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International Council for the Exploration of the Sea

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# REPORT OF THE SAITHE (COALFISH) WORKING GROUP

Charlottenlund, 9 - 13 April 1973



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1. Participants

Mrs N. BelaiaU.S.Mr N. DaanNethMr A. HylenNorwMr T. JakobsenNorwMr J.S. JoensenFaroMr B.W. Jones, ChairmanU.K.Dr V.P. PonomarenkoU.S.Dr H.H. ReinschGermMr J. RichardsU.K.Mrs T. SafianovaU.S.Dr S.A. SchopkaIcel

U.S.S.R. Netherlands Norway Faroe Isl. U.K. U.S.S.R. Germany (F.R.) U.K. U.S.S.R. Iceland

# 2. Terms of Reference

At the 60th Statutory Meeting of ICES it was resolved (C.Res.1972/2:7) that the Saithe Working Group be re-convened in order to assess the present status of the stocks and the desirability of including saithe in Recommendation 4 fisheries. In addition, the Working Group also considered the likely effects on saithe fisheries of an increased mesh size in the NE Arctic and Iceland areas, a task which was deferred from the Meeting of the North-East Arctic Fisheries Working Group.

# 3. Trends in Catch, Catch per Unit Fishing Effort and Effort

# 3.1. Catch

Annual catch data for the main statistical areas are given in Table 1. The Table has been compiled from national data sources where possible, with the remaining data taken from the "Bulletin Statistique".

The total catch from all areas .combined has increased steadily from about 200 000 tons in 1950 to 600 000 tons in 1971. The main increase in landings has taken place during the last 10 years. There have been big increases in landings from Division IV and Sub-area Va in recent years, but in most areas there has been a trend of increasing catches.

 x) General Secretary, International Council for the Exploration of the Sea, Charlottenlund Slot, 2920 Charlottenlund, Denmark.

#### 3.2. Catch per Unit Fishing Effort

Catch-rate data are available for the English, Icelandic, Scottish and German trawl fisheries and these are tabulated by statistical areas in Table 2 and are shown graphically in Figure 1. Catch per unit effort data as indices of stock abundance are of only limited value for the saithe fisheries. Catch rates in any area will reflect changes in abundance resulting from natural variations or fishery-induced changes, but they will also be affected by immigration to, or emigration from, any area. In addition, any systematic change in emphasis in any of the demersal fisheries, such as fishing specifically for saithe rather than taking saithe as a by-catch while fishing for other species, will result in a biassed index of stock abundance. In some of the fisheries such changes are known to have taken place in recent years. However, having made these reservations there is no clear indication from any of the fisheries, with the possible exception of the North Sea, that catch rates have been reduced as catches have been increasing.

## 3.3. Fishing Effort

Only very limited data on fishing effort are available. For the English and Icelandic trawlers there were data of hours fished and average gross tonnage; for German trawlers days fished were recorded, and for Scottish vessels there were data for the Faroe area. Total fishing effort for each area (Table 3) was calculated from the total landings and the English, German and Scottish catch per unit effort data. For Sub-area IIa the estimates of effort relate to trawl landings only, but for other areas they relate to total landings by all gears. These estimates of total fishing effort must be regarded at the best as being only a guide to the trend in fishing effort and possible biasses in the catch per effort data referred to in Section 3.2 will also affect estimates of effort.

The data from Table 3 are presented graphically in Figure 2. The general impression is one of relatively stable amounts of fishing in the various areas until recent years. At Farce, however, there appears to be a long-term trend of steadily increasing fishing effort. In recent years the data indicate a rapid increase in the amount of fishing in the North Sea and for the travl fisheries on the Norwegian coast.

It is believed, however, that in many areas the amount of fishing for saithe has been increasing. This has been brought about both by an increased amount of fishing and also, in some fleets, by a greater proportion of demersal fishing being directed more to fishing specifically for saithe.

# 4. Mortality Estimates

Estimates of total mortality coefficients (Z) were calculated from English, German and Scottish age compositions per unit fishing effort. The results are tabulated in Table 4. The values of Z shown are averages for the age groups indicated in the Table. The age groups chosen in each case covered the range from full recruitment to the age where numbers of fish become too small to give valid estimates. The age of recruitment varies for the different fisheries. The calculated values of Z show considerable variation, both between pairs of years and between estimates from the different fisheries. Any significant migration of fish between fishing areas will affect mortality estimates and the migratory habit of saithe will certainly be contributing to the variability of the mortality estimates. In making comparisons between the estimates of Z from the English and German fisheries it should be remembered that the fisheries are not directly comparable. Normally the English fisheries are generalised demersal fisheries, while from Germany there are specialised fisheries for saithe. German vessels frequently fish in deeper water than the English fleet. Age of recruitment differs for the various fisheries. For example, tagging experiments at Iceland (Jones and Jónsson, 1971) indicated that young saithe recruited first to the Icelandic purseseine and trawl fisheries, then to the English trawl fishery and finally to the German trawl fishery,

It must be concluded that this method of estimating mortality rates may not provide, for the saithe fisheries, a satisfactory means of determing the exploitation rates for the various stocks.

## 5. Virtual Population Analysis

The Working Group was of the opinion that the best method of assessing the state of the saithe stocks would be by Virtual Population Analysis. It was the Group's intention to make such an analysis based on the combined catch data for the whole of the North-East Atlantic. This approach would be expected to provide as reliable an indication of the overall intensity of exploitation as the data would permit. In the event the Group had to postpone this aim because it was not possible for all countries to prepare their age-composition data in time for the Meeting. At the ICES Meeting at least one country stated that data preparation could not be completed before June, 1973. The Group was able, however, to assemble most of the data in a form suitable for the analysis. The remaining data will be added as soon as they become available and the analysis can be made and the results circulated to members of the Group. Interpretation of the results could then be made by correspondence or at a further meeting of the Group. It was possible, however, to make Virtual Population Analyses for several of the statistical areas separately, where all the available data were to hand.

#### 5.1. Data Input

The age composition data which were available at the present Meeting are indicated in Table 5. There were no data available from some countries which have important fisheries in the areas concerned. As a result it has had to be assumed that the catches of the countries for which no data were available had the same age composition as the countries for which data were available. For each area for each year the available age distributions of national catches were summed and the resultant age composition was then raised by the ratio of total landed weight of all countries to landed weight of countries for which age compositions were known. In the calculation the coefficient of natural mortality was taken as M = 0.2.

## 5.2. Results

Estimates of stock size and fishing mortality for the years 1960-70 for the North Sea, Farce, Iceland and the West of Scotland are given in Tables 6 - 9. In interpreting these results it must be remembered that they may be influenced by migration of fish from one area to another. The estimates of stock size in any area will represent the stock in the sea needed to provide the observed catches, but it is possible that part of this stock may have spent part of their lives in another area. The fishing mortality shown is that suffered by the stock of the size given in the Table, but this may not represent the true value of the mortality on that part of the stock that may have been available in the area at a given time.

A better interpretation of these results should be possible when the analysis for all areas combined is completed. However, inspection of the present results suggests that fishing mortality is relatively low in the Iceland and West of Scotland areas. For the North Sea the data show a substantial increase in fishing mortality in recent years, and at Faroe there is a trend of increasing mortality. These results are generally in accord with the trends in the estimates of fishing effort.

Estimates of stock size for the North Sea indicate the year classes 1966-68, especially 1968, to be much more abundant than preceeding year classes. Whether or not these estimates of year class strength reflect the true abundance of these recent year classes is not yet clear.

# 6. Growth

On examining growth data it was noted that in the English data there was a clear trend of reducing length at age over the past 10-12 years for saithe from Sub-areas IIa, Va and Vb (Figure 1). The rate of reduction of average length has been about 1 cm per year, and over a period of 10 or 12 years this is equivalent to more than a year's growth. A similar but less marked trend is apparent in the German data. The reason for this change is not clear but on the Norway Coast the change appears to have commenced with the 1959 year class which is the first of a series of abundant year classes in that area. This suggests the possibility of a density-related growth change. This could be looked at in more detail when the combined North-East Atlantic Virtual Population Analysis is completed as this will provide a better indication of stock abundance.

# 7. Summary of the Status of the Fisheries

An earlier report of the Working Group (ICES, Coop.Res.Rep., Ser.A, No.6) summarised our knowledge of the identity of saithe stocks. There are several well-known spawning grounds in various areas of the North-East Atlantic. However, tagging experiments and interpretation of otolith types have shown that, at least from time to time, there are substantial migrations of fish between the different fishing areas. This makes it difficult, if not impossible, to relate catches from the various fisheries to particular well-defined and delimited stocks. For this reason assessment of the state of the fisheries is difficult and results of analyses have to be interpreted with care. As stated earlier, the Group considers that a Virtual Population Analysis for all areas combined would give as good an assessment of the overall state of exploitation of saithe as the data would permit. However, until this analysis is completed the following provisional conclusions have been reached:

- (a) With the possible exception of the North Sea, in none of the fisheries have catch rates been declining as catches have been increasing.
- (b) Until recently, fishing effort in the various fisheries appears to have been relatively stable with only short-term fluctuations. At Farce, however, there appears to have been a long-term trend of increasing fishing effort. In recent years the data indicate an increasing amount of fishing in the North Sea and in the trawl fisheries on the Norwegian Coast.
- (c) Estimates of fishing mortality so far available are in reasonable agreement with the trends in estimated fishing effort. Mortality rates have generally been relatively low but have been increasing in the Farce area and in recent years in the North Sea.
- (d) Subject to revision when the combined North-East Atlantic analysis and an analysis for the Norway Coast are completed, the Group concluded that the saithe stocks were moderately exploited.

# 8. Saithe as a Protected Species

The Working Group discussed the desirability of including saithe in the NEAFC Recommendation 4 species. The effect of including saithe in Recommendation 4 would be that this species would become subject to minimum permitted landing size regulations. The following points are considered relevant:

- (a) The Group considered that a degree of natural protection against trawl fishing for the youngest age groups was provided by the distribution of saithe. In the early part of their life the young fish inhabit the inshore areas especially on rocky coasts where it is generally not possible to fish them with trawls. However, it is possible that fisheries might develop using other gears. With a general increase in exploitation for the older age groups, a trend which is likely to continue if the abundance of other demersal species declines, any intensive exploitation of the youngest age groups would be undesirable. The inclusion in Recommendation 4 could prevent such fisheries developing.
- (b) Table 10 gives the percentage by weight of saithe less than 30, 35 and 40 cm in the landings from each statistical area for the countries for which length compositions were available. The greatest proportions of small fish were taken in the Norwegian fisheries in the southern part of Sub-area IIa (south of 64°N). These fisheries are exploited mainly by trawlers, for which the minimum legal cod-end mesh size is 30 mm, and by purse-seiners.

- (c) Some countries have domestic regulations for their saithe fisheries. In Norway it is forbidden to land saithe less than 35 mm total length other than for human consumption or for bait. It is also forbidden to use saithe larger than 35 cm for production of fish meal or to catch them for this purpose. Recent Icelandic regulations have banned the exploitation of demersal species by purse-seiners.
- (d) If saithe was to be included in Recommendation 4 it would become a protected species in the context of Recommendation 2 (mixed industrial fisheries). This would have some implications for the Dutch herring trawl fisheries in the North Sea. These fisheries employ 3 cm mesh nets in a "mixed fishery" on herring, mackerel and roundfish. Up till now the proportion of protected species has been relatively constant at 30% but the proportion of herring and mackerel has been steadily declining over the last ten years in favour of saithe. If saithe was to be added to the list of protected species, this fishery could hardly claim to be a "mixed fishery" any more, because generally more than 60% would consist of protected species.

In relation to these problems it was pointed out that no discards of small-sized saithe occur, because no saithe smaller than 35 cm are available to this fishery. This is in contrast with other gadoid species (cod, haddock and whiting) of which there certainly are discards of undersized juveniles.

(e) Lengths of saithe corresponding to various retention percentages for different mesh sizes are given in Table 11 to provide guidance in determing a minimum landing size should it be decided to include saithe in Recommendation 4 species.

# 9. Effects on the Saithe Fisheries of an increase in the minimum trawl codend mesh size in the North-East Arctic and Iceland

Assessments were made of the likely effects of a change in the minimum trawl mesh size from 130 mm (manila) to 145 mm. The basic method used was that described by Gulland (1961). The average length compositions of landings by trawlers are given in Table 12 and the length-weight data used in the assessment are given in Table 13. Selectivity data used were those of Hylen (1969) who found a selection factor of 3.8 for saithe. Values of M = 0.2 and

$$\mathbf{E} = \frac{\mathbf{F}}{\mathbf{E} + \mathbf{M}} = 0.7$$

were used. In the North-East Arctic area Norwegian landings from the southern part of IIa (south of 64°N) were excluded from the immediate loss calculations as they are in the 80 mm mesh area and would be unaffected by a mesh change in the 130 mm area. These fisheries could benefit in the long term from fish released in the northern trawl fisheries and so they have been included with Norwegian 'Other Gears' in the calculation of long-term gain.

Results are tabulated in Table 14.

For the Iceland area an increase of mesh size to 145 mm would be expected to have very little effect as the majority of the fish in the landings are outside the selection range. The estimated immediate losses for all fisheries are in the range of 3-5% by weight. The long-term effects are also expected to be very small.

For the North-East Arctic the range of immediate losses for the various trawl fisheries are much larger, in the range of 11-34%. The largest losses would be experienced by the U.S.S.R. trawlers. In the long term the mesh change would be expected to result in losses for all trawl fleets except for the German fleet for which the long-term gain would be about 10%. The long-term losses are estimated as 18% for the U.S.S.R., 4% for Norwegian trawlers, and 1% for England and other countries. Any significant migrations of fish between fisheries would affect the results of these assessments.

#### 10. References

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JONES, B.W. and JONSSON, J. 1971. Coalfish tagging experiments at Iceland. Rit Fiskideildar <u>5</u>, No.1.

Table 1. Summary of Saithe Landings by Regions Metric Tons Round Fresh Weight

 Fishing Area Year	I	IIa	IIЪ	IV	VA	γb	VI	TOTAL
1946	5 557	27 059	506	23 155	A1 569	5 325	1 781	107 952
1947	15 498	46 560	958	31 929	13 379	8 759	5 596	152 679
1948	29 754	62 037	861	29 201	111 286	3 569	1 622	211 333
1949	33 551	61 449	357	27 079	87 045	6 114	3 730	210 325
1950	29 236	86 007	647	21 108	55 174	5 367	3 329	200 868
1951	27 028	76 269	1 204	22 217	74 096	8 698	4 362	213 874
1952	14 203	105 058	632	23 227	87 940	6 851	6 701	244 612
1953	18 636	104 915	716	22 791	73 131	7 184	6 206	233 579
1954	11-162	91 277	576	36 224	69 629	6 212	6 646	221 726
1955	13 404	90 807	928	44 942	47 843	7 234	8 687	213 845
1956	15 321	98-409	1.351	51-067	67 860	10 884	11 679	256 571
1957	16 253	112 682	1 353	55 546	62 061	26 858	12 210	286 963
1958	12 306	105 265	1 217	50 372	53 178	12 978	12 780	248 096
1959	17 813	113 511	1 235	51 224	48 478	14 545	9 845	256 651
1960	17 627	117 782	620	31 515	48 120	11 845	8 532	236 041
1961	16 602	92 859	421	35 489	50 826	9 592	6 723	212 512
1962	11 456	110 968	419	24 559	50 514	10 454	7 159	215 529
1963	21 399	126 491	146	30 300	48 011	12 693	6 609	245 649
1964	55 714	141 335	1 061	58 669	60 257	20 550	16 655	354 241
 1965	18 676	164 995	877	73 274	60 177	22 071	18 276	358 346
1966	16 963	183 835	1 062	90 940	52 003	24 597	18 509	387 909
1967	15 452	175 331	408	76 759	75 712	23 219	16 034	382 915
1968	10 895	96 100	186	98 179	77 549	19 704	12 504	315 117
1969	19 524	118 851	1 004	115 564	115 853	27 536	16 366	414 698
1970	36 129	223 034	1 249	179 594	116 601	29 148	14 488	600 233
1971	38 448	174 493	720	209 532	134 127	30 867	11 203	599 390
		1	1	1	1	1	1	

Table 2. Catch per Unit Effort of Saithe by Statistical Area for English and German Trawlers.

Statistical Area I IIa IVa Va Vb VIa Country E. E. G. E. I. E. G. E. E. G. 2 911 3 206 5 323 3 647 6 051 7 379 3 867 7 052 2 115 9 296 2 742 8 164 2 186 6 033 3 705 6 240 7 878 3 416 11 507 7 310 2 501 3 804 6 492 2 678 5 447 7 539 2 407 3 914 6 154 2 851 3 579 6 932 3 025 2 539 6 110 2 105 2 876 5 252 2 269 3 801 7 772 1 652 2 561 1 768 3 648 6 884 7 428 2 411 4 456 6 410 1 915 3 995 7 663 3 946 7 116 13 542 3 405 4 119 7 546 2 842 4 417 11 087 3 918 2 810

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English data (E) and Icelandic data (I) tons per million ton-hours. German data (G) kg per fishing day.

Table 3.Estimates of Total Fishing Effort on Saithe in English, German and Scottish Units.Total effort =Total landingsTotal effort =Mational catch per unit effortEnglish units : millions of ton-hours.German units : thousands of days fishing.

Scottish units : thousands of hours fishing.

Icelandic units : millions of ton-hours.

Statistical Area	I	IIa (T	rawl)	IV		Va		29	₹Ъ	1	VIa
Country	E.	E.	G.	E.	E.	G.	I.	E.	G.	s.	E.
$     \begin{array}{r}       1946 \\       47 \\       48 \\       49 \\       1950 \\       51 \\       52 \\       53 \\       54 \\       55 \\       56 \\       57 \\       58 \\       59 \\       1960 \\       61 \\       62 \\       63 \\       64 \\       65 \\       66 \\       67 \\       68 \\       69 \\       1970 \\       71 \\     \end{array} $	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	174 178 239 271 242 205 283 240 309 233 202 243 273 202 243 273 287 443 261 379 884 666	3.6 3.2 5.2 5.4 5.0 4.7 4.4 4.7 4.5 3.1 3.4 5.3 4.7 7.9 8.1 4.8 6.4 9.9 11.8	317 216 261 398 352 241 101 46 98 123 132 176 148 146 104 140 106 108 218 196 264 232 591 505 795 1 541	$ \begin{array}{c} 135\\128\\398\\418\\406\\602\\778\\724\\703\\630\\881\\1017\\886\\866\\891\\941\\990\\873\\988\\940\\963\\1023\\862\\778\\1267\\1156\end{array} $	27 15 17 23 52 52 18 21 18 20 23 17 23 27 36 29 31 41 29 34 30	217 279 253 374 323 284 246 218 215 265	$\begin{array}{c} 16\\ 22\\ 16\\ 22\\ 34\\ 37\\ 32\\ 28\\ 27\\ 30\\ 42\\ 118\\ 53\\ 72\\ 74\\ 43\\ 56\\ 59\\ 77\\ 65\\ 88\\ 84\\ 50\\ 77\\ 71\\ 68\\ \end{array}$	$ \begin{array}{c} 135\\15\\1.7\\2.3\\3.4\\2.7\\3.0\\2.7\\4.1\\4.4\\5.4\\7.8\\6.7\\5.2\\4.9\\3.9\\7.1\\10.9\end{array} $	594 525 528 420 470 329 237 383 261 260	33 37 58 59 55 62 76 62 55 55 50 59 55 50 59 62 62 64 57 55 59 54 86 21 64 57 54 76 62 55 55 55 55 55 55 55 55 55 55 55 55 55

Statistical Area	I	Ia		IV		Ve	2		٧b		VIa
Country	G	E	E	G	S	G	E	G	E	S	E
Age Groups Years	(5-11)	(5-9)	(4-10)	(5-10)	(3-8)	(6-11)	(4-9)	(6-12)	(5-10)	(4-8)	(4-9)
1949-50	-0.40		13			0.45					
1950-51	0.31			in Line		-0.34					
1951-52	0.16				10	0.92					
1952-53	0.44	-	이 유지권		1.1	1.00		复去】			
1953-54	0.52		1 1 3	医尿管		0.51		연장의			
1954-55	0.65			1.5		1.17	194.6				1
1955-56	0.93					0.20				alara e	
1956-57	0.91	0.57				0.63	1.	-0.67	1 - 1		
1957-58	0.32	0.45	N 28 S		- 14	0.60		0.98	0.57		
1958-59	1.30	1.11	Line of	in the second	144	0.79		-0.57	0.57	1991 - 19 1	0.29
1959-60	-0.23	0.61		121.4		0.62		0.47	0.80		0.75
1960-61	0.77	1.61				0.70		0.68	0.03		0.50
1961-62	0.59	0.45	1.40			0.31	0.53	0.43	0.61		0.71
1962-63	0.02	1.24	0.65	1.	1.24	0.34	0.79	-0.02	0.34	in .	0.89
1963-64	0.33		0.75			1.27	0.77	0.51	0.54		0.57
1964-65	-0.31		1.31	1.66		1.25	0.29	0.24	0.00	<i>ē</i> -0	0.26
1965-66	0.41	0.20	1.40	-0.90		0.53	0.42	0.04	0.92		1.28
1966-67	0.27	1.12	0.44	0.19		0.45	-0.26	0.06	0.65	1	0.65
1967-68	0.29	0.75	1.49	0.56		0.63	-0.10	0.63	0.34		0.82
1968-69	0.52	0.81	0.21	-0.56		0.15	-0.38	-0.48	0.87		1.00
1969-70	-0.56		0.53	-0.72		0.40	0.63	0.61	0.14		0.46
1970-71	0.68		1.70	1.24	0.77	0.22	-0.10	1.01	0.75	0.55	0.56
1971-72	-0.18		1.2.2.2.	Letter film	12.12.25	0.90		0.19			

Table 4. Estimates of Coefficients of Total Mortality for Saithe from German (G) and English (E) and Scottish (S) Age Compositions Per Unit Effort.

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Area Country	I + IIa + IIb	IV	Va	٧b	VI
Germany	1960-1971	1964-1971	1960-1971	1960-1971	
Netherlands		1970-1971			
Norway		1 A 2 -			
U.K. (England)	1960-1971	1960-1971	1961-1971	1960-1971	1960-1971
U.K. (Scotland)		1969-1971		1970-1971	
U.S.S.R.	1970-1971	1968-1971			

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# Table 5. Age Composition Data Available for Virtual Population Analysis (1960 onwards).

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Age Group 2 3 4 5 6 7 8 9 10 11 12 13 14	45 35 16 11 7 4 3 2 0.3 0.2 0.1	5544 36 22 10 7 4 3 2 1 0.2 0.2 0.1	52 36 26 12 6 4 2 2 1 0.1 0.1 0.1 0.1	67 42 26 16 7 4 3 2 2 1 0.9 0.1 0.1	185 54 34 17 9 5 32 1 1 1 0.7 0.1	166 147 39 23 10 6 4 2 1 1 0.8 0.8 0.5	175 136 112 23 14 7 4 3 2 1 0.7 0.6 0.6	124 138 105 70 12 8 4 2 1 0.9 0.5 0.3 0.3	402 98 106 76 47 8 4 1 0.7 0.5 0.3 0.2 0.2	438 327 69 70 44 27 5 2 0.7 0.3 0.2 0.2 0.1	1 069 348 243 42 43 24 13 2 1 0.2 0.1 0.1 0.1
58 - C.	2	•		Ē	ISHING	MORTA	LITY				
2 3 4 5 6 7 8 9 10 11 12 13 14 15	.03 .25 .28 .34 .31 .10 .03 0 .03 .04 0	.01 .14 .43 .28 .34 .28 .13 .13 .13 .11 .33 .50 .39	0 .12 .28 .26 .15 .06 .04 .03 .03 .19 .10 .66	.01 .04 .23 .39 .16 .07 .04 .06 .02 .06 .05 .42 .43	.03 .12 .16 .28 .26 .19 .21 .26 .22 .19 .12 .11	0 .07 .31 .29 .18 .21 .12 .06 .11 .11 .07 .09 .05	.04 .06 .28 .44 .36 .49 .39 .45 .47 .57 .67 .28 .57	.03 .06 .12 .20 .26 .57 .82 .82 .78 .77 .54 .15 .44	0 .15 .22 .34 .35 .26 .26 .33 .80 .91 .55 .84 1.42	0.03 .10 .30 .28 .44 .51 .53 .58 1.04 .55 .42 .51 .50	0 .11 .38 .68 .61 .37 .28 .32 .41 .61 .77 .41 .50

Table 6. Estimates of Stock Size and Fishing Mortality for North Sea Saithe from Virtual Population Analysis (M = 0.2).

 $F_{I}$  = Assumed value of F in the last year used to initiate the analysis.

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Estimates of Stock Size and Fishing Mortality for Saithe at Iceland from Virtual Population Analysis (M = 0.2) Table 7.

Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
2	41	45	115	76	151	116	106	106	219	484	
3	30	34	36	94	62	124	95	87	87	179	396
4	23	25	24	28	71	48	100	77	70	70	145
5	9	19	17	15	21	48	35	80	60	55	53
6	4	8	11	10	10	14	32	26	60	46	40
7	3	3	5	6	6	6	10	23	17	44	32
8	3	3	2	3	3	. 4	4	7	14	11	27
9	2	2	2	1	2	2	2	2	4	9	7
10	0.7	1	2	1	0.8	1	1	2	1	3	6
11	0.5	0.6	0.9	1	0.8	0.6	0.7	0.5	0.9	0.9	2
12	0.5	0.4	0.4	0.6	0.6	0.6	0.4	0.5	0.3	0.6	0.7
13		0.4	0.2	0.2	0.3	0.4	0.4	0.2	0.3	0.4	0.4
14			0.3	0.1	0.1	0.2	0.3	0.2	0.1	0.2	0.7

STOCK NUMBERS (millions)

FISHING	MORTALITY
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1	1.0		Ť.		FISHI	NG MORT.	ALITY					FI
2	0	.01	0	.01	0	0	0	0	0	0		-
3	0	.15	.05	.07	.06	.02	.01	.01	.01	.01	0	
4	0	.19	.26	.09	.20	.12	.02	.05	.04	.07	.04	.01
5	0	.33	.29	.21	.21	.19	.11	.08	.07	.12	.11	.10
6	0	.33	•45	.38	.29	.19	.15	.20	.12	.17	.18	.20
7	0	.22	.29	.43	.26	.27	.16	.27	.23	.26	.24	.30
8	0	.14	.24	.38	.22	.22	.24	.22	.26	.32	.27	.30
9	0	.13	.18	.30	.18	.21	.20	.28	.17	.26	.33	.30
10	0	.22	.19	.26	.21	.19	.21	.26	.29	.18	.26	.30
11	0	.27	.19	.30	.15	.22	.23	.23	.27	.13	.17	.30
12	0	.40	.27	.42	.17	.18	.23	.18	.22	.21	.33	.30
13		.06	.16	.42	,22	.22	.33	.66	.32	.02	.27	.30
14			.05	.18	.33	.31	.32	• 35	.60	.29	.31	.30
15		1 - a* -								100		.50

<u>Table 8.</u> Estimates of Stock Size and Fishing Mortality for Saithe at Faroe from Virtual Population Analysis (M = 0.2)

	1.00	and the second		1 Adams to	1	1. 1. 1. 1. 1. 1.	1	() · ·	11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	· · · · ·	1. C. M. C
Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
2 3 4 5 6 7 8 9 10 11 2 3 14	9.3 10 6.5 4.4 3.0 2.2 1.4 1.1 0.56 0.15 0.16	14 7.4 7.0 5.0 3.2 2.0 1.6 0.97 0.79 0.39 0.09 0.09 0.10	22 12 59 5.4 3.7 2.3 1.5 1.2 0.69 0.57 0.28 0.05 0.0	13 18 8.9 4.3 3.9 2.6 1.6 1.1 0.84 0.46 0.40 0.20 0.03 0.05	18 11 14 7.0 3.3 2.8 1.7 1.1 0.74 0.54 0.29 0.18 0.11 0.02	14 15 8.3 9.9 4.5 2.1 1.8 1.1 0.77 0.48 0.36 0.17 0.11 0.06	19 12 11 6.1 6.6 2.8 1.3 1.1 0.59 0.45 0.25 0.19 0.06 0.06	14 15 9.1 8.0 3.9 4.0 1.6 0.74 0.66 0.31 0.23 0.13 0.11 0.02	53 12 12 6.8 5.4 2.6 2.3 0.92 0.43 0.39 0.17 0.13 0.07 0.08	30 43 9.1 8.4 4.6 3.5 1.6 1.3 0.53 0.24 0.24 0.09 0.07 0.03	25 34 5.5 4.8 2.5 1.8 0.80 0.54 0.22 0.09 0.11 0.04 0.03
			4 1		FISHI	NG MORT	ALITY	•	•		
2 3 4 5	0.03 0.19 0.07 0.12	0.01 0.03 0.06 0.11	0.00 0.06 0.11 0.13	0.01 0.04 0.04 0.09	0.01 0.07 0.15 0.25	0.01 0.11 0.12 0.21	0.00 0.05 0.16 0.24	0.01 0.04 0.09 0.19	0.00 0.06 0.16 0.19	0.00 0.03 0.29 0.36	0.06

15+ STOCK NUMBERS (millions)

	1999	4 1		FISHI	NG MORT.	ALITY	· · · ·				FI
0.03 0.19 0.07 0.12 0.18 0.13 0.18 0.13 0.18 0.17 0.17 0.25 0.22	0.01 0.03 0.06 0.11 0.15 0.12 0.09 0.14 0.12 0.14 0.12 0.14 0.38	0.00 0.06 0.11 0.13 0.16 0.15 0.10 0.13 0.20 0.15 0.12	0.01 0.04 0.09 0.13 0.19 0.15 0.19 0.23 0.25 0.61	0.01 0.07 0.15 0.25 0.22 0.24 0.29 0.18 0.24 0.21 0.35	0.01 0.11 0.12 0.21 0.27 0.30 0.28 0.38 0.38 0.34 0.44 0.45	0.00 0.05 0.16 0.24 0.31 0.36 0.37 0.32 0.45 0.46 0.50	0.01 0.04 0.09 0.19 0.22 0.35 0.35 0.35 0.34 0.33 0.37 0.38	0.00 0.06 0.16 0.19 0.24 0.26 0.36 0.35 0.38 0.28 0.45	0.00 0.03 0.29 0.36 0.41 0.44 0.51 0.67 0.67 0.74 0.60	0.06 0.23 0.37 0.41 0.50 0.57 0.56 0.67 0.55 0.82	-1 .2 .3 .4 .5 .5 .6 .6 .75
	0.07	0.32 0.25	0.41 0.33	0.32 0.33	0.84 0.37	0.35 0.92	0.36 0.11	0.40 0.56	0.57 0.61	0.63 0.49	•5

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Table 9. Estimates of Stock Size and Fishing Mortality for West of Scotland Saithe from Virtual Population Analysis (M = 0.2).

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Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	
2	7.0	6.9	16	13	23	16	14	19	11	13		
3	5.4	5.5	5.6	13	11	19	13	11	15	9	11	
4	2.6	3.3	3.9	3.7	9.1	6.4	12	7.9	7.4	10	5.7	1.
5	3.4	1.3	1.8	2.1	2.4	4.9	2.6	5.8	3.9	4.0	4.4	
6	1.3	1.5	0.81	1.0	1.4	1.2	2.5	1.0	3.0	2.1	2.0	
7	0.53	0.73	0.80	0.51	0.63	0.80	0.55	1.4	0.59	1.9	1.3	
8	0.55	0.31	0.43	0.43	0.35	0.34	0.42	0.32	0.73	0.35	1.1	
9	0.46	0.36	0.19	0.27	0.22	0.24	0.20	0.31	0.18	0.49	0.20	
10	0.93	0.29	0.19	0.12	0.17	0.12	0.13	0.14	0.21	0.13	0.33	1.
11	0.06	0.72	0.16	0.09	0.10	0.10	0.07	0.10	0.09	0.15	0.08	1
12	0.03	0.05	0.04	0.11	0.06	0.05	0.04	0.04	0.07	0.06	0.11	
13		0.03	0.03	0.02	0.08	0.04	0.04	0.03	0.03	0.05	0.04	
14			0.02	0.02	0.01	0.05	0.02	0.03	0.02	0.02	0.03	

STOCK NUMBERS (millions)

FISHINC	MORTALTTES
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2	0.04	0.02	0.04	0.01	0.01	0.02	0.01	0.02	0.01	0.03	
3	0.28	0.16	0.20	0.14	0.31	0.21	0.28	0.22	0.19	0.26	0.35
4	0.47	0.40	0.40	0.23	0.42	0.72	0.56	0.51	0.40	0.63	0.59
5	0.62	0.31	0.39	0.19	0.49	0.49	0.73	0.45	0.40	0.49	0.58
6	0.35	0.43	0.27	0.27	0.38	0.61	0.37	0.35	0.25	0.29	0.39
7	0.32	0.33	0.42	0.17	0.41	0.46	0.32	0.44	0.32	0.37	0.22
8	0.23	0.30	0.26	0.48	0.18	0.34	0.11	0.37	0.20	0.38	0.22
9	0.26	0.42	0.23	0.23	0.36	0.38	0.16	0.17	0.18	0.19	0.26
10	0.05	0.40	0.52	0.05	0.33	0.40	0.10	0.25	0.12	0.20	0.21
11	0.05	0.45	0.13	0.33	0.43	0.69	0.22	0.17	0.15	0.13	0.30
12	0.03	0.34	0.48	0.17	0.20	0.14	0.20	0.32	0.12	0.15	0.22
13		0.29	0.31	0.19	0.29	0.45	0.16	0.37	0.18	0.19	0.35
14 15+		in sector	0.64	0.38	0.41	1.4	0.34	0.30	0.15	0.28	0.14

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		Percentage by Weight				
Country	Length	I + IIa	IV	Va	VЪ	VI
England	-30	0	0	0	0	0
	35	<0.1 <	0.1	0	<0.1	k0.1
algorit-strait Y.	40	0.4	1.0 <	:0.1	0.2	0.1
Germany	30 .	0	0	0	0	
	35	0	0	0	0	
	40	< 0.1	0	<0.1	<0.1	
Netherlands	30 5.		0		1	
	35	1.1	0.1			
	40		1.0			
U.S.S.R.	30	< 0.1	0			
	35	0.6	0.2			1.1.1
	40	6.6	2.8			
Norway	30	0				1
(Sub-area I + IIa North of 64°N)	35	1.3	100		1.1	
inter of of it)	40	6.7			12.25	
Norway	30	4.0	1.1		1.4.5	
(Sub-area IIa South of 64°N)	35	18.0				
50000 01 04 II)	40	45.1				

Table 10. Percentages by Weight of Saithe less than 30, 35 and 40 cm in Length in the Landings from the Different Areas<sup>1</sup>)

> 1)Germany (except IV), Norway and U.S.S.R. averaged for 1970-72. Germany (Division IV) and England averaged for 1970-71.

Table 11. Lengths of Saithe Corresponding to Different Rates of Retention. Selection Factor: 3.8.

т. 1. Мак. у к. — .	Mark Gine (m)					
. t.	· · ·		mean 5	ize (mm	·/··	
n n n n N n n	% Retention	80	110	130	145	
	5	18.4	29.0	37•4	43.1	
•	25	26.2	37.6	45.2	50.9	
	50	30.4	41.8	49•4	55.1	
	75	35.0	46.4	54.0	59•7	
	95	41.2	52.6	60.2	65.9	

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	(a) North-East Arctic			(b) Iceland			
<u></u>	England <sup>1)</sup>	Germany <sup>2)</sup>	Norway <sup>3)</sup> (Trawl)	Norway <sup>4)</sup> (Other Gears)	USSR <sup>5)</sup>	England	Germany
Length cm.	1970-71	1970-72	1970-72	1970-72	1970-72	1970-71	1970-72
<30			- 17	9 481	48		
30-34	14			24 091	608		
35-39	75	38	24	36 208	4 307	3	1
40-44	219	309	717	40 047	5 367	48	32
45-49	538	607	2 057	25 500	4 178	133	191
50-54	1 041	1 016	1 765	7 554	2 635	235	630
55-59	1 067	1 1 37	1 412	2 858	1 877	318	1 201
60-64	944	1 321	1 162	1 477	1 526	387	1 557
65-69	619	1 158	879	1 047	1 092	454	1 638
70-74	272	922	632	955	733	562	1 474
75-79	135	619	243	844	560	582	1 254
80-84	86	351	137	1 117	339	549	929
85-89	60	194	76	478	196	450	575
90-94	41	82	30	241	81	274	267
95-99	16	42	19	72	54	144	109
100-104	6	19	4	110	34	52	29
105-109	3	13	4	39	11	23	12
110+	3	7	2	15	11	10	3

Table 12. Average Length Compositions of Saithe Landings from the North-East Arctic and from Iceland. Total Landings - Thousands of Fish.

1)<sub>Division</sub> I, Sub-areas IIa and IIb. 2)<sub>Sub-area</sub> IIa.

3) Division I, Sub-area IIa North of 64°N and IIb.
4) Includes trawl landings from IIa South of 64°N.
5) Sub-area IIa.

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Length/Weight Relationship for Saithe Based on German Data. Fitted Relationship: Iceland  $W = 1^{3.12} \times 5.4 \times 10^{-6}$ Lofoten  $W = 1^{3.15} \times 4.4 \times 10^{-6}$ 

Length (cm)	Whole Weight (kg)					
	 Iceland	Lofoten				
32.5	.281	.255				
37.5	.440	.400				
42.5	.650	.593				
47.5	.92	.84				
52.5	1.25	1.13				
57.5	1.70	1.50				
62.5	2.20	1.95				
67.5	2.75	2.52				
72.5	3.45	3.15				
77.5	4.25	3.85				
82.5	5.15	4.70				
87.5	6.25	5.68				
92.5	7.40	6.75				
102.5	10.15	9.40				
107.5	11.76	10.85				
112.5	13.55	12.72				

Table 14. Effects of an Increase in the Minimum Trawl Cod-End Mesh Size from 130 to 145 mm in the North-East Arctic and Iceland Areas. M = 0.2, S.F. = 3.8, E = 0.7.

n Anna Anna Alana an ann an an	Immediate Loss %	Long-Term Change %
North-East Arctic	ร้าน เราสำเว็จราย	
England	19	-1
Germany	11	+10
Norway (Trawl)	23	-4
U.S.S.R.	34	-18
Others (Trawl)	19	-1 -1
Norway 'Other Gears'	0	+11
Iceland	1	
England	3	4
Germany	5	-2
Other Countries	3	-4



Figure 1 Catch per unit effort of saithe by statistical area for English (solid lines) and German (broken lines) trawlers.

C.M.1973/F:10





Figure 1 (continued)

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Figure 2 Trends in estimates of total fishing effort on saithe by statistical area. German units: open circles, English units: solid circles.

C.M. 1973/F:10



Figure 3

Mean lengths of age groups of saithe in English and German landings from Faroe, Norway Coast and Iceland.