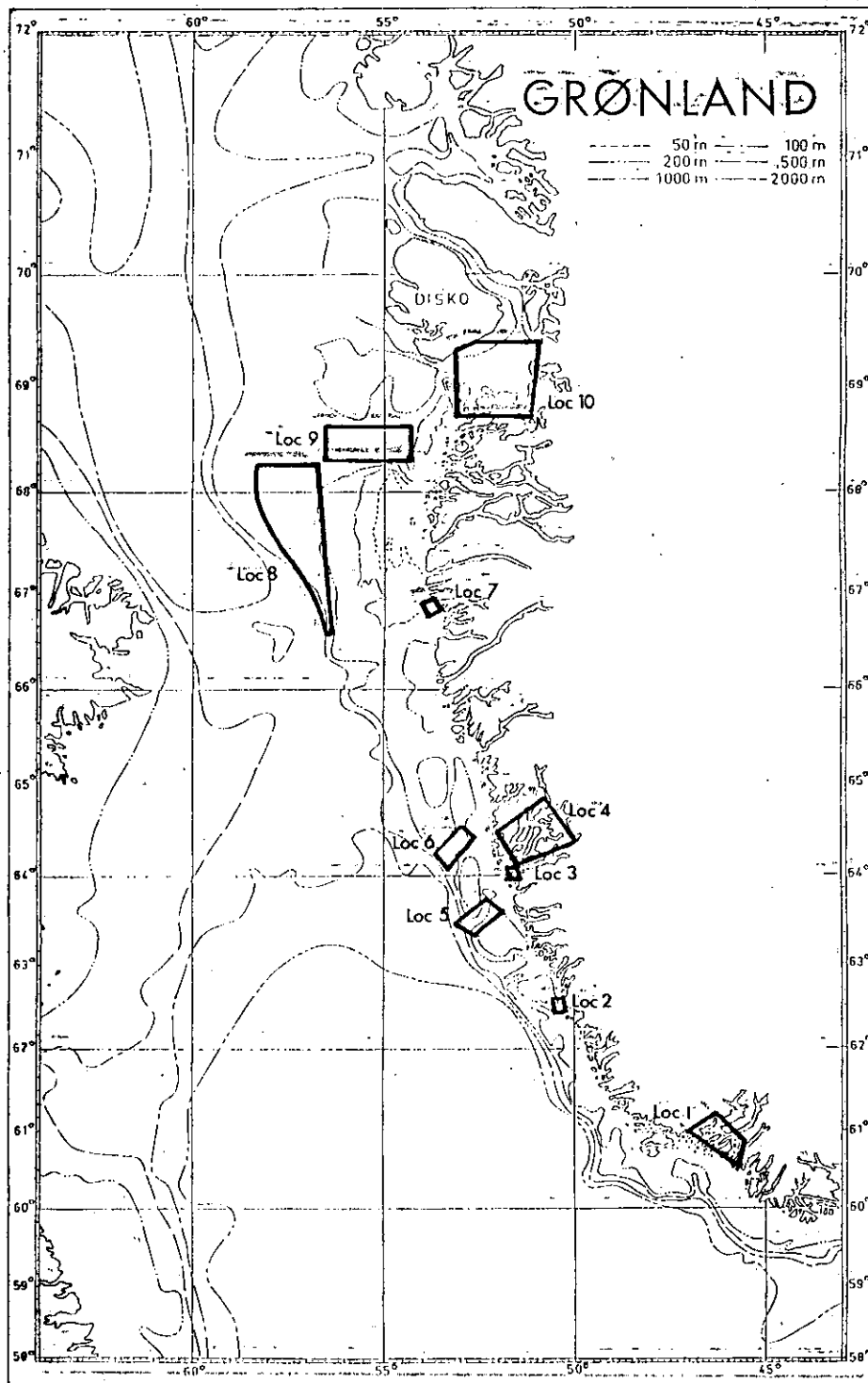
Fig.2. Map of the localities off West Greenland, where research trawling for shrimp was carried out.
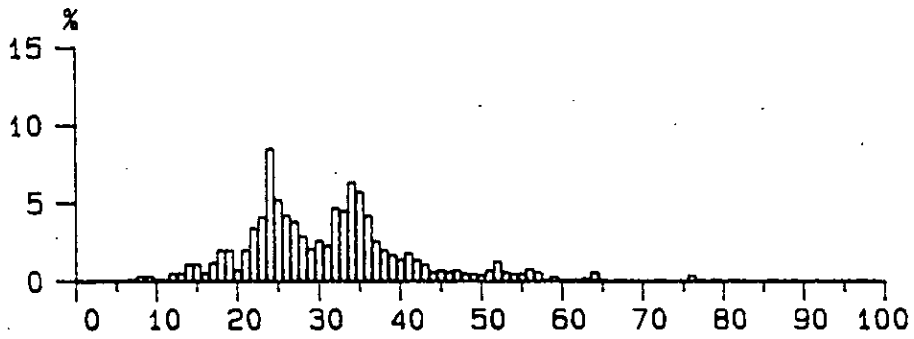
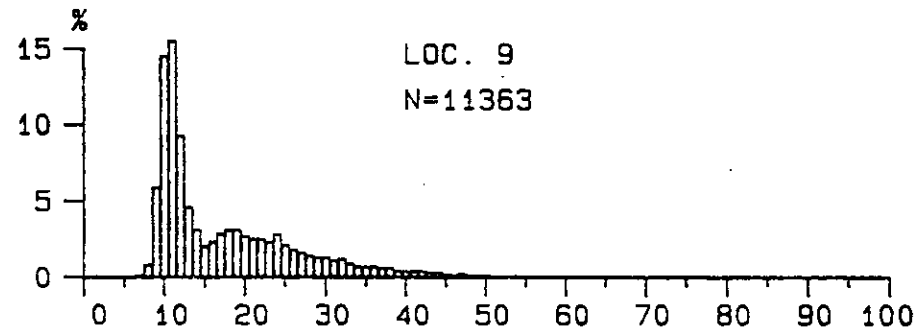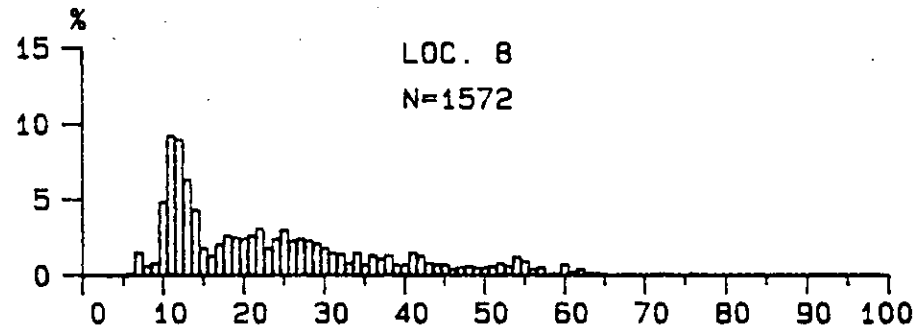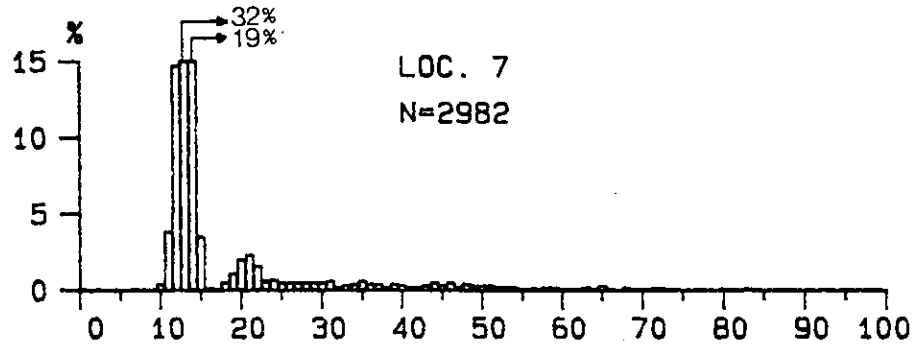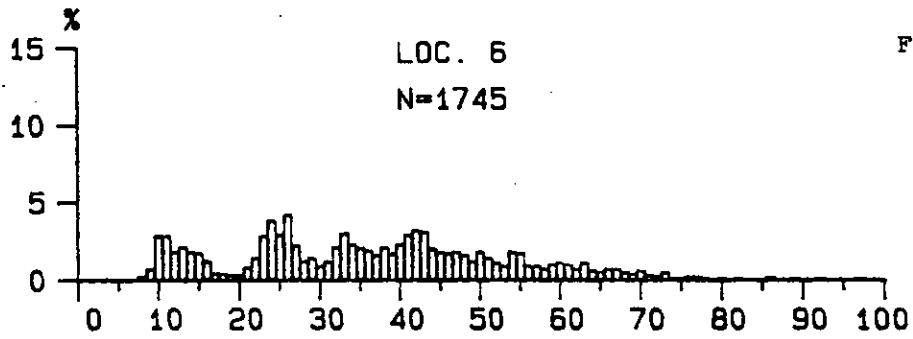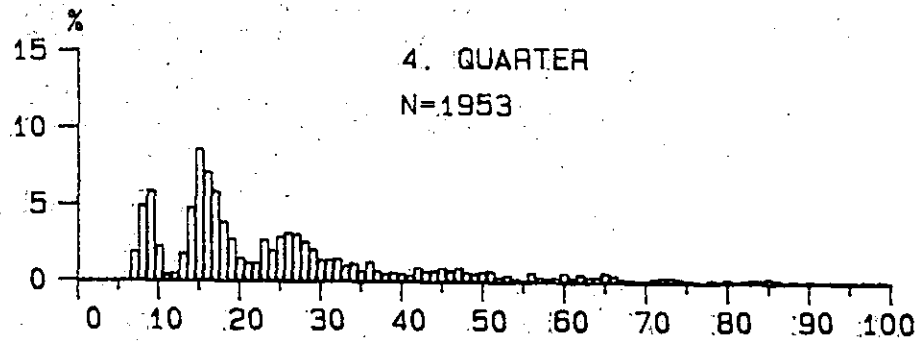Fig.3. Percentage length distribution in 1 cm group of Greenland halibut, caught in trawl surveys in 1982 and 1984.
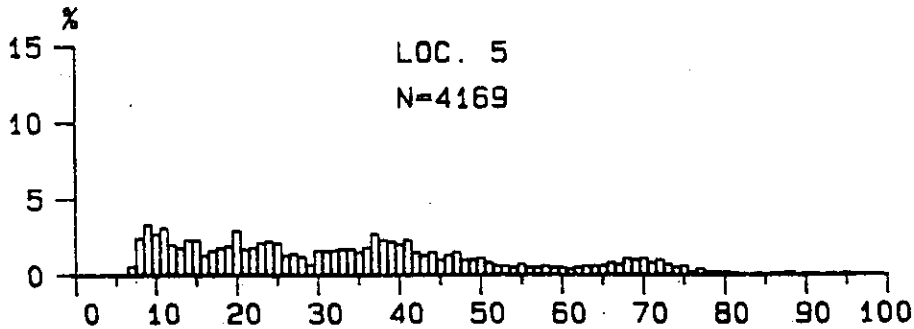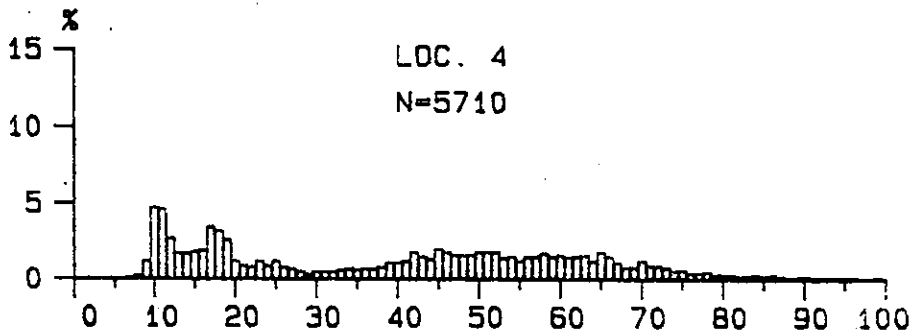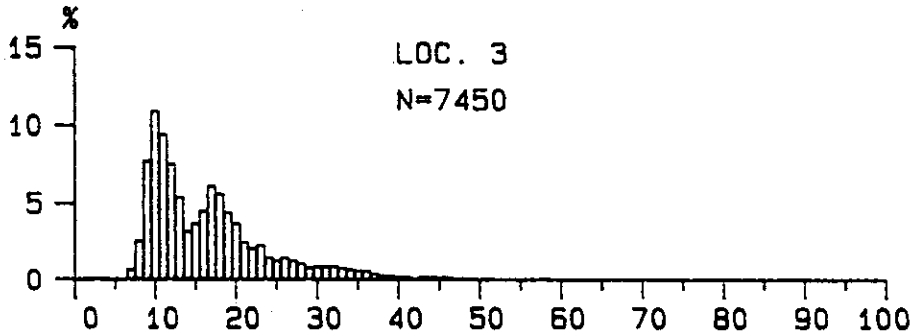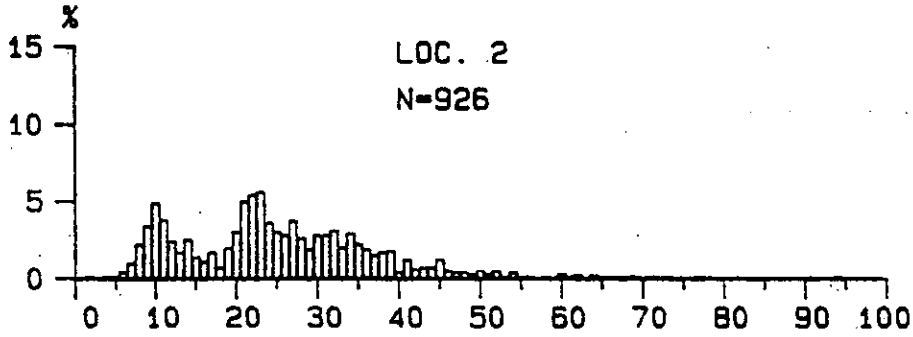
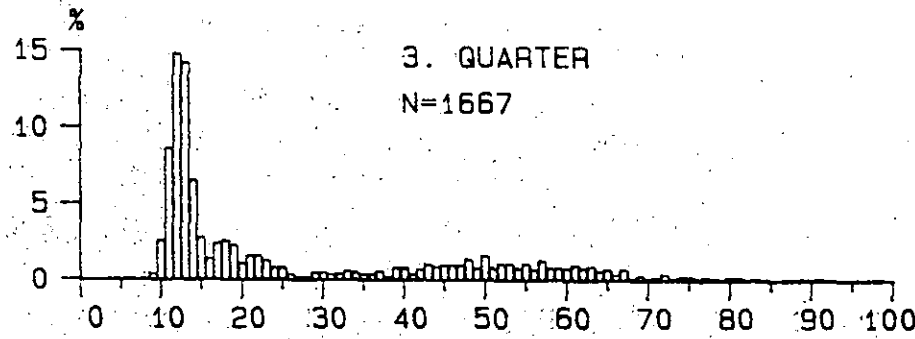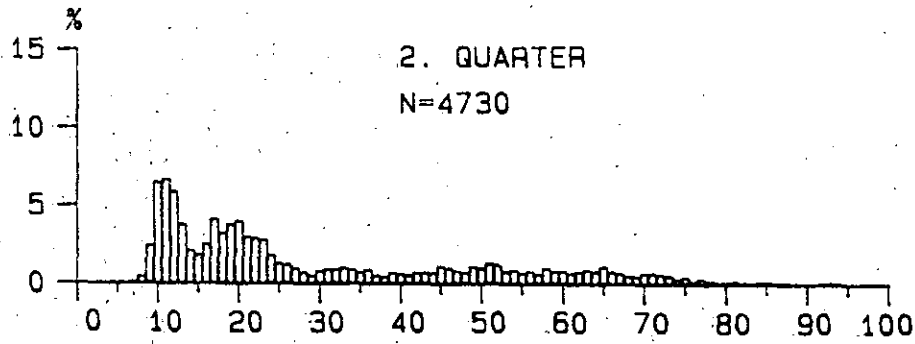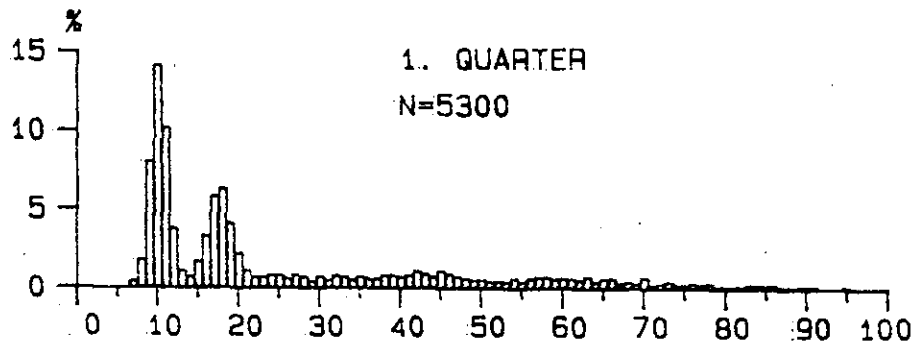**Fig.4.** Percentage length distribution in 1 cm group of Greenland halibut in different localities, caught in research hauls for shrimp.

Fig. 4 continued

LOC. 6
N=1745

LOC. 7
N=2982

LOC. 8
N=1572

LOC. 9
N=11363

LOC. 10
N=26495
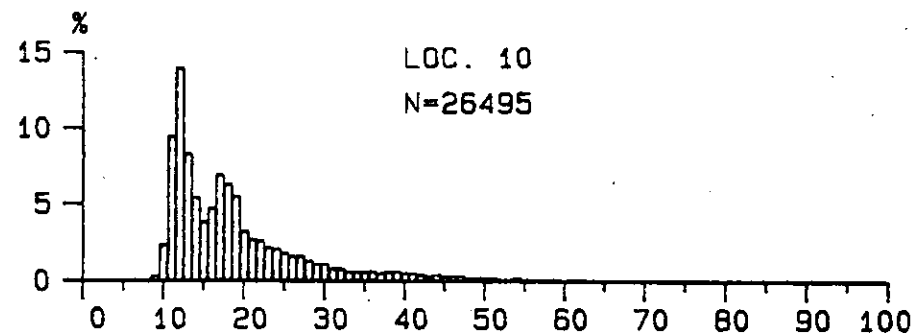
Fig.5. Percentage length distribution in 1 cm group of Greenland halibut in different quarters for loc. 3 and 4, caught in research hauls for shrimp.