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REPORT OF THE DANISH-SWEDISH STUDY GROUP ON THE HERRING IN KATTEGAT

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1. Introduction.

1.1. In 1974 the Danish and Swedish Fisheries Laboratories set up a study group to assess the fish stocks in Kattegat and adjacent waters with special reference to herring. A preliminary report was presented at the statutory meeting of ICES the same year. From the limited data then at hand the Study Group tentatively concluded: "at present the fishing mortality in Kattegat proper could well be about 1.0 or even higher for the adult herring" (Anon 1974). The Study Group continued work in 1975 and 1976 and the present report is a short review of the present state of knowledge.

1.2. The Study Group has until now held five meetings with the following participants:

Place	Bornö	Bornö	Bornö	Charl.	Bornö
Time	10-14/6 1974	4-10/6 1975	30/8-3/9 1976	18-23/10 1976	8-13/8 1977
Dr. H. Ackefors (S)	X	X	X	X	X
Mr. B. Sjöstrand (S)	X	X	X	X	X
Mrs. B.M. Karlsson (S)	X	X			
Miss A.-C. Rudolphi (S)	X				
Mr. O. Hagström (S)			X		X
Mr. J. Andersson (S)					X
Mr. J. Modin (S)					X
Mrs. I. Boëtius (D)	X				
Mrs. E. Nielsen (D)		X	X	X	X
Mrs. H. Scavenius Jensen (D)		X	X	X	X
Mr. H. Knudsen (D)				X	
Mr. K. Popp Madsen (D)	X	X	X	X	X

The results of the meetings in 1975 and 1976 are contained in two internal reports.

2. Herring Landings from Kattegat.

2.1. Danish and Swedish catch data for the years 1950-76 together with preliminary figures for the first half of 1977 are given in table 2.1.

The industrial fishery has been the dominant component almost throughout the entire period. As shown in fig. 2.1. the industrial catches kept below 20 000 tons until 1960 except for the years 1957 and 1958. The pronounced peak in the catch figures in these years reflects a strong immigration of 0 and I group herring of the outstanding 1956-yearclass in the North Sea autumn spawning stock. In the early sixties the industrial catches increased sharply to a level of 55-60 000 tons about which they have fluctuated, apparently with an increase in amplitude, but without any obvious trend. The rather great variation in the Swedish industrial landings between 1973 and 1975 was due to fluctuating prices on the world market for fish meal.

2.2. The landings for human consumption show a steady increase after 1955 from a level of 3-4 000 tons anually to a peak of 47 000 tons in 1971. The following decline in catches was arrested in 1975 and the landings increased again in 1976. The latter development is probably caused by an increase in fishing effort. Fig. 2.1. also shows the landings of herring for human consumption in the first half years in the period 1969-77. It appears, that the higher landing figures in the early seventies are due to increased fishing in the first half of the calender year, while landings in the second half have been rather stable at least over the last ten years. This feature coincides with the decline of the herring fisheries in the northeastern North Sea and western Skagerrak in winter and the resulting movement of fishing effort into the Kattegat area. In the last few years this transfer of effort has continued into the eastern Baltic.

2.3. Effort data are unfortunately not available in a form suitable for comparative estimates of abundance. Ackefors (1976) calculated HP x fishing months as a measure of effort in the Swedish fishing fleet in Kattegat. The results indicate that from 1960/64 to 1970/74 the effort exerted by herring bottom trawl increased by 48 %, that by pelagic trawl by 165 % while the effort of purse seiners was increased by a factor of 6.2. In the same period the Swedish landings of adult herring increased by 162 %. It is reasonable to assume

that a major part of the effort-increase have been placed in the early part of the year.

2.4. Catch in numbers was obtained by sampling the Swedish landings of consumption herring and the Danish landings of industrial fish. On the assumption that Danish and Swedish vessels share the same fishing grounds, the numbers caught per age group[x] were raised to the total landings of each of the two categories of fishing respectively. The results are shown in table 2.4.1. where catch in numbers is given by half-year periods and by type of fishery. In tables 2.4.2.and 2.4.3. the total numbers caught are arranged on a yearly basis as input data for a Virtual Population Analysis (VPA). This is done both by calender year and on a July-June basis. In the latter case the beginning of the year of capture coincides with the entry of the 0-group herring into the fishery. The total numbers caught are very high and comparable to those taken in the North Sea herring fisheries. A contrast to the latter is the all dominant proportion of 0-groups in the Kattegat landings.

3. Stock Components in Kattegat

3.1. Herring Spawning in Kattegat

The spawning herring in the Kattegat consist of three components: the Kattegat Winter Spawners (VS = 56.7-57.3, K_2 = 14.2-14.7), the Kattegat Spring Spawners (VS = 55.7-56.5, K_2 = 13.8-14.2) (cf. fig. 3.1.1.) and the Kattegat Coastal Spring Spawners (VS = 55.5-56.1, K_2 = 13.7-14.2). The Kattegat Winter Spawners which spawn in January-February seems to be closely connected with the Skagerrak Spring Spawners, which spawn along the Norwegian and Swedish coast. They have, however, different K_2 values (cf. fig. 3.1.1.). The Kattegat spring spawning herring spawn in April-May and is also found spawning in some years in the Skagerrak. The third component consists of the Kattegat Coastal Spring Spawners. They spawn in the Danish fjords from the middle of April until the beginning of June. The Longshore Herring of the Danish west coast belong to this component. Tagging experiments show that, except in spawning time, the local coastal spring spawners occur together with the Kattegat Spring Spawners. They are therefore included in the Kattegat Spring Spawning herring in all discussions below.

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[x] All ages are given as winter rings; i.e. a fish in the 0-groups is born the same year if it is a spring spawner; the year before if it is an autumn spawner.

The autumn spawning Kobberground herring is probably nearly extinct nowadays. These herring used to spawn mainly in September and October and migrated from the North Sea, through Skagerrak, to and back from its spawning grounds east of Laesø. According to larval surveys the stock disintegrated in the late sixties and early seventies.

3.2. Herring Spawning in Adjacent Areas.

Herring spawn in the Skagerrak from February until the end of April. According to the VS character they are similar to the Kattegat winter herring. The K_2 is, however, more like the Kattegat spring spawners (cf. fig. 3.1.1.). This population is called the Skagerrak Spring Spawners. The spring spawning herring of Rügen in the Baltic area may be a component of the Kattegat and Skagerrak herring stock according to tagging experiments (Biester et al., 1976). The meristic characters of this herring show a VS of around 56.0 and a mean value of K_2 of about 14.0. On these characters they can not be distinguished from the Kattegat Spring Spawners (Heincke, 1898). Autumn spawning herring from the Belt and the Sound may be found i the Kattegat (Anon. 1974). The results of tagging experiments indicate that herring tagged in the Kattegat, are recaptured in the Skagerrak as well as in the Baltic-Belt seas and vice versa.

3.3. Fisheries on Juvenile Herring.

The fishery is based on both autumn spawned herring and spring spawned herring. The autumn spawning herring is dominated by the North Sea herring both in the Kattegat and the Skagerrak. Larvae from the North Sea, and perhaps even from the areas northwest of Scotland, drift into the Skagerrak in February-April. After the metamorphosis in inshore waters in May-June they spend about one year in the Kattegat-Skagerrak and seem to leave the area in the following spring at approximately 1 1/2 - 1 3/4 years of age.

In the samples of juvenile spring spawning herring the Kattegat Spring Spawners dominate both in Kattegat and Skagerrak throughout the year. There are few samples of young herring from the Kattegat Winter Spawners or the Skagerrak Spring Spawners in either areas.

3.4. Fisheries on Adult Herring.

The heavy exploitation of the North Sea herring in the sixties led to a decrease in herring catches in the Skagerrak area. Since 1970 total

landings from Skagerrak have been smaller than those from Kattegat. Their time sequence indicates, however, that both fisheries are based on the same stocks (fig. 3.2.1.). The fishing pattern corroborates this theory (fig. 3.2.2.). The main fishery starts in May-June in the western part of the Skagerrak and moves subsequently into Kattegat where the maximum catches are taken one to three months later.

The main component is the Kattegat Spring Spawners being very important in the Kattegat fishery throughout the year. In the Skagerrak it dominates the landings from May-September.

The Skagerrak Spring Spawners are exploited by the fisheries from October-April along the Bohuslän coast in the Skagerrak.

The Kattegat winter spawning herring is exploited along the coast of Kattegat in January and February. During the rest of the year this stock is not represented in any of the samples from the Kattegat and Skagerrak analysed in 1971-1976 and, at present, its whereabouts is unknown.

4. Virtual Population Analysis.

4.1. Input.

Fishing mortalities and stock sizes for the period 1969-1975 were calculated at the Study Group meetings in 1976. At the latest meeting, data from 1976/77 could be included in the VPA and the results are shown in tables 4.1.1. and 4.1.2. Mean values per yearclass for the period 1970-74 and 1969/70 - 1974/75 were used as input F's for 1976 and 1976/77 respectively. The analyses were run with natural mortality changing with age as shown below:

Age	0	I	II	III	>III
M	0.30	0.25	0.20	0.15	0.10

The higher M-values in the younger age group were thought more realistic than the application of the same low value throughout the age range.

4.2. Results.

The most remarkable feature is the very high fishing mortality, especially in the calculations on a July-June basis. Though figures calculated for the last 2-3 years are less reliable, there appears to be a slightly increasing trend over the years. It is also noted that a high fishing

mortality is common to all age-groups.

5. Weight at Age.

5.1. Quarterly mean weights for each age group were calculated for 1976 and the first half of 1977 for Danish industrial landings and Swedish consumption landings respectively (see table 5.1.). Combined mean weights at age for 1976 were then calculated by weighing the national quarterly means by catch in numbers and are shown below.

Age	0	I	II	III	IV	V	VI	VII	VIII
grms.	14.7	26.3	116.3	138.2	190.4	213.9	241.1	277.5	295.3

6. Recruitment and Spawning Stock.

6.1. The mean recruitment as 0-group calculated from the VPA (by calender year) for the years 1970-1974 is 3 428 million fish. This figure is likely to be an overestimate due to the fact, that it refers to the numbers as at 1. January whereas the time of recruitment is about June-July. In this respect, the figures derived at by using July-June as basis are perhaps more relevant. The Study Group, however, chose the calender year basis for its present considerations partly for practical reasons and partly because the difference between the two sets of values would only have a slight influence on a prognosis.

6.2. The biomass in weight of herring older than 2 years was calculated from the VPA stock in numbers and is shown below.

1970	28 000 tons
1971	42 000 tons
1972	34 000 tons
1973	32 000 tons
1974	32 000 tons
1975	8 000 tons
1976	7 000 tons

Though the estimates for the last two years are very unreliable they indicate a serious decline in the spawning potential. This is corroborated by some observations concerning local spawning populations. In the Limfjord, for example, landings of adult herring dropped to 500 tons in 1975 and about 164 tons in 1976 as compared with an average catch of 2200 tons in 1950-72. In the Isefjord (Southern Kattegat)

the traditional fishery on spawning herring has almost ceased in the last two years.

7. Prognoses.

7.1. In order to assess the effect of possible changes in the present fishing pattern upon the fishery and the herring stock in Kattegat, the Study Group undertook a number of trial runs under different assumptions. Stock in numbers at 1. January 1976 is a base in common and was calculated from the catch in numbers in 1976 applying mean F's at age in 1973-74 (VPA figure, calender year). The 1976-catch in numbers of 0-group herring is as low as that of 1972. Consequently the corresponding VPA-figure for 1972 was used as 0-group strength in 1976. The initial stock figures are shown below (in millions):

Age	0	I	II	III	IV	V	VI	VII	VIII
nos.	2104	2209	328.6	31.4	4.21	2.74	1.43	1.53	1.7

7.2. Natural mortality rates were the same as those used in the VPA i.e. $M_o = 0.30$, $M_1 = 0.25$, $M_2 = 0.20$, $M_3 = 0.15$ and $M_{4-8} = 0.10$.

7.3. Average weight at age was based on 1976 data as described in section 5.1.

7.4. Three runs were made using different F-values and, in 1977, different 0-group strength.

Run		A	B	C
F_{juv}/F_{ad}	1977	0.9/0.9	0.9/0.9	0.9/0.9
-"-	1978	0.2/0.9	0.2/0.9	0.9/0.9
-"-	1979	0.2/0.7	0.2/0.7	0.9/0.9
-"-	1980	0.2/0.5	0.2/0.5	0.9/0.9
0-group	1977	3428×10^6	2104×10^6	3428×10^6
0-group	1978	3428×10^6	3428×10^6	3428×10^6

Catch in tons ($\times 10^{-3}$)	juv.	ad.	juv.	ad.	juv.	ad.
1977	34.7	35.6	24.5	35.6	41.8	35.6
1978	12.3	26.6	10.4	26.6	40.97	26.4
1979	16.8	45.3	16.8	30.0	40.97	32.5
1980	16.8	73.3	16.8	67.4	40.97	34.4
Steady state	16.8	145.4	16.8	145.4	40.97	36.1

Spawning stock in tons ($\times 10^{-3}$)	Run A	Run B	Run C
1977	7.2	7.2	7.2
1978	26.2	26.2	26.2
1979	20.9	20.9	20.9
1980	48.3	32.2	24.3
Steady state	241.2	241.2	27.3

Run A, as shown in the table above, is based on the assumption that the poor 1976 yearclass is followed by yearclasses of average strength. In run B it is assumed that owing, to the low spawning potential indicated in section 6.2, yearclass 1976 will be followed by another poor yearclass in 1977. In both cases it is assumed, that F for juveniles (0 and I groups) can be reduced to F = 0.2 from the beginning of 1978 followed by a stepwise decrease in the adult fishing mortality in 1979 and 1980. Run C is included in order to show the possible development if F is kept at a high level. It must be emphasized, that in the latter case it is assumed, that a stock recruitment relationship is not induced by the low spawning potential.

Fig. 7.4.1. shows the calculated biomass at different values of adult fishing mortalities. The experiences from overfished herring stocks in other waters indicate, that a spawning biomass less than about 1/3 of the size when the stock is lightly fished can rapidly induce a stage of recruitment overfishing followed by a collapse of the fishery. In case of the Kattegat herring this lower limit of spawning biomass appears to be about 200 000 tons.

The prognoses tabulated above indicate that run A and B will secure a reasonably rapid increase in spawning biomass which will pass the critical level already in the early eighties. According to run C, the biomass will never get beyond 10-20 % of the lower limit and it should be noticed that even F = 0.9 probably implicates a reduction of the present fishing effort with 20-30 %

8. Summary and Discussion

8.1. Herring landings in Kattegat increased rapidly in the early sixties to a level of 80-100 000 tons. In the last 3-4 years catches have stagnat-

ed or declined despite an increase in fishing effort. Data on age composition and numbers caught are available since July 1969. They show that the number of older fish declined in the subsequent years, and that more than 90 % of the total catch in numbers consists of juvenile herring. These features are already sufficient reason for grave concern as to the future of the herring stock and fisheries in Kattegat.

8.2. A Virtual Population Analysis based on data from July 1969 to June 1977 indicates very high fishing mortalities over the period considered and over the entire age range. The calculated spawning biomass was at a very low level in 1970-74 and though the estimates for 1975 and 1976 are inefficient they still indicate a further decline so serious that it could make recruitment overfishing inevitable.

8.3. Prognoses of the possible effect of restrictions in Kattegat herring fisheries indicate, that a cut down on juvenile fishing mortality to a level which will allow unavoidable bycatch in other fisheries, i.e. $F \sim 0.2$, and be effective from the end of 1977, combined with a gradually diminished fishing mortality on adult herring, might allow a rapid build up of the spawning stock.

Calculations, of what empirically has been indicated as a critical lower limit of spawning biomass (1/3 of the size when the stock is lightly fished), gives a level of 200 000 tons (corresponding to F 0.5) for the adult Kattegat herring. In the way indicated above, this level could be surpassed in the early eighties.

8.4. The present assessment is only based on data from Kattegat. This introduces an unknown bias in the results obtained by the VPA technique as, in fact, an important part of the Kattegat herring stock is the basis of the fisheries in Skagerrak in summer and early autumn. Exogene herring stocks, on the other hand, enter Kattegat on feeding migrations e.g. spring spawners from the Baltic-Belt Seas and longshore herring from the Danish westcoast. The inclusion of these emi- and immigrants in the Kattegat assessment will, however, hardly change the general picture of a poorly managed natural resource.

9. References

Ackefors, H. 1976: Den svenska fiskeaktiviteten i Kattegatt 1960 - 1974. Meddelande från Havsfiskelaboratoriet, Lysekil, nr 203.

Anon. 1974: Preliminary report of a Danish-Swedish study group on the herring in Kattegat and adjacent waters, Bornö, 10-14 June 1974. ICES C.M. 1974/H:11.

Biester, E., Jönsson, N. and G. Krüger 1976: The results of marking experiments in 1975 on the Rügen spring herring. ICES C.M. 1976/P:15.

Heincke, F., 1898: Naturgeschichte des Herings. Abhandl. Seefisch.-Vereins, 2.

Legends

Fig. 2.1. Annual herring landings in the Kattegat 1950-1976.

Fig. 3.1.1. VS and K_2 charachters of herring sampled in Kattegat and Skagerrak 1971-1976.
KW = Kattegat Winter Spawners
SS = Skagerrak Spring Spawners
KS = Kattegat Spring Spawners

Fig. 3.2.1. Monthly landings of herring in the Swedish fishery in 1975-76 (Skagerrak and Kattegat).

Fig. 3.2.2. Annual Swedish landings of herring in the Kattegat and Skagerrak 1960-76.

Fig. 7.4.1. Biomass for fish older than 2 years (spawning stock) versus fishing mortality (F). Recruitment based on a mean value 1970-74.

Fig 2.1

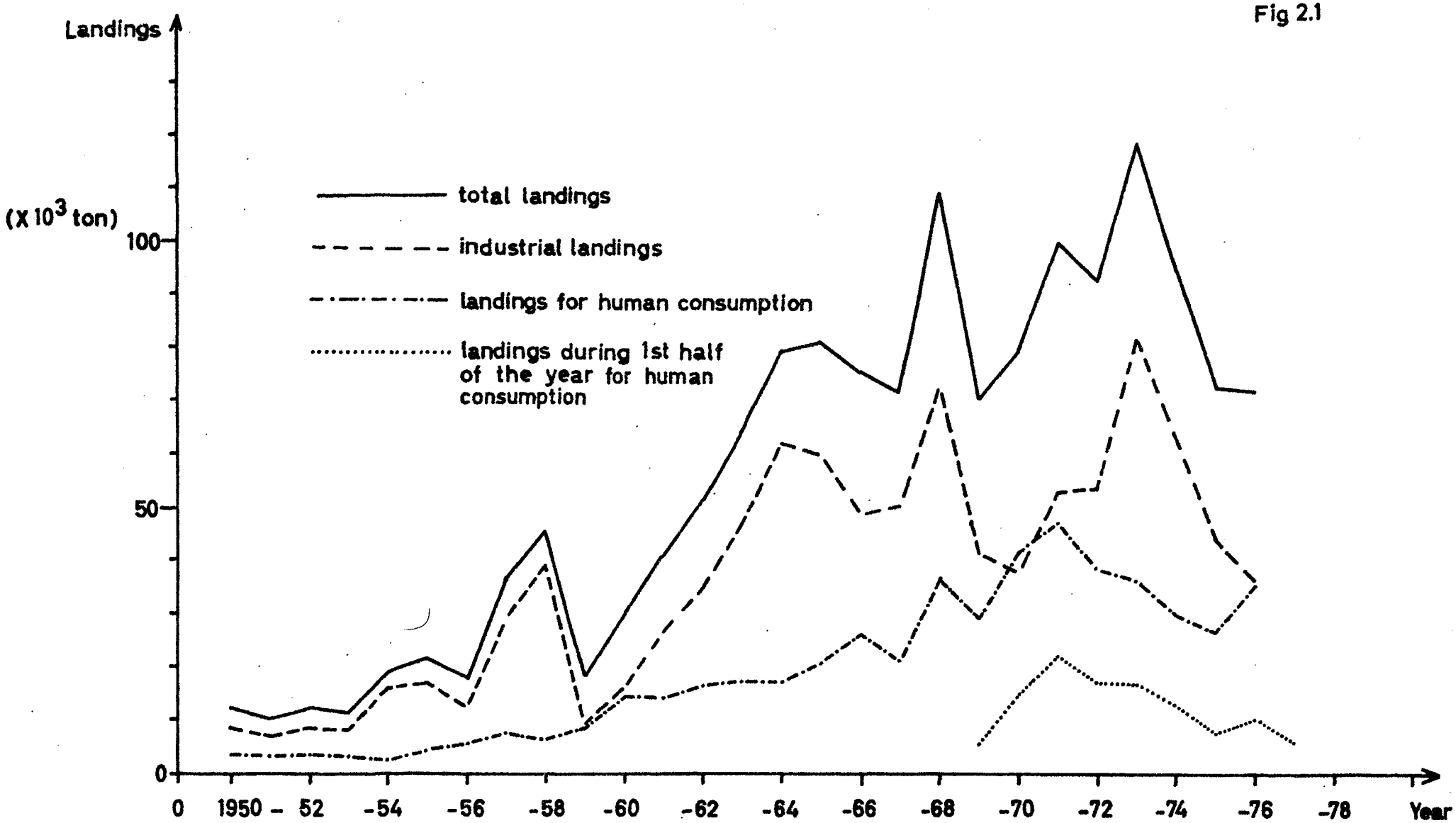
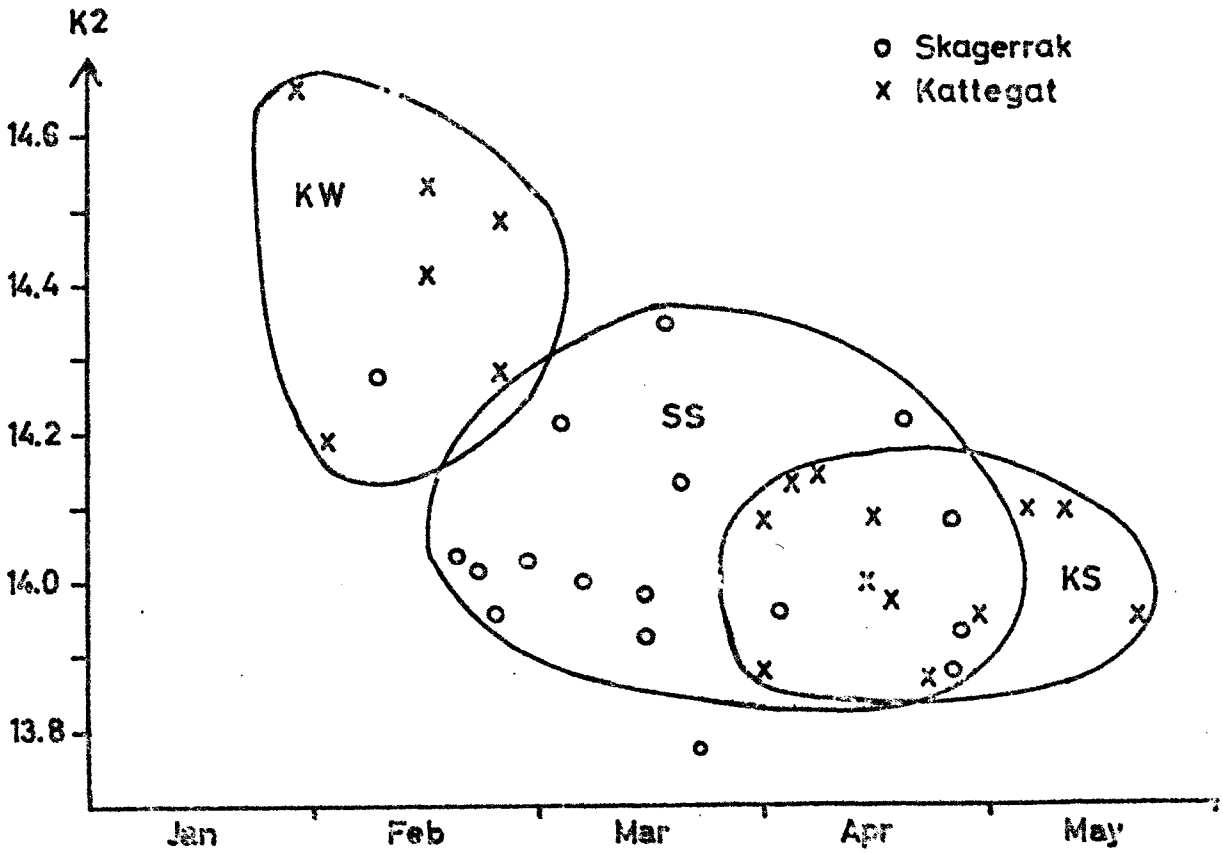
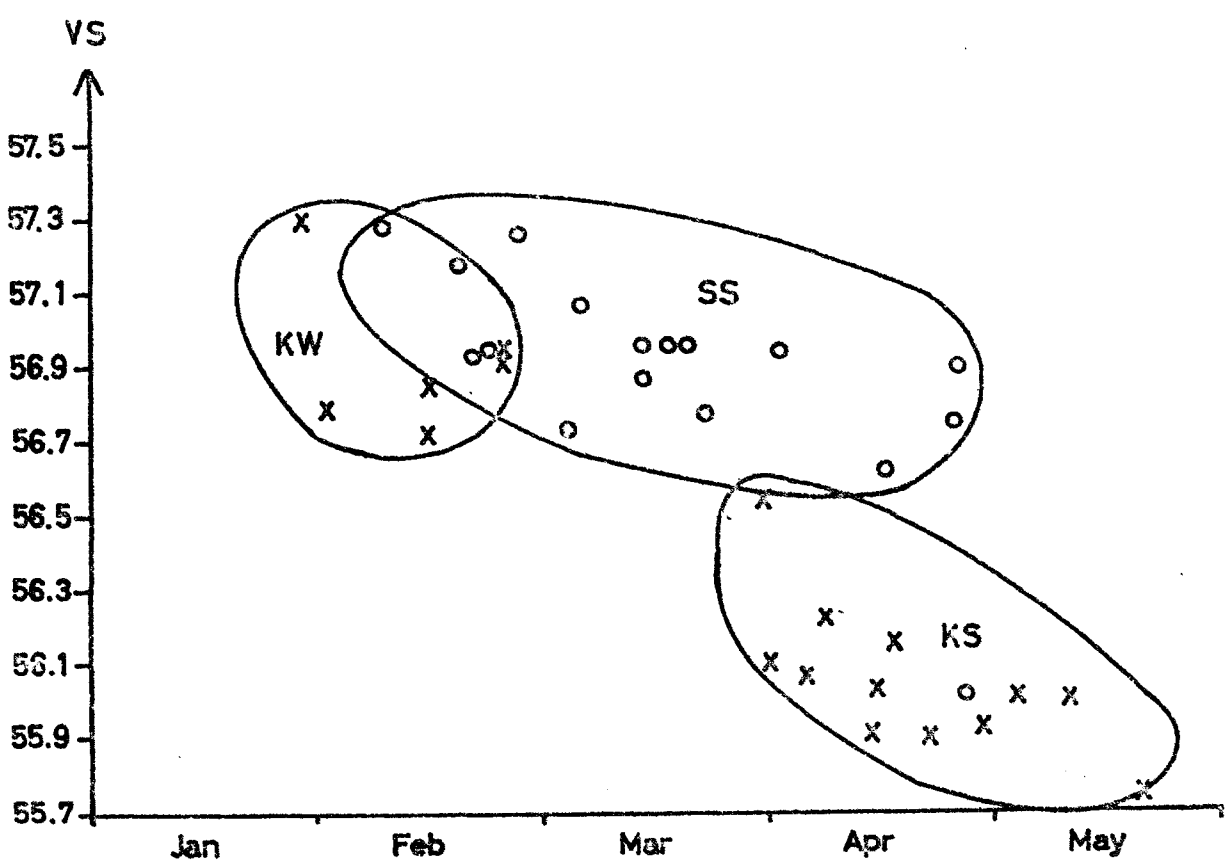

Landings
(X 10³ ton)
100
50
0
total landings
industrial landings
landings for human consumption
landings during 1st half of the year for human consumption
0
1950 – 52
-54
-56
-58
-60
-62
-64
-66
-68
-70
-72
-74
-76
-78
Year

Fig. 3.1.1.


K2
o Skagerrak
x Kattegat
14.6
14.4
14.2
14.0
13.8
KW
SS
KS
Jan
Feb
Mar
Apr
May


VS
57.5
57.3
57.1
56.9
56.7
56.5
56.3
56.1
55.9
55.7
KW
SS
KS
Jan
Feb
Mar
Apr
May

000' tons Fig 3.2.1

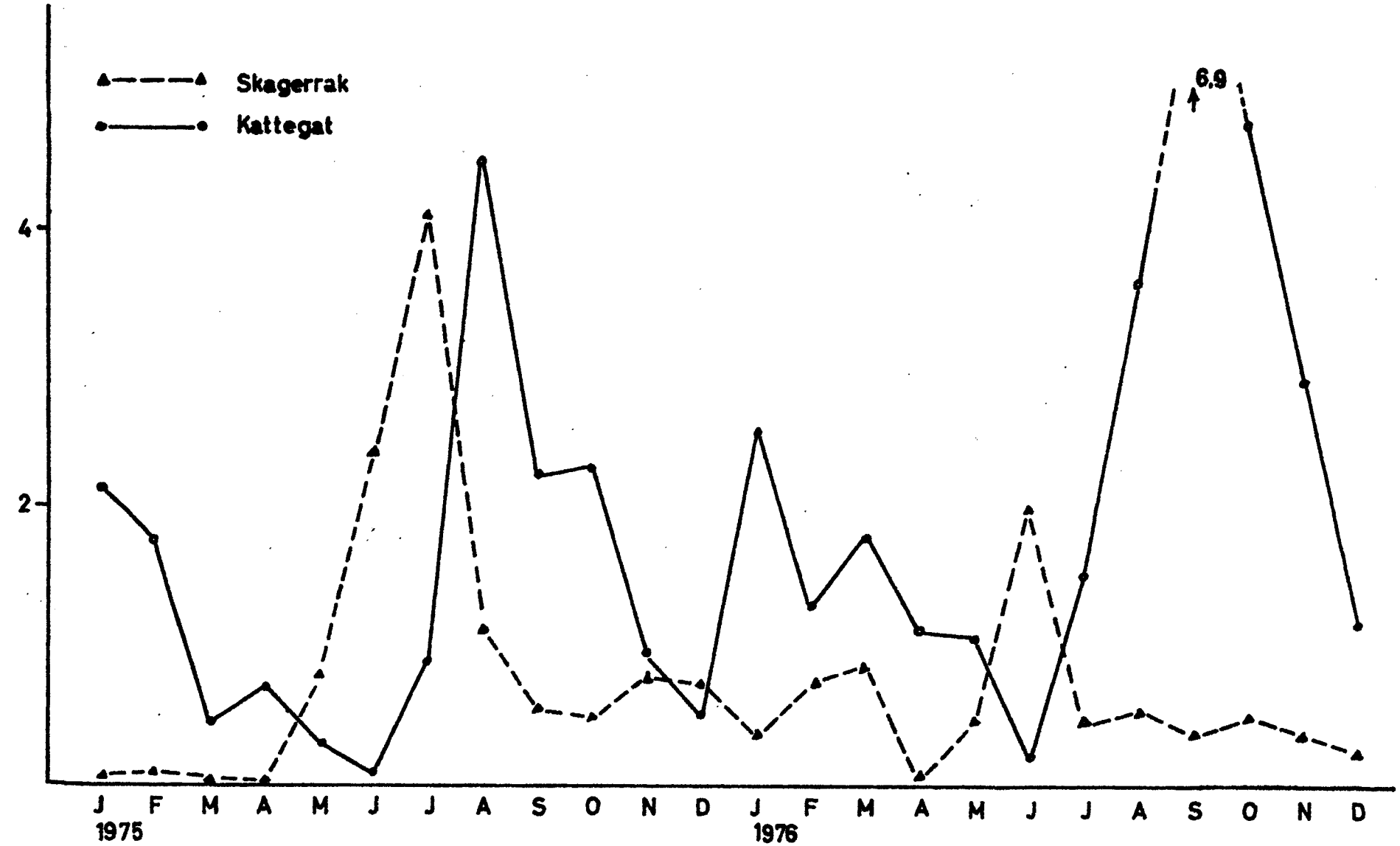


Fig. 3.2.2.

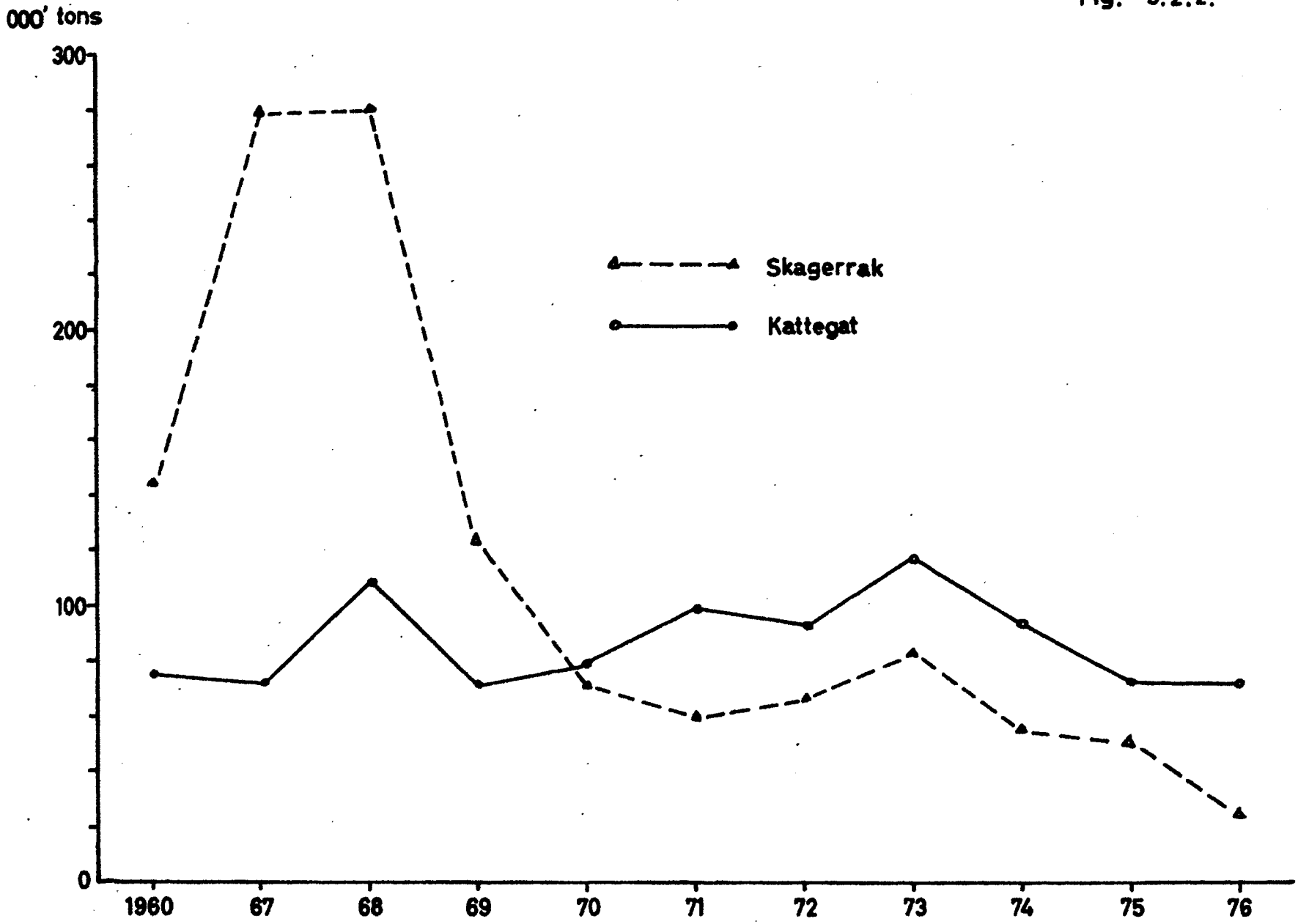

000' tons
300
200
100
0
Skagerrak
Kattegat
1960
67
68
69
70
71
72
73
74
75
76

Fig. 7.4.1.

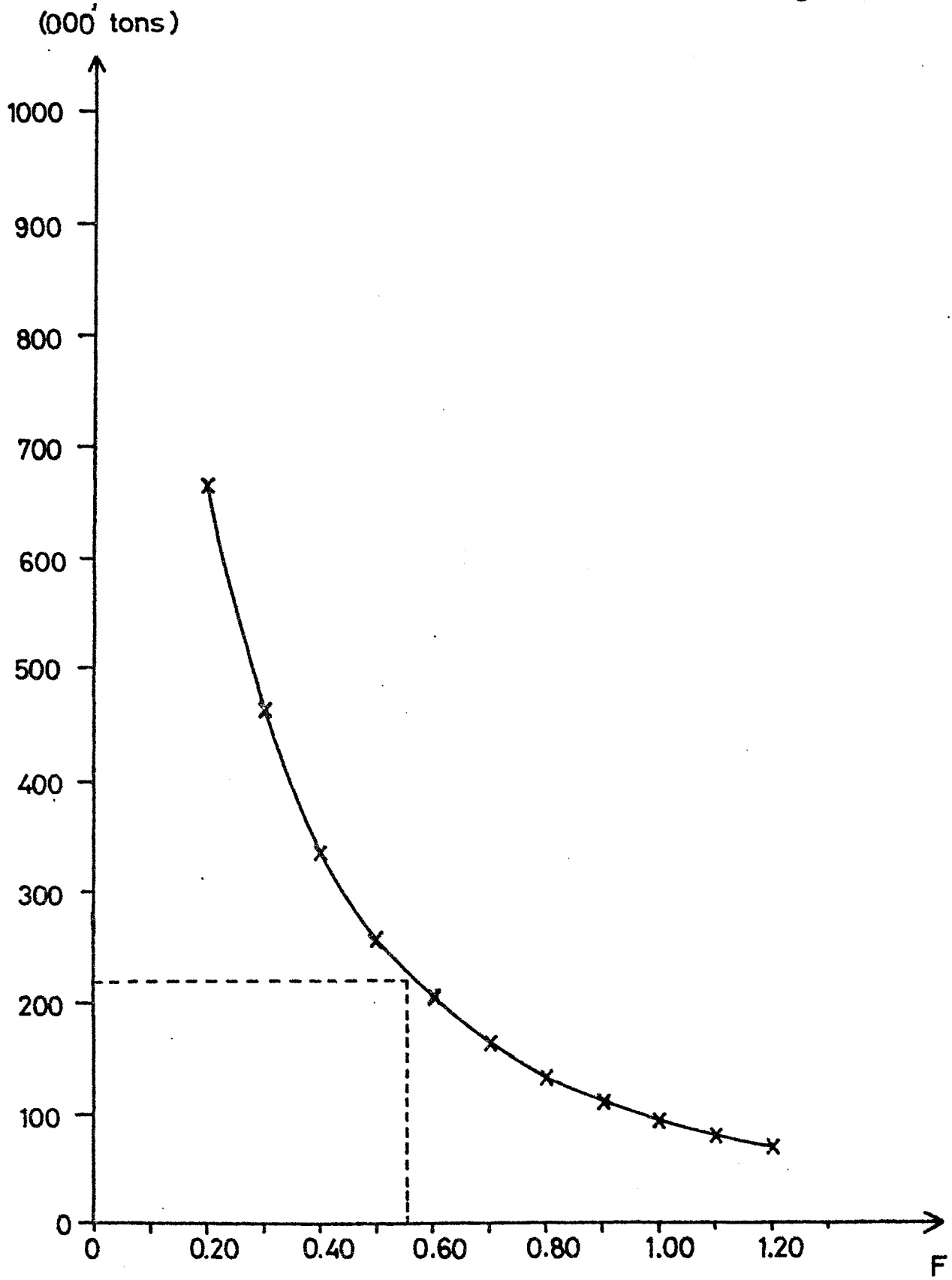

(000' tons)
1000
900
800
700
600
500
400
300
200
100
0
0
0.20
0.40
0.60
0.80
1.00
1.20
F

Table 2.1. Herring catches in Kattegat 1950-1977. C=herring for human consumption. I=industrial landings. Figures in tons.

Year	Sweden		Denmark		Total		Grand total
	C	I	C	I	C	I	
1950	2 024		1 534	8 600	3 558	8 600	12 158
1951	2 110		1 130	7 040	3 240	7 040	10 280
1952	2 323		1 351	8 600	3 673	8 600	12 273
1953	1 497		1 707	8 100	3 204	8 100	11 304
1954	1 129		1 609	16 298	2 738	16 298	19 036
1955	2 899		1 543	17 243	4 442	17 243	21 685
1956	3 655		2 145	12 439	5 800	12 439	18 239
1957	4 168		3 491	28 996	7 659	28 996	36 655
1958	3 435		3 011	39 192	6 446	39 192	45 638
1959	4 887		3 798	9 762	8 685	9 762	18 447
1960	8 800	2 800	5 842	13 618	14 642	16 418	31 060
1961	8 200	3 700	6 017	23 154	14 217	26 854	41 071
1962	12 500	5 500	4 130	29 542	16 630	35 042	51 672
1963	12 700	6 400	4 617	40 542	17 317	46 942	64 259
1964	12 900	17 500	4 421	44 545	17 321	62 045	79 366
1965	15 400	17 600	5 773	42 572	21 173	60 172	81 345
1966	20 100	10 900	6 320	38 142	26 420	49 042	75 462
1967	15 300	12 600	6 094	37 960	21 394	50 560	71 954
1968	27 400	14 400	9 030	58 422	36 430	72 822	109 252
1969	21 400	10 300	7 912	31 137	29 312	41 437	70 749
1970	31 400	9 053	10 562	28 872	41 962	37 925	79 887
1971	36 586	13 174	10 588	39 589	47 174	52 763	99 937
1972	26 214	13 758	12 740	40 015	38 954	53 773	92 727
1973	27 969	12 449	8 713	69 412	36 682	81 861	118 543
1974	22 356	17 423	7 705	46 835	30 061	64 258	94 319
1975	20 074	3 695	8 619	40 355	28 693	44 050	72 743
x1976	27 652	2 611	7 820	33 929	35 472	36 540	72 012
x1977 I	5 310	855	903	10 547	6 212	11 402	17 615

x preliminary figures

Table 2.4.1. Total landings of herring from the Kattegat in million fish per age group. I = landings for industrial purposes C = landings for human consumption

		0	I	II	III	IV	V	VI	VII	VIII	VIII+	Total
	I	638.1	50.5	7.8								696.4
1969 II	C	0.1	46.9	38.7	18.5	6.9	1.18	1.43	1.83	0.76	0.32	116.6
	Σ	638.2	97.4	46.5	18.5	6.9	1.18	1.43	1.83	0.76	0.32	813.0
	I		412.0	18.1								430.1
1970 I	C		16.0	67.2	25.2	5.1	1.65	0.72	0.39		0.20	116.5
	Σ		428.0	85.3	25.2	5.1	1.65	0.72	0.39		0.20	546.6
	I	1004.9	56.4	25.4	1.9							1088.6
1970 II	C	17.3	166.0	34.9	9.6	3.2	1.47	0.05	0.05	0.05	0.20	238.8
	Σ	1022.2	222.4	60.3	11.5	3.2	1.47	0.05	0.05	0.05	0.20	1321.4
	I		660.2	38.8								699.0
1971 I	C		1.7	110.8	84.7	19.9	5.03	3.04				225.2
	Σ		661.9	149.6	84.7	19.9	5.03	3.04				924.2
	I	625.8	153.7	19.0								798.5
1971 II	C	125.2	83.2	51.0	12.1	8.7	3.25	0.92	0.08		0.11	284.6
	Σ	751.0	236.9	70.0	12.1	8.7	3.25	0.92	0.08		0.11	1083.1
	I	28.1	420.5	111.3	14.4	0.1						574.4
1972 I	C		12.3	7.3	6.9	16.7	18.2	12.6	3.1	0.77	2.02	79.9
	Σ	28.1	432.8	118.6	21.3	16.8	18.2	12.6	3.1	0.77	2.02	654.3
	I	248.9	258.9	49.4	7.4	2.1	0.16					566.9
1972 II	C	102.6	140.1	33.5	9.4	1.1	0.65	0.19	0.08	0.03	0.03	287.7
	Σ	351.5	399.0	82.9	16.8	3.2	0.81	0.19	0.08	0.03	0.03	854.5
	I		438.7	291.2	28.0	2.9	0.23					761.0
1973 I	C		27.8	100.1	8.9	7.6	3.44	1.59	0.34	0.18	0.07	150.0
	Σ		466.5	391.3	36.9	10.5	3.67	1.59	0.34	0.18	0.07	911.0
	I	2766.7	207.8	16.8	2.5							2993.8
1973 II	C	56.5	51.7	52.7	25.1	11.1	2.31	1.09	0.08			200.6
	Σ	2823.2	259.5	69.5	27.6	11.1	2.31	1.09	0.08			3194.4
	I		445.6	216.9	18.5	10.1	4.6					695.7
1974 I	C		0.5	28.8	45.0	13.8	9.7	5.80	1.77	0.91		106.3
	Σ		446.1	245.7	63.5	23.9	14.3	5.80	1.67	0.91		802.0
	I	1859.8	126.4	5.0	0.8							1992.0
1974 II	C	7.2	44.7	32.2	24.5	8.8	5.8	2.16	0.55	0.31	0.16	126.4
	Σ	1867.0	171.1	37.2	25.3	8.8	5.8	2.16	0.55	0.31	0.16	2118.4

Table 2.4.1. (Cont'd)

		0	I	II	III	IV	V	VI	VII	VIII	VIII+	Total
1975 I	I		548.4	51.4	3.34							603.1
	C		66.4	27.5	9.4	4.99	1.08	0.23	0.27			109.8
	M		614.8	78.9	12.74	4.99	1.08	0.23	0.27			712.9
1975 II	I	1920.2	278.1	1.77	0.48							2200.6
	C	9.35	197.2	30.6	7.43	2.89	0.97	0.55		0.09		249.1
	M	1929.55	475.3	32.37	7.91	2.89	0.97	0.55		0.09		2449.7
1976 I	I		916.7	107.5	7.10	0.46						1031.8
	C		34.8	87.6	12.33	1.61	1.60	0.73	0.77	0.33	0.13	139.9
	M		951.5	195.1	19.43	2.07	1.60	0.73	0.77	0.33	0.13	1171.7
1976 II	I	365.4	232.6	4.0	0	0	0	0	0	0	0	602.0
	C	3.4	239.8	62.8	3.89	1.07	0.35	0.17	0.12	0.03	0.03	311.6
	M	368.8	472.4	66.8	3.89	1.07	0.35	0.17	0.12	0.03	0.03	913.6
1977 I	I		584.9	32.4	0.95	–	–	–	–	–	–	618.1
	C		2.82	80.8	3.49	0.53	0.34	0.09	0.02	0.001	0.001	88.1
	M		586.6	113.2	4.44	0.53	0.34	0.09	0.02	0.001	0.001	

Table 2.4.2. Herring Kattegat. Total landings in millions per age group and calender year 1970-1976.

year/age group	0	I	II	III	IV	V	VI	VII	VIII	VIII+	Total
1970	1022.2	650.4	145.6	36.7	8.3	3.12	0.77	0.44	0.05	0.40	1868.0
1971	751.0	898.8	219.6	96.8	28.6	8.28	3.96	0.08	-	0.11	2007.2
1972	379.6	831.8	201.5	38.1	20.0	19.0	12.8	3.18	0.80	2.05	1508.8
1973	2823.2	726.0	460.8	64.5	21.6	5.98	2.68	0.42	0.18	0.07	4105.4
1974	1867.0	617.2	282.9	88.8	32.7	20.1	7.96	2.32	1.22	0.16	2920.4
1975	1929.5	1090.1	111.3	20.7	7.88	2.05	0.78	0.27	0.09	-	3162.7
1976	368.8	1423.9	261.9	23.3	3.14	1.95	0.90	0.89	0.36	0.16	2085.3

Table 2.4.3. Herring Kattegat. Total landings in millions per age group and July-June year.

	0	I	II	III	IV	V	VI	VII	VIII	VIII+	Total
1969/70	1066.2	182.7	71.7	23.6	8.55	1.90	1.82	1.83	0.96		1359.3
1970/71	1684.1	372.0	145.0	31.4	8.23	4.51	0.05	0.05	0.05		2245.4
1971/72	1183.8	355.5	91.3	28.9	26.9	15.85	4.02	0.95	2.02		1709.2
1972/73	846.1	790.3	119.8	27.3	6.9	2.40	0.53	0.26	0.10		1793.7
1973/74	3269.3	502.2	133.0	51.5	25.4	8.11	2.86	0.99	-		3993.4
1974/75	2481.8	250.0	49.9	30.3	9.9	6.03	2.43	0.55	0.31	0.16	2831.4
1975/76	2881.0	670.4	51.8	9.98	4.49	1.70	1.32	0.33	0.22	-	3621.4
1976/77	955.4	585.6	71.2	4.42	1.41	0.44	0.19	0.121	0.031	0.03	1618.8

Table 4.1.1. Herring Kattegat.

Fishing mortalities from VPA.
M variable M_0=0.30, M_1=0.25, M_2=0.20, M_3=0.15, M_{4-8}=0.10

By calender year	1970	1971	1972	1973	1974	1975	1976
W.rings							
0	0.47	0.31	0.23	1.29	0.67	0.49	0.79
1	0.95	1.15	0.77	1.05	1.43	1.31	0.95
2	0.62	1.10	0.96	1.57	2.27	1.28	1.69
3	0.45	1.15	0.55	0.95	2.10	1.47	1.06
4	0.22	0.71	0.72	0.63	2.35	1.32	0.88
5	0.29	0.32	1.38	0.43	2.26	1.08	1.38
6	0.16	0.63	1.02	0.63	1.49	0.47	2.79
7	2.27	0.02	1.50	0.07	1.79	0.14	1.39
8	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Weighted mean F	0.59	0.63	0.53	1.26	0.93	0.69	0.99

By July-June	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77
0/1	0.87	1.13	0.64	0.75	2.14	1.21	1.32	1.02
1/2	0.54	1.00	0.89	1.52	1.96	1.46	1.77	1.36
2/3	0.61	1.21	0.77	0.93	1.41	1.48	1.94	1.07
3/4	0.53	0.58	0.84	0.54	1.55	1.84	1.68	0.96
4/5	0.61	0.33	1.43	0.44	1.36	1.66	2.21	1.23
5/6	0.71	0.67	1.66	0.38	1.25	1.44	1.66	2.08
6/7	0.15	0.03	2.54	0.17	0.94	1.71	1.49	0.76
7/8	2.11	0.00	1.06	1.81	0.49	0.41	1.14	0.43
8/8+	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Weighted mean F	0.78	1.09	0.71	1.02	2.07	1.24	1.41	1.13

Table 4.1.2. **Herring Kattegat.**

Calculated stock size in number $\times 10^{-6}$.
M variable. M_0=0.30, M_1=0.25, M_2=0.20, M_3=0.15, M_{4-8}=0.10.

By calender year	1970	1971	1972	1973	1974	1975	1976
W.rings 0	3126	3196	2104	4372	4343	5681	767
1	1178	1449	1729	1235	892	1643	2574
2	342	356	356	626	336	167	345
3	108	150	97	112	106	28	38
4	44	59	41	48	37	11	6
5	13	32	26	18	23	3	3
6	6	9	21	6	11	2	1
7	1	4	4	7	3	2	1
8	0	0	4	1	6	0	2

By July-June	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77
W.rings 0/1	2086	2801	2848	1820	4086	3982	4400	1687
1/2	491	650	670	1110	636	358	883	866
2/3	171	223	185	215	190	70	65	118
3/4	61	76	54	70	69	38	13	8
4/5	20	31	37	20	35	13	5	2
5/6	4	10	20	8	12	8	2	1
6/7	14	2	5	3	5	3	2	0
7/8	2	11	2	0	3	2	1	0
8/8+	5	0	10	0	0	1	1	0

Table 5.1. Herring Kattegat. Mean weight per agegroup and quarter. 1976 and 1977.

Age		0	I	II	III	IV	V	VI	VII	VIII
Quarter										
Sv.	I	-	28.5	98.0	133.8	176.6	202.7	226.5	280.0	276.0
	II	-	34.3	79.1	121.8	153.1	171.4	191.0	205.7	204.6
	III	-	67.8	118.2	156.0	178.2	237.9	255.0	289.9	325.0
	IV	-	88.3	143.5	190.0	225.4	258.1	244.3	-	290.5
Dk.	I	-	13.9	113.9						
	II	-	18.4	18.4	124.0					
	III	11.3	26.7	103.3						
	IV	15.7	40.6	105.7						
Year 1976		14.72	26.31	116.32	138.23	190.38	213.94	241.08	277.53	295.3

Age		0	I	II	III	IV	V	VI	VII	VIII
Quarter										
Sv.	I	-	35.1	84.2	149.5	177.1	206.3	224.6	257.3	235.5
	II	-	47.7	79.7	109.2	129.0	147.0	169.1	182.3	-
Dk.	I	-	15.8	46.7	118.9					
	II	-	20.3	50.2	79.2					