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Distribution Pattern of Atlantic Wolffish (*Anarhichas lupus* L) and Spotted Wolffish (*A. minor* Olafsen) in Offshore Waters of Southwest Greenland

by

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Abstract

The distribution and length composition of Atlantic and spotted wolffish by depth,year and NAFO subarea is described on the basis of bottom trawl surveys carried out by the Federal Republic of Germany in the West Greenland area south of 67° N during 1982-84. Atlantic wolffish is the most abundant of the two species with the mean catch-per-hour-trawling generally decreasing from north to south. It occurs mainly in depths of 0-400 m. Spotted wolffish is uniformily distributed over the range of depth investigated and in the north/south direction. Both species tend to increase in mean length toward south and both show a decrease in CPUE during 1982-84. The results are discussed in relation to the assumption of life cycle of especially spotted wolffish in West Greenland waters.

Introduction

Three species of wolffish live in Greenlandic waters, namely : Atlantic wolffish (*Anarhichas lupus* L), spotted wolffish (*A. minor* Olafsen) and northern wolffish (*A. denticulatus* Krøyer). Only Atlantic and spotted wolffish are of commercial interest.

Little is known about the distribution and abundance of Atlantic and spotted wolffish in the West Greenland area. Some data have been reported on the depth and temperature related distribution (Beese and Kändler 1969) and on the more general distribution pattern in the West Greenland area (Smidt, 1981).

Based on bottom trawl surveys carried out by the Federal Republic of Germany this paper describes the distribution and length composition of Atlantic and spotted wolffish in the offshore area of West Greenland in 1982-84.

Materials and Methods

Catch data from the bottom trawl surveys off West Greenland 1982-84 has kindly been supplied for this analysis by the Bundesforchungsanstalt für Fischerei, Hamburg.

The area covered by the stratified-random bottom trawl surveys includes the West Greenland shelf outside the 3-mile limit and the continental slope down to 600 m depth, extending from the southern part of Div. 1B (south of 67°N) southward as illustrated in Fig. 1. All surveys are conducted in the autumn. Further information on trawl parameters are given by Cornus et al. (1985). The area is divided into 7 main strata equal to Div. 1B-F or parts thereof. Because of few hauls in stratum 4 the results from this stratum are pooled with the results of stratum 3. Each main stratum is subdivided by 200 m depth zones into 3 substrata. The strata coverage is shown in Table 1.

Catch data were analysed after logarithmic transformation and it was assumed that LOG(mean catch by number per hour trawling) were normally distributed. A full three-way ANOVA was used in the analysis. All main effects (year,strata and depth) were regarded as deterministic:

$$Y_{ijkl} = my + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + E_{l(ijk)}$$

where Y_{ijkl} = LOG(mean catch per hour trawling), my = general mean, A_i = year effect, B_j = strata effect, C_k = depth effect, AB_{ij} AC_{ik} BC_{jk} ABC_{ijk} = interactionseffects and E_{ijkl} = error

The model was successively reduced to include only effects significant at the 5% level.

Results

The trawl surveys clearly indicate that Atlantic wolffish is the dominant wolffish in all strata (Tables 2 and 3).

For Atlantic wolffish the three-way ANOVA on LOG(CPUE) gives significant (5%-level) effects of year, strata, depth and strata-depth interactions. There is no clear pattern in the interaction effect so it seems reasonably to reduce the model by excluding this. The effects were highly significant (1%-level) and the model explained 26% of the total variation.

The mean number caught in one-hour trawling (CPUE) is higher in year 1982 than in years 1983 and 1984 (Table 2) and a Newman-Keuls range test (Hicks, 1982) on mean LOG(CPUE) shows that this is significant (5%-level). Table 2 also shows a generel decreasing CPUE from north to south. However, it is only strata 7 which has a significantly lower mean LOG(CPUE) (Newman-Keuls range test). Mean CPUE by depth intervals shows no differences between 0-200 m and 2-400 m, but deeper than 400 m mean LOG(CPUE) was considerably lower (significant at 5%-level, Newman-Keuls range test).

Table 3 gives the mean catch-per-hour-trawling of spotted wolffish. Because of the generally low catches it is not adequate to make an analysis of variance but some general trends can be taken from the table. Figures for 1982 seem to bee higher than those for the two following year, as is also the case with Atlantic wolffish. The catch is rather uniform over depth and in a north/south direction. In all years strata 3+4 had the lowest CPUE among strata.

The mean length of Atlantic wolffish caught in the different strata and depths (all years pooled) is shown in Table 5. The mean fish length in different depth interval is almost the same although there is a small tendency to higher mean length of fish with depth. The mean length increases in a southern direction. This is due to a relative dominance of larger fish in the southern strata (Fig 3). In strata 1 and 2 fish of 20 to 40 cm dominate, while in strata 5, 6 and 7 it is fish from 50 to 60 cm.

Due to the small numbers caught it was necessary to pool years and depth when calculating mean length for spotted wolffish. There seems to be a tendency of higher mean length in the southern strata, especially between stratum 5 and stratum 7, the two strata with highest number of fish caught. Like for Atlantic wolffish almost all length groups are represented in each stratum but the proportion of larger fish is increasing towards south (Fig 4).

Discussion

The area of the bottom trawl surveys is selected to give a good coverage of the cod distribution and it is not optimal for a description of the distribution pattern of wolffishes. The survey area therefore covers only the southern part (south of 67° N) of the distribution area of Atlantic and spotted wolffish. Atlantic wolffish occur commenly along West Greenland from south to Disko Bay and the spotted wolffish is quite common from south to about 73° N, and is found occasionally so far north as 77.5 N.

In the offshore area investigated Atlantic wolffish is the most abundant of the species, with mean catch-per-hour-trawling occasionally exceeding 100 specimens (Table 2). Mean catch-per-hour-trawling of spotted wolffish never exceeds 10 specimens (Table 3). The ratio between the two species found in the present analysis is somewhat opposite to the composition in inshore waters where spotted wolffish is the dominant species according to Smidt (1980).

For both species there is a decline in catch-per-hour-trawling in the period of investigation, especially from 1982 to 1983. The reason for this declining abundance is not known. In the same period the annual catches of wolffish off Southwest Greenland is decreased (ICNAF Statistical Bulletin).

Atlantic wolffish becomes more abundant from south to north in the area of investigation, while there is no clear differenc in mean catch of spotted wolffish between strata.

Maximum mean-catch-per-hour-trawling of Atlantic wolffish was found in 0-400 m depths and with markedly reduced catches below 400 m. For spotted wolffish no depth interval seems to be prefered. The vertical distribution found of each species is in agreement with similar studies by Beese and Kändler (1969).

For both species the mean length of fish increases from north to south. All strata have approximately the same range in length of fish but the length frequencies differ between strata. Increasing mean length in a north/south direction has been found ealier for spotted wolffish in inshore waters (Hansen, 1959) combined with larvae distribution data this led to the hypothesis (Hansen, 1968) that the larvae are carried by the West Greenland current to nursery grounds in northern waters where they grow and later migrate back to more southern spawning grounds. Tagging experiments of spotted wolffish indicate, however, that this species is rather stationary with few long-range migrations (Riget, F., this meeting). It might therefore be necessary to look for other explanations for the observed length distribution pattern. The most important fishery for wolffish is in the northern part of the area , and this may affect the length distribution by harvesting large fish mainly. There may also be differences in growth rate due to climatic and hydrographic conditions, may influence the size distribution.

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Table 1.
Distribution of number of trawl hauls on strata, depth intervals and years.

	year 1982	1983	1984	total
stratum 1				38
0-200 m	8	5	11	
2-400 m	4	2	5	
4-600 m	1	0	2	
stratum 2				36
0-200 m	5	9	11	
2-400 m	3	2	2	
4-600 m	1	1	2	
stratum 3+4				91
0-200 m	12	21	14	
2-400 m	6	10	9	
4-600 m	3	6	10	
stratum 5				103
0-200 m	17	25	26	
2-400 m	7	13	10	
4-600 m	2	1	2	
stratum 6				73
0-200 m	10	18	20	
2-400 m	7	8	8	
4-600 m	0	0	2	
stratum 7				93
0-200 m	18	20	25	
2-400 m	5	11	9	
4-600 m	2	0	3	
total	121	152	171	

Table 2.

Mean number of Atlantic wolffish per hour trawling by strata, depth and year.

1982

stratum / depth	1	2	3+4	5	6	7	total
0-200 m	92	72	72	74	48	16	57
2-400 m	87	243	58	122	28	31	82
4-600 m	6	0	8	22	-	0	8
total	84	121	59	83	40	18	60

1983

stratum / depth	1	2	3+4	5	6	7	total
0-200 m	116	40	37	39	39	15	38
2-400 m	7	131	81	28	15	15	38
4-600 m	-	0	1	0	-	-	1
total	85	52	43	34	32	15	36

1984

stratum / depth	1	2	3+4	5	6	7	total
0-200 m	75	35	35	29	35	16	31
2-400 m	7	129	22	13	16	18	22
4-600 m	0	5	1	4	0	0	1
total	43	44	21	23	28	15	25

Table 3.

Mean number of spotted wolffish per hour of trawling by strata, depth and years.

1982

stratum / depth	1	2	3+4	5	6	7	total
0-200 m	6	1	1	8	3	5	5
2-400 m	7	4	1	8	1	9	5
4-600 m	2	15	3	9	-	0	5
total	6	4	1	8	2	6	5

1983

stratum / depth	1	2	3+4	5	6	7	total
0-200 m	4	2	0	3	2	8	3
2-400 m	0	2	1	0	2	3	1
4-600 m	-	0	2	0	-	-	1
total	3	2	1	2	2	6	3

1984

stratum / depth	1	2	3+4	5	6	7	total
0-200 m	2	2	0	4	2	4	3
2-400 m	3	3	1	1	1	2	1
4-600 m	0	1	1	2	1	2	1
total	2	2	1	3	2	3	2

Table 4.
Atlantic wolffish.
Variance table for a reduced model of LOG(CPUE).

effect	Sum of squares	Degrees of freedom	Mean squares	F	pr>F	R^2
Model	282.6	10	28.3	14.3		0.26
Year	37.3	2	18.7	9.5	0.0001	
Strata	47.7	5	8.0	4.9	0.0003	
Depth	197.6	2	98.8	50.2	0.0001	
Error	817.0	414	2.0			

Table 5.
Mean fish length in different strata and depth intervals.
` calculated on basis of >100 fish.

Atlantic wolffish

Stratum	1	2	3+4	5	6	7	total
depth 0-200 m	38.2	35.8	36.8	47.0	42.6	45.8	41.5
2-400 m	36.1	36.3	45.6	49.6	45.6	46.6	44.5
4-600 m	52.0`	38.0`	45.2`	51.0`	67.0`	65.0`	47.9`
total	37.9	36.0	40.3	47.8	43.1	46.1	-

Spotted wolffish

Stratum	1	2	3+4	5	6	7
total	65.9`	62.6`	47.6`	65.4	66.1`	71.7

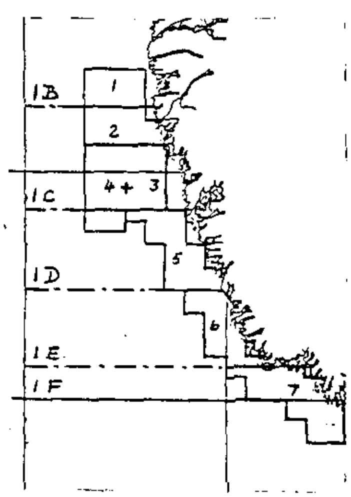
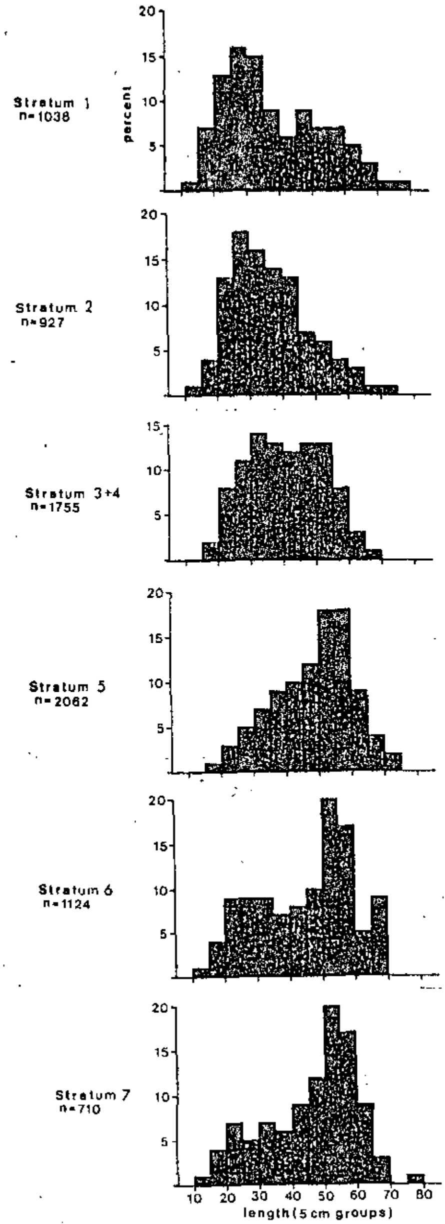
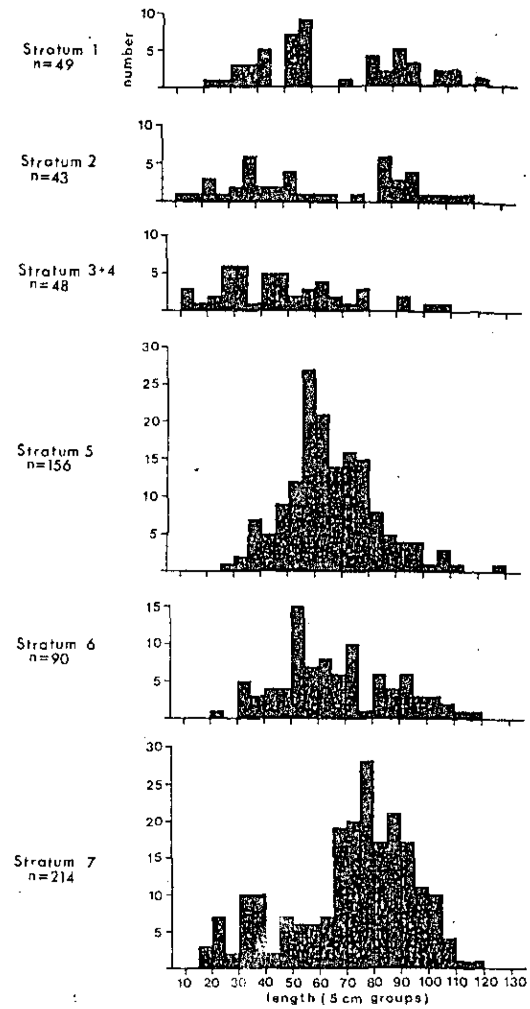


Fig 1 : Map of survey areas and stratification off West Greenland. Numbers indicate the stratum. (from Cornus et al., 1985)





<u>Fig 3</u> : Length frequencies in 5 cm groups of spotted wolffish from different strata.
n = number of fish.

<u>Fig 2</u> : Percentage length distribution in 5 cm groups of Atlantic wolffish from different strata.
n = number of fish.