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Distribution, Abundance and Migration of Atlantic Wolffish (*Anarhichas lupus*) and Spotted Wolffish (*Anarhichas minor*) in West Greenland*

by

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Abstract

Data from stratified-random bottom trawl surveys in NAFO Subarea 1, 1982-86, were used to estimate the offshore abundance and biomass of Atlantic wolffish (*Anarhichas lupus* L.) and spotted wolffish (*Anarhichas minor* Olafsen). In addition, the distribution pattern of the two species is described. The survey results indicate a decline in biomass and abundance of both species during the period of observations.

Atlantic wolffish is the most abundant of the two species with mean catch-per-hour of trawling generally decreasing from north to south. This species occurs mainly in depths from 0 to 400 m. Spotted wolffish is uniformily distributed over the range of depths investigated and in a north/south direction. Mean lengths of both species tend to increase towards the south.

Tagging data from the years 1955-64 (174 Atlantic wolffish and 679 spotted wolffish) were used to describe the migration of the two species. From these experiments 2 and 53 recaptures, respectively were reported. The recaptures generally showed short-distance migrations. For spotted wolffish few cases of long-distance migration were observed. Returns of spotted wolffish in the Nuuk area are discussed in the light of results of some longline catches and seem to indicate local seasonal migrations.

Introduction

Three species of wolffish are found in Greenland waters: 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

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Greenland area, although some data on the more general distribution pattern (Smidt, 1981) and on the depth and temperature related distribution (Beese and Kändler, 1969) are available.

More data are available from other parts of the North Atlantic. For the Newfoundland area, studies on distribution and abundance for both species were reported by Albikovskaya (1982) and on migrations from tagging by Templeman (1984). Furthermore, Templeman (1986a, 1986b) described the biology of the two species in the Northwest Atlantic. In Iceland waters, Jonsson (1982) studied the biology of Atlantic wolffish, partly based upon tagging experiments. Barsukov (1959) described the biology of both species in the Barents Sea, and Østvedt (1963) dealt with spotted wolffish in the northern Norwegian and Barents Sea areas.

The present paper describes the distribution, abundance and migration of Atlantic and spotted wolffish in West Greenland waters based on bottom-trawl surveys, experimental longline fishing and tagging experiments.

Materials and Methods

Stratified-random bottom-trawl surveys were carried out in late autumn between mid-October and mid-December of 1982-86 by research vessels from the Federal Republic of Germany. The surveys were especially designed to cover the present distribution of cod off West Greenland comprising the offshore areas of Subarea 1 south of 67°N outside territorial waters to a depth of 600 m. However, wolffish are known to be distributed considerably further north than the northern border of the survey area and also within territorial waters. Consequently, the survey results only deal with part of the stocks. The survey area was divided into 7 main strata which correspond to parts of Div. 1B-1F (Fig. 1). Each main stratum was subdivided into 3 substrata by 200 m depth contours. Strata areas in nautical square miles and coverage by number of sets in 1982-86 are given in Table 1. Further information on trawl parameters are given by Horsted (1986), which also includes the methods by which survey abundance and biomass estimates for wolffish were calculated. All length measurements were taken as total length to the cm below.

Catch data were analysed further after logarithmic transformation 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 (number-per-hour trawling + 1), my = overall mean, A_i = year i effect, B_j = strata j effect, C_k = depth k effect and $E_{l(ijk)}$ = error.

During the 1955-64 period, a total of 174 Atlantic wolffish and 679 spotted wolffish were tagged at several localities along the West Greenland coast between 61°N and 72°N. Tagging of Atlantic wolffish was carried out in Nuuk, Manitsoq and Sisimiut districts, while tagging of spotted wolffish was carried out mainly in four areas: Nuuk, Manitsoq and Sisimiut, Disko Island and Upernavik Kujalleq (Fig. 1).

Fish for tagging were obtained from longline catches. The fish were tagged with Petersen discs.

Catches of spotted wolffish from 268 longline sets (approximately 350,000 hooks) by Greenland Fisheries Investigation in the Nuuk area in the period 1955-79 have been analysed. For the analysis, the fishing operations were grouped according to the location: offshore, inshore and fjords (see Fig. 7). The depth range was 60-360 m.

Results

Distribution pattern in the survey area

Table 1 shows mean numbers of Atlantic and spotted wolffish per hour of trawling by year, strata and depth.

Atlantic wolffish

An ANOVA analysis was applied to the catch data for Atlantic wolffish after logarithmic transformation of the data. The ANOVA shows significant ($P < 0.01$) effects of year, strata and depth and the model explains 24% of the total variation (Table 2). A Newman-Keuls range test (Hicks, 1982) on mean LOG(CPUE+1) gives a significant ($P < 0.05$) higher value for 1982 than for the following years, whereas no significant difference in abundance was evident among the years 1983, 1984, 1985 and 1986. There is a general decrease in the catch rates from north to south (Table 1). However, the range test showed only stratum 7, the southernmost area considered, to have a significantly ($P < 0.05$) lower value. With regard to depth intervals, there was no difference between the 0-200 m and the 200-400 m intervals, but the range test showed a significantly ($P < 0.05$) lower abundance value for the deepest stratum (>400 m).

Length distributions of Atlantic wolffish during the surveys in the different strata are shown in Fig. 2. The number of fish measured was usually the same each year and contributes equally to length distribution in the strata. The length distributions in the northern area (stratum 1 and 2) were almost alike and were dominated by fish of 25 and 40 cm length. Southwards the proportion of larger fish increased, and in stratum 7 the length distribution peaked at fish lengths of 45-55 cm. The length distributions do not differ much between depth intervals, although there is a slight tendency toward larger fish in the 400-600 m depth intervals.

Spotted wolffish

The catches of spotted wolffish were generally so low that it was not justified to do an analysis of variance. However, some general trends in distribution were evident (Table 1). The mean CPUE values generally were to be higher in 1982 than in the following years. There was no general trends in a north-south direction. The lowest mean CPUE in all years were in stratum 3 + 4 and stratum 6. The catch rate was rather uniformly depth interval.

Due to the small catches, it was necessary to pool data from the different years and depths when calculating the length distribution (Fig. 3). As in the case of Atlantic wolffish, almost all length groups are represented in each stratum, but the proportion of larger fish increased toward the south, especially stratum 5 and stratum 7, where the highest number of fish were caught.

Biomass and abundance during 1982-86

Atlantic wolffish is the dominant wolffish species in the West Greenland area (Table 3, Fig. 4 and 5). The biomass of Atlantic wolffish is approximately double that of spotted wolffish, and the abundance of Atlantic wolffish about 15 times as high as that of spotted wolffish.

For Atlantic wolffish, the survey results show that biomass declined rapidly (75%) from 28,000 tons in 1982 to only 7,000 tons in 1984 and has remained at this low level since then. Abundance declined during the same period, to a less extent than did biomass, indicating a change in length composition (Fig. 6). While fish of 45 to 60 cm dominated in 1982, the dominating group in the following years was considerably smaller. Since 1984 the length distribution mode again tends to increase.

Biomass and abundance levels of spotted wolffish revealed a similar decline during the period, in particular as far as biomass is concerned. Unfortunately the catches of spotted wolffish were too small to allow comparisons of length distribution in the different years.

Migration

Only two recaptures of Atlantic wolffish out of 174 tagged fish have been reported. Both fish were tagged in the inshore area at Nuuk and they were recaptured about 2 years later near the tagging area. At the time of tagging the two fish measured 72 and 74 cm respectively.

Data on the 53 reported recaptures of spotted wolffish are summarized in Table 4. The place of recapture is unknown or uncertain in 19% of the cases. Likewise for some fish, the time of recapture is uncertain. The period between the time of tagging and the time of recapture varied from 1 day to 13 years. However, 88% of the recaptures were made more than half a year after tagging.

Most of the recaptures (67%) were made within 10 n. miles of the tagging area (Table 4). Only 5 fish migrated more than 60 n. miles, 3 in a southern direction, 1 in a northern and 1 in an eastern (inshore) direction. No evident relationship between distance migrated and the time spent at sea is seen.

In the Nuuk area where most data were obtained, spotted wolffish were tagged mainly in the outer Godthåb Fjord (Fig. 7). Out of a total of 19 fish, 8 were recaptured less than 10 n. miles from the tagging locality, 6 were recaptured from 15 to 60 n. miles from the tagging site inshore in Godthåb Fjord, 4 were recaptured from 15 to 20 n. miles south and west of Nuuk, while 1 was recaptured 110 n. miles north of Nuuk. The relatively many recaptures in an inshore direction may be interpreted as a local migration pattern.

It is not possible to detect any seasonal movement on the basis of the tagging experiments; therefore, an analysis of longline experiments carried out in different months in the Nuuk area were performed. The analysis shows a marked peak in mean catch per 100 hooks (CPUE) in the inshore area in June, and in the fjords a similar peak occurs in July (Fig. 8). This indicates an inshore migration in the summer. In the offshore area, there seems to be no difference in CPUE between the months of investigation.

Discussion

The research vessel surveys covered only a part of the area of distribution of the two species. Within the survey area, Atlantic wolffish was found to be more abundant and abundance increased from south to north. It is known that Atlantic wolffish are even more abundant north of the survey area, especially in Disko Bay. Maximum mean catch of Atlantic wolffish per hour trawling was found in the depth range 0-400 m with a significant reduction in catch rates below 400 m.

Within the survey area, there is no clear difference in mean catch rate for spotted wolffish between strata. Spotted wolffish is the dominant species in inshore waters (Smidt, 1980) along West Greenland from south to about 73°N. Spotted wolffish does not seem to prefer any particular depth interval within the survey area. The observed vertical distribution of each species is in agreement with observations by Beese and Kändler (1969).

Biomass and abundance of both species declined during the period of investigation. For Atlantic wolffish, the decline in biomass occurred especially during the period from 1982 to 1984, together with a change in length distribution, whereby rather large fish dominated in 1982 while smaller fish dominated in 1985 and 1986. The reasons for this change in biomass and length distribution are unknown. However, it seems unlikely that the offshore commercial trawl fishery, exerting a relatively low and even decreasing level of fishing effort during the same period, could have contributed significantly to the observed changes. Since 1984, the biomass remained at the same low level. Abundance, however, increased somewhat due to increased recruitment of younger fish. This can also be seen by a shift in mode of the length distribution since 1984 (Fig. 6).

The mean lengths of both species increased from north to south. All strata showed approximately the same range in length of fish but the length frequencies differed between strata. Increasing mean length in a north-south direction had been found earlier for spotted wolffish in inshore waters (Hansen, 1959).

Only two recaptures from 1874 tagged Atlantic wolffish were reported. Judged from their size, the two fish were probably mature at the time of tagging. These two specimens, were very stationary although, theoretically, they may have undertaken longer migrations in the 2 years they spent in the sea as tagged fish.

The reported recaptures of spotted wolffish indicate that this species may be considered to be mainly stationary, although some examples of long distance migration were found.

Although the number of recaptures is small, the conclusions from the tagging experiments in West

Greenland waters are similar to those reported by Østvedt (1963) from tagging experiments in the Barents Sea and by Templeman (1984) for the Newfoundland area.

The tagging experiments in the outer Godthåb Fjord show 6 recaptures out of a total of 19 in an inshore direction from the tagging area. The recaptures were made between 8 and 121 months after tagging. These results indicate an inshore migration, although the possibility of bias in the distribution of fishing effort should be taken into consideration. The CPUE values from longline fishing peaked in June in the inshore area and in July in the fjords. This may be interpreted as a seasonal movement to the inner area in the summer.

Hansen (1968) put forward the theory that adult spotted wolffish live chiefly in the southern part of West Greenland waters from where they propagate. He further suggested that the larvae in the southern area seek the surface and are carried by the current towards the north where they settle to the bottom. When reaching maturity, they migrate to the southern spawning grounds. This theory was based partly on differences in length distribution which were observed in fishing experiments along West Greenland and partly on the occurrence of wolffish larvae in the plankton.

The increasing mean length of spotted wolffish in a north-south direction from this study is in agreement with Hansen's (1968) theory, and this theory could be valid for Atlantic wolffish as well. However, in this study, the migration pattern for spotted wolffish in particular does not give support to the theory. The tagging experiments indicate that spotted wolffish are rather stationary, with few examples of long distance migration, but there was some indication of minor seasonal and local movements.

It might, therefore, be necessary to look for other explanations of 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 mainly the large fish. There may also be differences in growth rate along West Greenland.

Templeman (1986b) found that the maximum length of Atlantic wolffish increases in a southern direction in the Northwest Atlantic due to the onset of maturity at a considerably smaller fish size in the northern part. It could be valid for wolffish in Greenland waters too, but no data on sexual maturity are available.

References

ALBIKOVSKAYA, L. K. 1982. Distribution and abundance of Atlantic wolffish, spotted wolffish and northern wolffish in the Newfoundland area. NAFO Sci. Coun. Studies, 3: 29-32.

BARSUKOV, W. W. 1959. Wolffishes family (Anarhichadidae). Fauna USSR, 5(5): 1-171 (in Russian). [English transl. 1972. The wolffish (Anarhichadidae iii + 292).]

BEESE, G., and R. KÄNDLER. 1969. Beitrage zur Biologie der drei nord atlantischen Katfischenarten *Anarhichas lupus* L., *A. minor* Olafs. und *A. denticulatus* Krøyer. Ber. Dtsch. Wiss. Komm.

Meeresforsh., N.F., 20: 21-59.

HANSEN, P. M. 1959. Spotted wolffish, Anarhichas minor. Ann. Biol. (1957), 14: 40 p.

1968. Report on wolffish larvae in West Greenland waters. ICNAF Spec. Publ., No. 7. Environmental Surveys. NORWESTLANT 1-3, 1963 Part I: 183-185.

HICKS, C. R. 1982. Fundamental concepts in design of experiments. (3rd Ed.) New York: Holt, Rinehart and Winston.

HORSTED, Sv. Aa. 1986. Status of Subarea 1 cod and the fisheries (An extract of the Report of the ICES Working Group on cod stocks off East Greenland, January 1986). NAFO SCR Doc., No. 55, Serial No. N1172, 19 p.

JONSSON, G. 1982. Contribution to the biology of catfish (Anarhichas lupus) at Iceland. Rit. Fiskideild 6(4): 3-26.

SMIDT, E. 1980. The wolffish fishery at West Greenland. NAFO Sci. Coun. Studies, 1: 35-39.

TEMPLEMAN, W. 1984. Migrations of wolffishes, Anarhichas sp., from tagging in the Newfoundland area. J. Northw. Atl. Fish. Sci., 5(1): 93-97.

1986a. Contribution to the biology of the spotted wolffish (Anarhichas minor) in the Northwest Atlantic. J. Northw. Atl. Fish. Sci., 7(1): 47-55.

1986b. Some biological aspects of Atlantic wolffish (Anarhichas lupus) in the Northwest Atlantic. J. Northw. Atl. Fish. Sci., 7(1): 57-65.

ØSTVEDT, O. J. 1963. On the life history of the spotted wolffish (Anarhichas minor Olafsen). Fiskeridirektoratets skrifter, Serie Havundersogelser, 13(6): 54-72.

Table 1. Mean number of Atlantic wolffish and spotted wolffish per-hour-trawling by strata. (n = number of trawl hauls).

		Atlantic wolffish										Spotted wolffish									
	Area (nm²)	Year 1982	(n)	1983	(n)	1984	(n)	1985	(n)	1986	(n)	1982	(n)	1983	(n)	1984	(n)	1985	(n)	1986	(n)
Stratum 1																					
0-200 m	2,121	92	(8)	98	(6)	75	(5)	9	(4)	27	(8)	6	(8)	3	(6)	2	(5)	3	(4)	7	(8)
2-400 m	506	87	(4)	4	(1)	7	(2)	68	(2)	50	(5)	7	(4)	0	(1)	3	(2)	11	(2)	12	(5)
4-600 m	364	6	(1)	-	(0)	0	(2)	-	(0)	0	(3)	2	(1)	-	(0)	0	(2)	-	(0)	0	(3)
Stratum 2																					
0-200 m	2,167	72	(5)	46	(7)	43	(9)	-	(0)	39	(10)	1	(5)	3	(7)	3	(9)	-	(0)	4	(10)
2-400 m	313	117	(3)	131	(2)	129	(2)	-	(0)	158	(1)	6	(3)	2	(2)	3	(2)	-	(0)	0	(1)
4-600 m	415	0	(1)	0	(1)	5	(2)	-	(0)	1	(3)	0	(1)	0	(1)	1	(2)	-	(0)	1	(3)
Stratum 3+4																					
0-200 m	2,517	79	(12)	39	(21)	30	(13)	78	(7)	52	(12)	1	(12)	0	(21)	0	(13)	1	(7)	1	(12)
2-400 m	1,062	69	(6)	81	(10)	22	(9)	79	(6)	44	(4)	2	(6)	1	(10)	1	(9)	1	(6)	3	(4)
4-600 m	412	8	(3)	2	(3)	1	(10)	1	(3)	3	(2)	3	(3)	3	(3)	1	(10)	1	(3)	1	(2)
Stratum 5																					
0-200 m	2,350	74	(17)	39	(25)	29	(26)	32	(27)	50	(26)	8	(17)	3	(25)	4	(26)	2	(27)	2	(26)
2-400 m	1,018	122	(7)	28	(13)	13	(10)	23	(11)	28	(11)	8	(7)	0	(13)	1	(10)	0	(11)	2	(11)
4-600 m	259	22	(2)	-	(0)	4	(2)	0	(2)	0	(3)	9	(2)	-	(0)	2	(2)	0	(2)	1	(3)
Stratum 6																					
0-200 m	1,938	48	(10)	39	(19)	36	(19)	27	(19)	38	(18)	3	(10)	2	(19)	2	(19)	1	(19)	2	(18)
2-400 m	742	33	(6)	11	(7)	7	(7)	54	(9)	37	(7)	1	(6)	2	(7)	1	(7)	2	(9)	1	(7)
4-600 m	57	-	(0)	-	(0)	0	(1)	-	(0)	0	(1)	-	(0)	-	(0)	2	(1)	-	(0)	2	(1)
Stratum 7																					
0-200 m	2,568	18	(16)	16	(19)	16	(23)	18	(23)	16	(19)	6	(16)	8	(19)	4	(23)	2	(23)	3	(19)
2-400 m	971	39	(4)	15	(10)	20	(8)	37	(9)	22	(8)	12	(4)	3	(10)	2	(8)	2	(9)	2	(8)
4-600 m	353	-	(0)	-	(0)	0	(2)	0	(1)	0	(1)	-	(0)	-	(0)	0	(2)	0	(1)	4	(1)
TOTAL	20,133		(105)		(144)		(152)		(123)		(142)		(105)		(144)		(152)		(123)		(142)

Table 2. Atlantic wolffish variance table for a model of LOG(CPUE + 1) (see text).

	sum of squares	degrees of freedom	mean squares	F	pr> F	R^2
Model	381.3	11	34.7	19.0		0.24
Year	61.5	4	15.4	8.4	0.0001	
Strata	38.5	5	7.7	4.2	0.0010	
Depth	281.3	2	140.7	77.1	0.0001	
Error	1185.4	650	1.8			

Table 3.. Wolffishes - West Greenland, bottom trawl survey results, 1982 - 1986.

year	cruise Nr.	weighted mean catch kg/30'	biomass estimate to	mean density to/nm²	confidence interval ±%	weighted mean catch nos./30'	abundance estimate nos.x10-3	mean density nos./nm²	confidence interval ±%	average weight kg
Atlantic wolffish (*Anarhichas lupus* L.)										
1982	WH 55	38.021	28 257	1.423	31.96	32.784	24 365	1 227	22.91	1.160
1983	WH 62	17.944	13 336	0.671	32.30	21.897	16 274	819	31.00	0.819
1984	AD 137	9.381	7 066	0.351	25.65	14.620	11 013	547	29.49	0.642
1985	WH 71	10.060	7 578	0.376	27.29	20.924	15 769	783	31.16	0.481
1986	WH 77	9.741	7 337	0.364	21.92	16.899	12 730	632	27.03	0.576
Spotted wolffish (*Anarhichas minor* Olafsen)										
1982	WH 55	12.426	9 235	0.465	40.53	2.414	1 794	90	27.40	5.148
1983	WH 62	8.389	6 235	0.314	41.60	1.359	1 010	51	35.00	6.173
1984	AD 137	5.374	4 048	0.201	31.30	1.093	823	41	25.15	4.919
1985	WH 71	2.751	2 072	0.103	37.77	0.952	717	36	47.76	2.890
1986	WH 77	5.197	3 914	0.194	32.37	1.426	1 074	53	24.42	3.644

Table 4. Recaptures of spotted wolffish tagged at West Greenland in the period 1955-64 showing time spent from date of tagging to date of recapture, and distance as well as direction of tagging and location of recapture.

Time year	Distance n.miles	Direction	Tagging locality	Length at tagging cm
6.2	420	south	Sisimiut	68
13.0	120	south	Upernavik Kujaleq	66
2.9	110	north	Nuuk	110
1.3	70	south	South of Sisimiut	94
1.3	60	inshore	Nuuk	104
1.9	20	inshore	Nuuk	92
0.8	20	south	Nuuk	108
1.8	20	south	Nuuk	93
10.1	20	inshore	Nuuk	105
1.9	20	inshore	Nuuk	86
0.8	15	inshore	Nuuk	99
1.8	15	south	Nuuk	109
0.8	15	inshore	Nuuk	97
2.1	15	south	Disko	84
1.1	<10		Nuuk	127
0.8	<10		Nuuk	111
1.4	<10		Nuuk	103
0.8	<10		Nuuk	93
6.8	<10		Nuuk	101
4.8	<10		Nuuk	93
5.7	<10		Nuuk	97
6.5	<10		Nuuk	74
0.3	<10		Nuuk	91
0.5	<10		Marmoralik	64
1.4	<10		Maniitsoq	71
2.6	<10		Upernavik Kujaleq	52
0.7	<10		Upernavik Kujaleq	79
1 day	<10		Upernavik Kujaleq	76
1-9 days	<10		Upernavik Kujaleq	71
2 ?	<10		Disko	70
1.0	<10		Disko	67
1.1	<10		Disko	95
23 days	<10		Disko	73
17 days	<10		Disko	76
28 days	<10		Paamiut	113
1.5	<10		Maniitsoq	93
1.7	<10*		Upernavik Kujaleq	68
1.7	<10*		Upernavik Kujaleq	62
1.6	<10*		Upernavik Kujaleq	53
2.0	<10*		Upernavik Kujaleq	67
3.9	<10*		Disko	78
4.0	?		Sisimiut	81
4.0 ?	?		West of Sisimiut	83
3.7	?		South of Sisimiut	86
3.0 ?	?		South of Sisimiut	85
6.0	?		Disko	107
6.4	?		Nuuk	102
2.2	?		Nuuk	101
1.3	?		Nuuk	82
5.9	?		Nuuk	74
2.9	?		Nuuk	97
0.8	?		Nuuk	70
1.9	?		Nuuk	76

*Distance probably less than 10 n.miles.

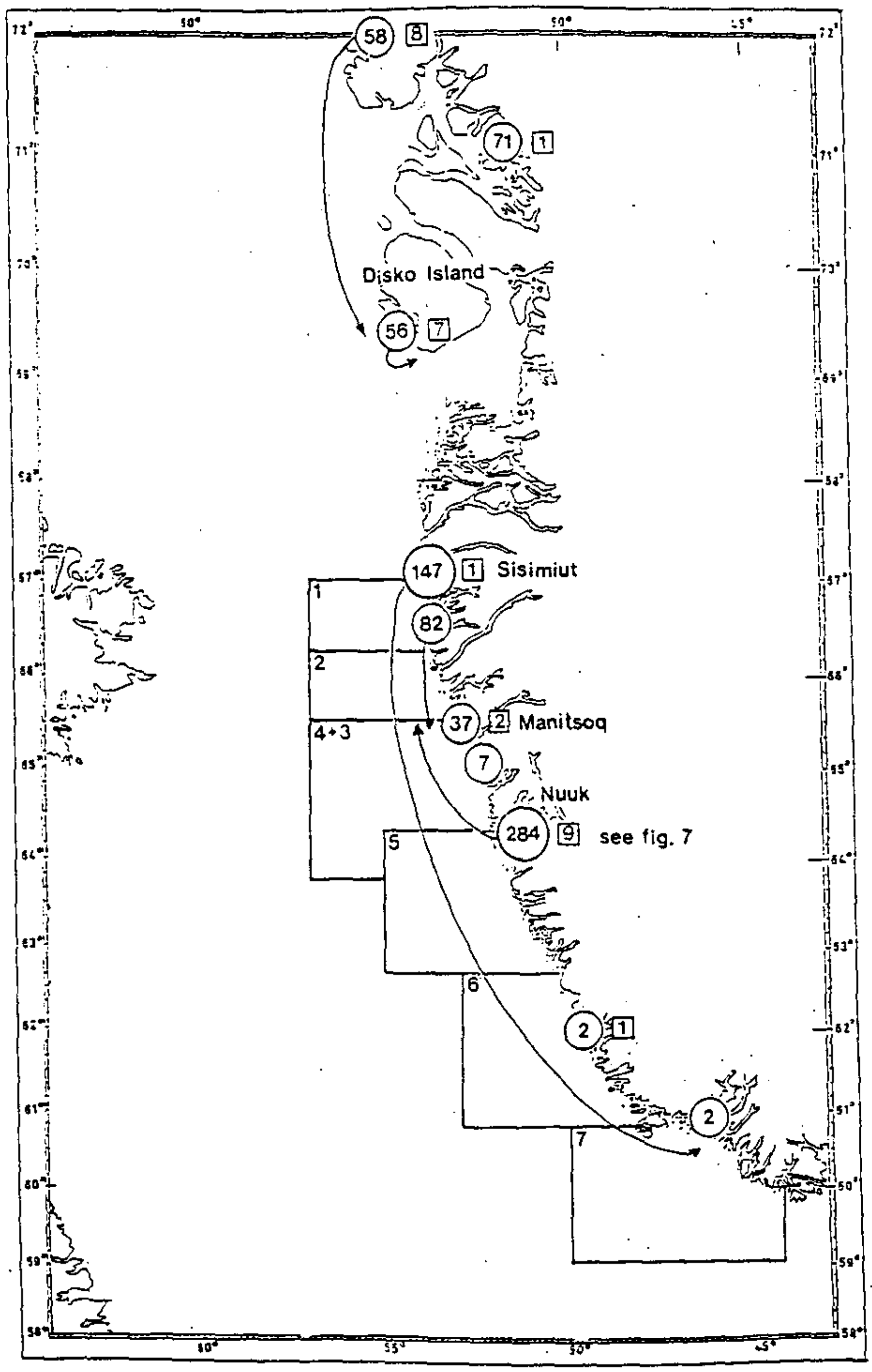
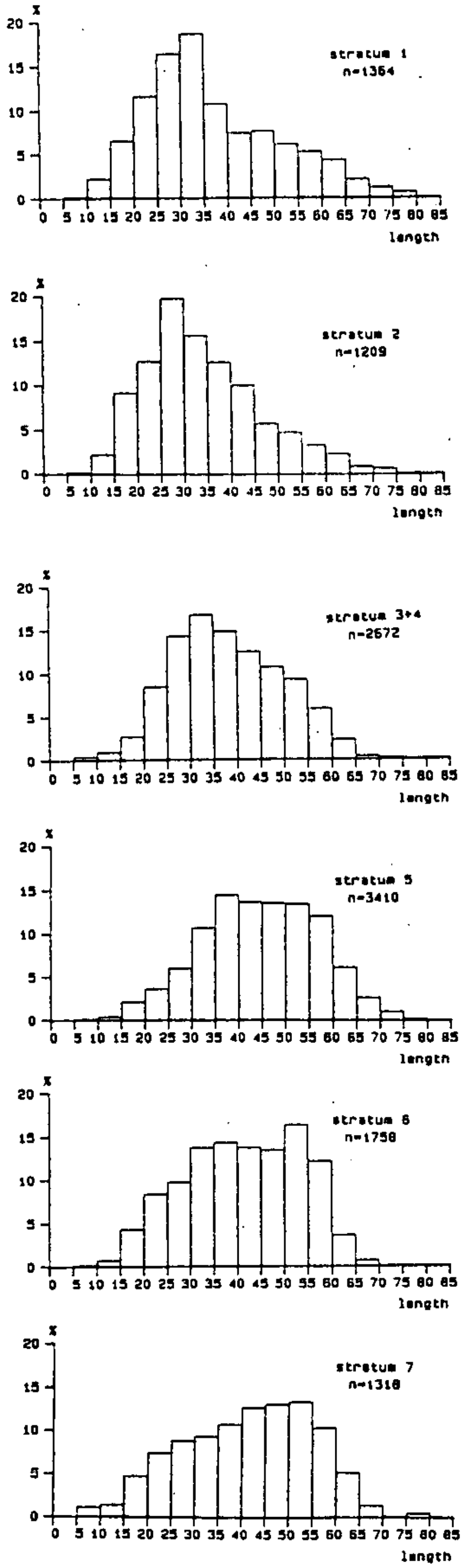


Fig. 1 : Map of the survey area off West Greenland. Numbers indicate the stratum used in the trawl surveys by the Federal Republic of Germany.

Migrations of spotted wolffish. (Circles are tagging sites with number of fish tagged, squares with numbers represent fish recaptured < 10 n.miles from tagging locality and tips of arrows are location of other recaptures).



<u>Fig. 2</u> : Percentage length distribution in 5 cm groups of Atlantic wolffish in different strata at West Greenland, caught in trawl surveys 1982-86. n=number of fish.

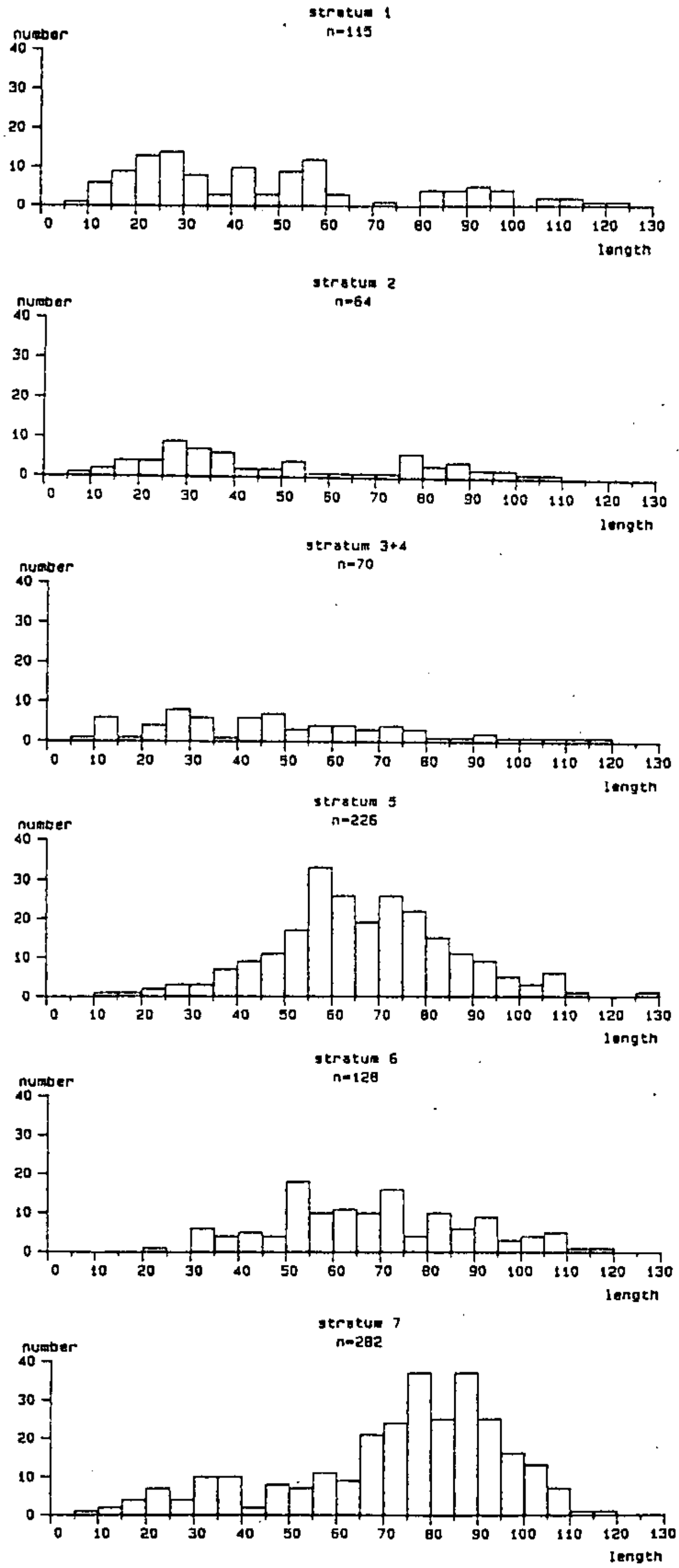


Fig. 3 : Length frequencies by 5 cm groups of spotted wolffish from different strata at West Greenland, caught in trawl surveys 1982-86. n=number of fish.

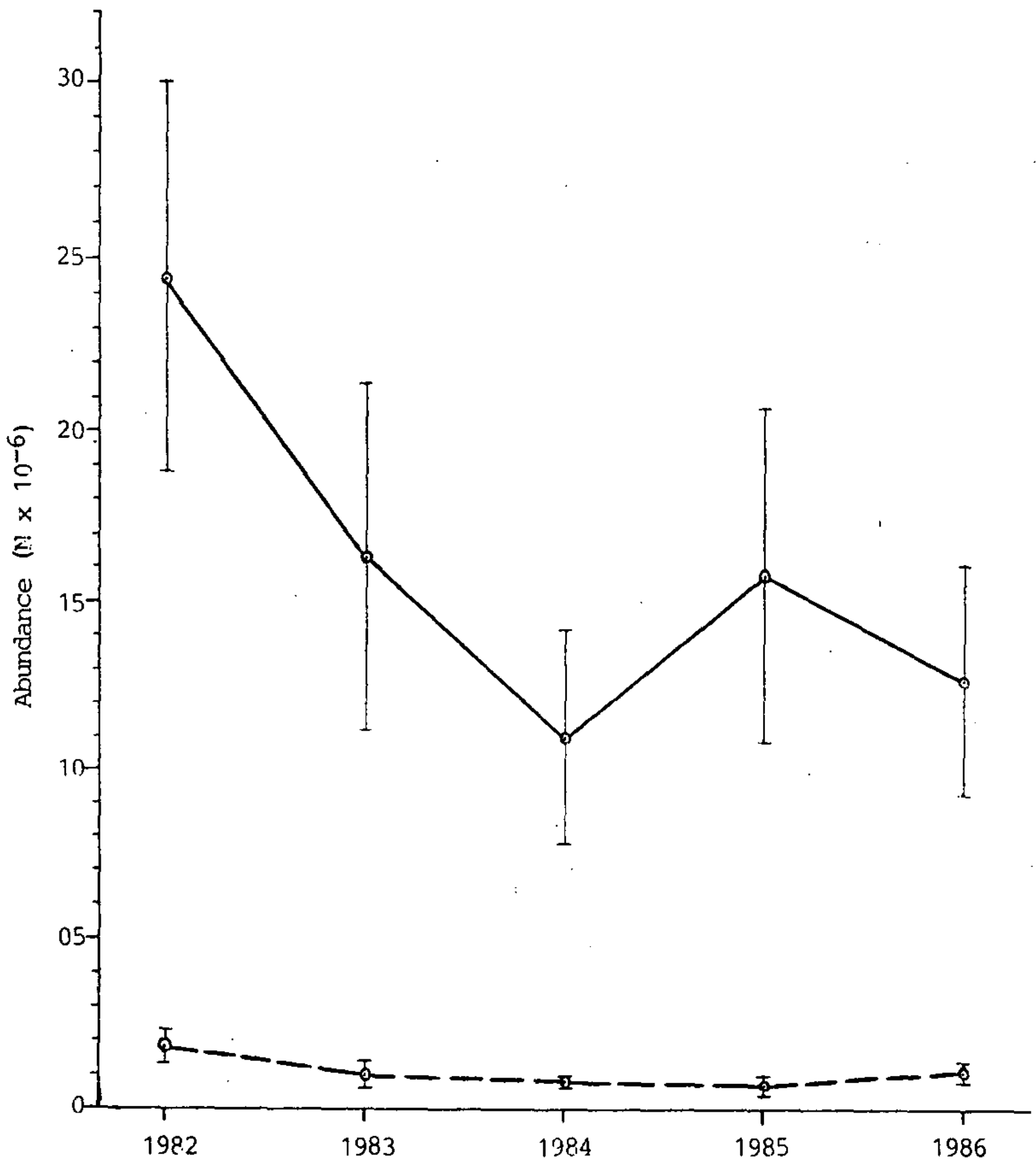


Figure 4. Wolffishes - West Greenland: Trends in survey abundance estimates with confidence intervals for Atlantic wolffish (solid line) and Spotted wolffish (broken line), 1982-86.

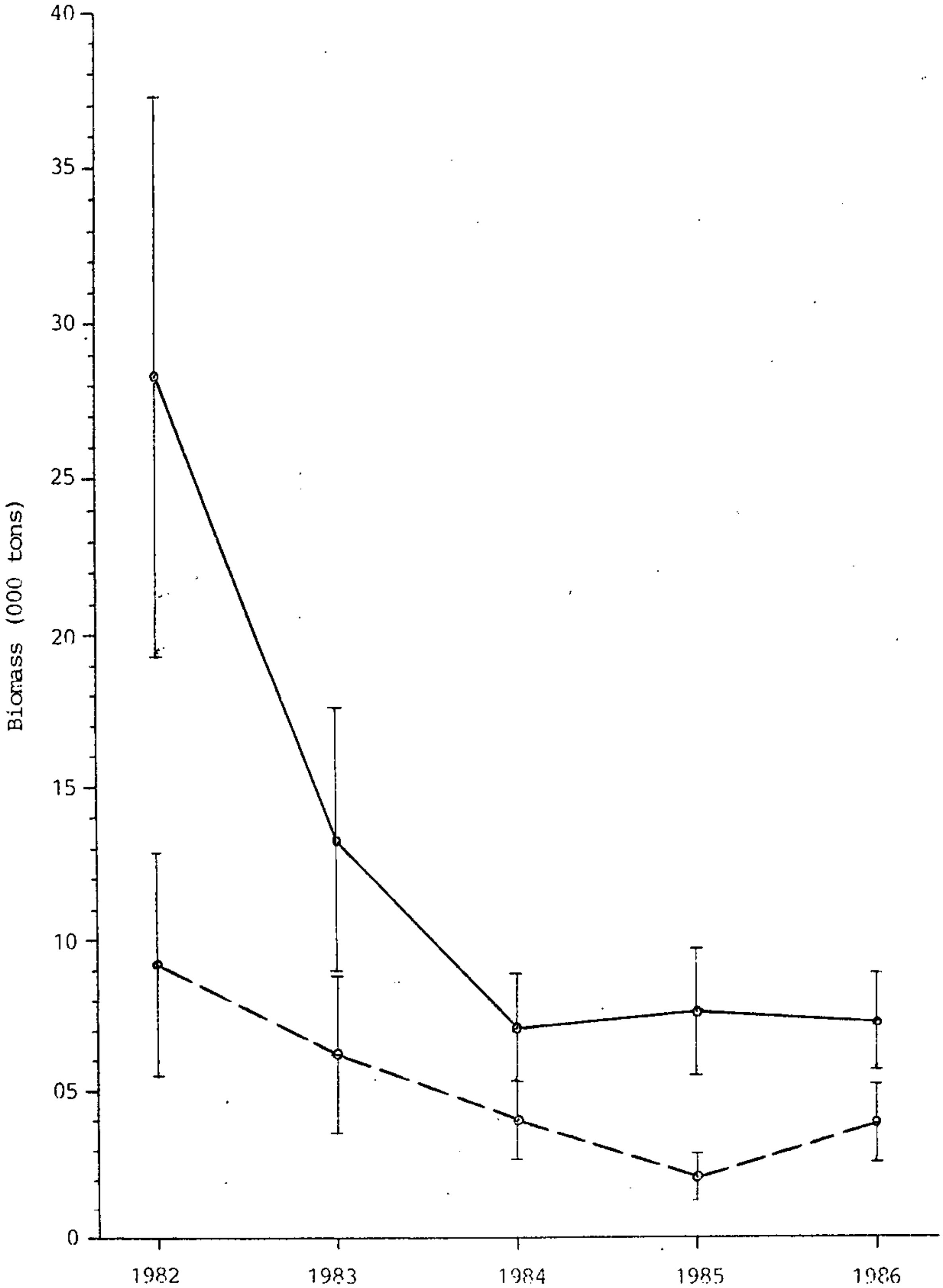


Figure 5. Wolffishes - West Greenland: Trends in survey biomass estimates with confidence intervals for Atlantic wolffish (solid line) and Spotted wolffish (broken line), 1982-86.

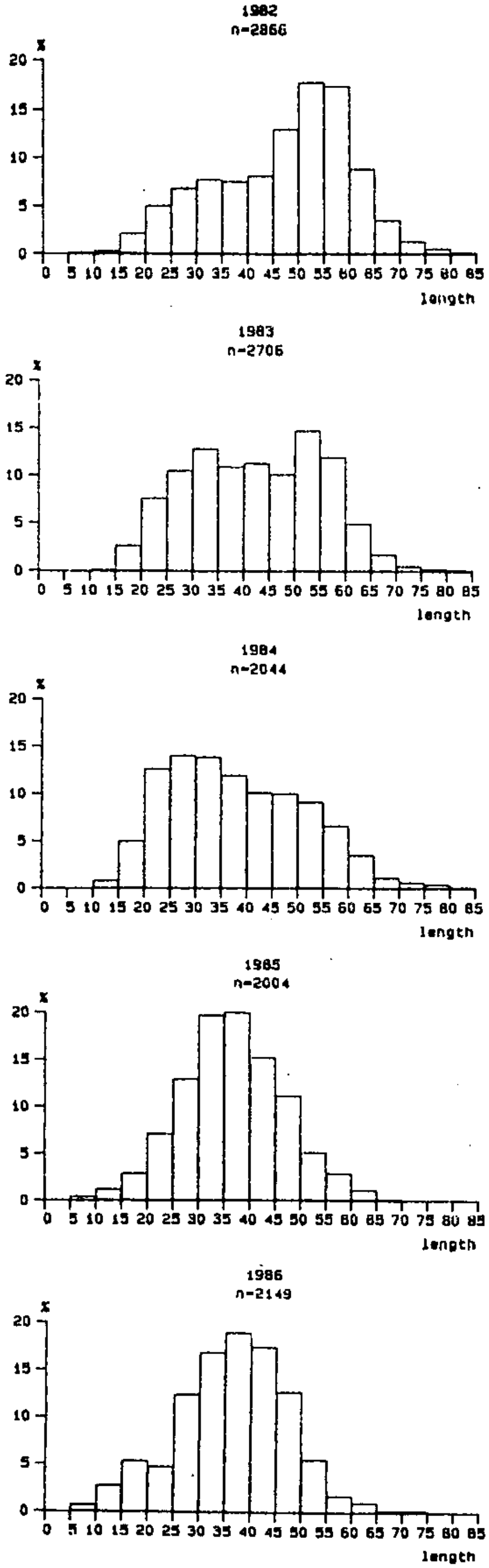


Fig. 6 : Percentage length distribution in 5 cm groups of Atlantic wolffish caught in trawl surveys at West Greenland in different years. n=number of fish.

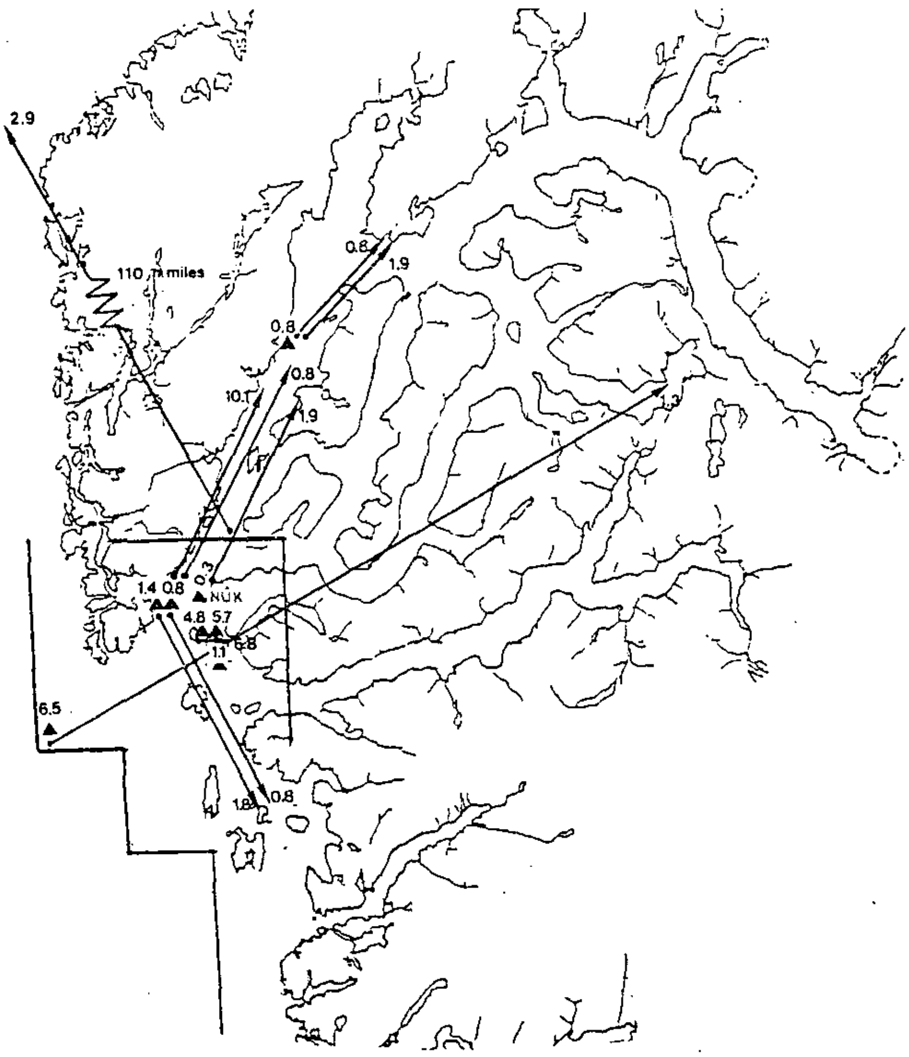


Fig. 7 : Migration of spotted wolffish in the Nuuk area, West Greenland. (Triangles represent fish recaptured < 10 n.miles from tagging locality, arrows are locality of recaptures and numbers are years between tagging and recapture).

The two lines represent the division of the area in offshore, inshore and fiords for the analysis of catch data.

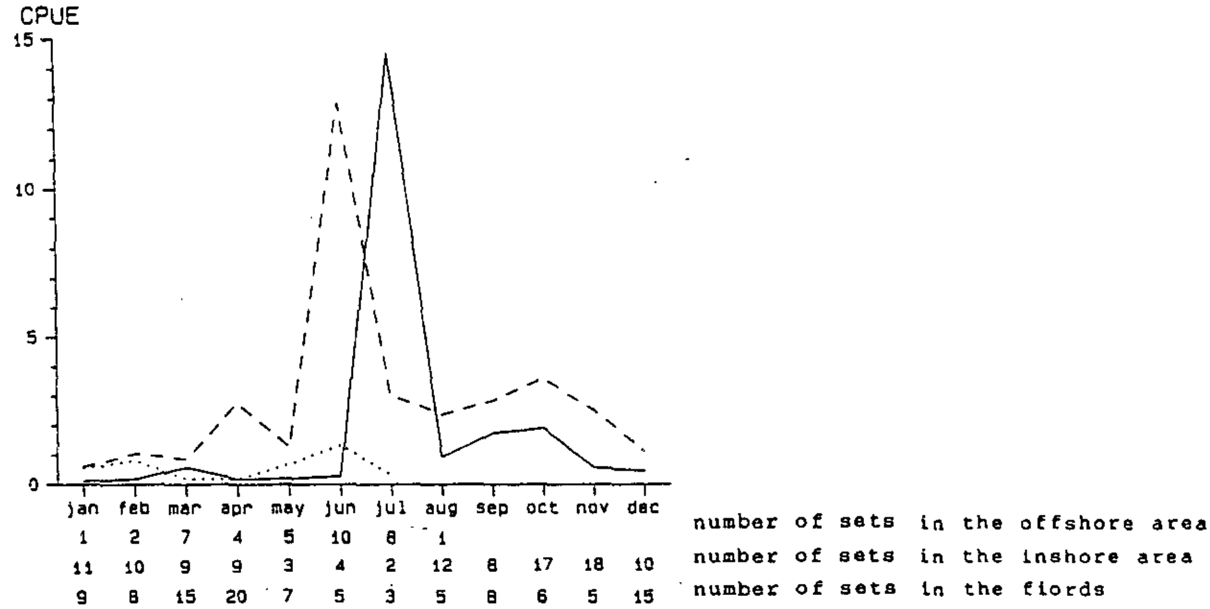


Fig. 8 : Relationship between mean CPUE (catch in numbers per 100 hookes) of spotted wolffish and month in the Nuuk area. Spotted line represent the offshore area, brokken line represent the inshore area and solid line represent the fiords.