

This paper not to be cited without prior reference to the Council^{x)}

International Council for the
Exploration of the Sea

C.M.1974/F:2
Demersal Fish (Northern) Committee

Björn J.

Report of the Saithe (Coalfish) Working Group

Charlottenlund, 4 - 8 February 1974

<u>Contents</u>	<u>Page</u>
1. Participants	1
2. Terms of Reference	1
3. Catch and Fishing Effort	1
4. Mortality Estimates from Catch per Unit Effort Data	1
5. Virtual Population Analysis	1
6. Growth	3
7. Yield per Recruit and Age at First Capture	3
8. The Effect on the Saithe Fisheries of the Arrangement Relating to Fisheries in Waters Surrounding the Faroes	3
9. Length-Weight Data	4
10. 0-Group Saithe Survey	5
Tables 1 - 14	6
Figures 1 - 2	15

^{x)} The General Secretary,
ICES,
Charlottenlund Slot,
2920 Charlottenlund,
Denmark.

Report of the Saithe (Coalfish) Working Group

Charlottenlund, 4 - 8 February 1974

1. Participants:

Mr N.N. Argurov	U.S.S.R.
Mr N. Daan	Netherlands
Mr K. Hoydal	Denmark
Mr A. Hysten	Norway
Mr T. Jakobsen	Norway
Mr B.W. Jones (Chairman)	U.K. (England)
Mr E.S. Prosivirov	U.S.S.R.
Dr H.H. Reinsch	Germany (F.R.)
Mr J. Richards	U.K. (Scotland)

Mr D. de G. Griffith ICES Statistician, also
attended the Meeting.

2. Terms of Reference

The Working Group was asked to update assessments of the state of the saithe stocks and to assess the effect of the new fisheries regulation at Faroes upon these stocks (C.Res.1973/2:21).

3. Catch and Fishing Effort

Tables 1, 2 and 3 are reproduced from the previous report with the addition of data for 1972 and provisional estimates for 1973. Recent catches from the north-east Atlantic have remained stable at about 600 000 tons. There has been little change in the last two years in the landings from the individual fishing areas with the exception of Faroe where there has been an increase in the reported landings, particularly by French vessels.

The data of catch per unit effort and estimates of total fishing effort (Tables 2 and 3) have to be accepted with caution, and the limitations of of these data are discussed in Sections 3.2 and 3.3 of the Report of the 1973 Meeting.

4. Mortality Estimates from Catch per Unit Effort Data

Table 4 has been updated. The recent data do not change the earlier conclusion of the Working Group that the method used does not provide very reliable total mortality estimates for the saithe fisheries.

5. Virtual Population Analysis

At the previous (1973) Meeting of the Working Group, data were assembled for Virtual Population Analysis (VPA) for all main fishing areas except the north-east Arctic. Preliminary analyses were made with the available data. At the present Meeting data were presented for the north-east Arctic and the data for all areas were updated to include landings in 1972.

Analyses were made and the results were inspected to assess whether the initial assumed values of the fishing mortality coefficient for the oldest age-groups of each yearclass (F_I) appeared to be consistent with the calculated values for the younger age-groups. Further analyses were made with different values for F_I where these were considered desirable. A VPA was also made using the combined data for all areas.

5.1. Results

The VPA method suffers from the disadvantage that estimates of mortality for the most recent years can be subject to error if the assumed values of fishing mortality in the most recent year (F_I) are incorrect. However, errors resulting from incorrect assumptions become reduced in the earlier years. The final values of F_I which were used were based on an inspection of the preliminary runs and interpolation of the trend of fishing mortality with what the recent changes in fishing effort were believed to be. The resultant values of fishing mortality for a natural mortality coefficient = 0.2 are tabulated in Tables 5 - 10. At Faroe and west of Scotland fishing mortality appears to have remained fairly constant over the period, but in the other areas there has been a trend of increasing fishing mortality and this has been particularly marked in the north-east Arctic and northern North Sea. The results for the combined data for all areas will be closely related to the estimates for the Arctic and North Sea because the numbers of fish caught in these two areas are much larger than in the other areas and together account for about 85% of the catch in the north-east Atlantic. Bearing in mind the limitations of the VPA method in providing accurate estimates of fishing mortality in the most recent years, the Working Group believes that the present levels of F on the fully exploited age-groups in the various fishing areas lie within the limits indicated below:

Area	Fishing Mortality
North-east Arctic (I + IIa)	0.4 - 0.6
Northern North Sea (IV)	0.5 - 0.7
Iceland (Va)	0.3 - 0.5
Faroe (Vb)	0.2 - 0.5
West of Scotland (VIa)	0.2 - 0.4
All areas combined	0.4 - 0.6

Estimates of yearclass strength as population size of 2 year old fish are given in Table 11. With the exception of the yearclasses 1967 onwards, the sum of the populations in the areas separately agrees very closely with the population size calculated from the combined total catch data.

In the VPA calculations described above no allowance has been made for migration of saithe between the different areas. It is well known from the results of tagging experiments that such long distance migrations do take place, but the magnitude and regularity of the migrations are not sufficiently well known to be expressed in a quantitative manner which could be incorporated in the calculations.

6. Growth

Growth data were available as mean length at age over a period of years for each stock. von Bertalanffy growth parameters were calculated for each area by a least squares fit of the growth curve, and the results are given in Table 12.

7. Yield per Recruit and Age at First Capture

The yield per recruit (Y_w/R) for each area was calculated for a range of values of instantaneous fishing mortality coefficient (F) and mean age at first capture (t_c), using a constant value of the instantaneous coefficient of natural mortality (M) of 0.2. The calculations were based on the Beverton and Holt yield equation, and the von Bertalanffy growth parameters used were those calculated from the English data:-

	I+II	IVa	Va	Vb	VIa
W_∞ (kg)	17.2	14.5	15.3	12.2	16.4
K	0.104	0.120	0.141	0.145	0.106
t_0 (years)	-1.26	-1.47	-0.50	-1.30	-1.91

W_∞ was calculated as $L_\infty^3 \times 8 \times 10^{-6}$ kg. Age at recruitment (t_r) was taken as 2 years in all cases, and maximum age as 25 years. The results are presented in Table 13 and Figures 1 and 2. The graphs show the relationship between yield per recruit and F for the estimated present mean age at first capture (Figure 1), and the relationship between yield per recruit and mean age at first capture at present levels of F (Figure 2). The results indicate that at Iceland and Faroe the present values of t_c are optimum for the present levels of F . In the other areas the present value of t_c is lower than that required to give maximum yield per recruit at current estimated levels of F . In Table 13 the average number of 2 year old recruits (mean for the period 1962 - 1966) is given for each area. The present theoretical total catch (weight) from each area is calculated from yield per recruit $\times$ number of recruits. Some discrepancies between the calculated present yield and the observed landings must be expected, due to variation in recruitment. This can be compared with the estimated catch using the yield per recruit which would be obtained if the age at first capture was adjusted to the optimum value at the current levels of F . This indicates that an increase in the average age at first capture would result in increases in the total catches of 25%, 12% and 10% for the north-east Arctic, North Sea and west of Scotland areas respectively.

The Report of the 1973 Meeting of the Working Group includes an assessment of the effects of an increase in the minimum trawl cod-end mesh size in the north-east Arctic and at Iceland.

8. The Effect on the Saithe Fisheries of the Arrangement Relating to Fisheries in Waters Surrounding the Faroes

According to Article 2 in the Arrangement, which refers to species other than cod and haddock, the countries fishing in the area are placed in 3 categories:

Category 1 are those countries "...directing their fisheries in the area solely towards demersal species other than those covered by Article 1...." (i.e. cod and haddock). The countries in this category fishing

with trawl "....shall not exceed by more than 10% the highest figure they have respectively achieved" in the period 1968 - 1972. The countries in this category fishing solely by gill-nets and line shall not exceed by more than 25% the highest figure in the same period. This allows up to a 10% increase for France and Germany (F.R.) and a 25% increase for Norway.

Category 2 are those countries "....which have not habitually exercised fishing in the area....". They shall limit their catches of species other than cod and haddock to 2 000 tons each.

Category 3 are those countries which primarily direct their fishing towards cod and haddock. These countries are the U.K. and Faroes. No restriction is placed on their fishery of species other than cod and haddock.

Thus within the terms of the Arrangement, and if saithe catches increase by the stated percentages, catches that may be taken by Germany (F.R.), France and Norway as follows:

Country	Largest catch in period 1968-72 (tons)	Percentage increase	Catch (tons)
France	28 346	10	31 181
Germany (FR)	7 532	10	8 285
Norway	1 839	25	2 299

However, it is not possible to predict changes in catch by the U.K. or the Faroes, nor is it possible to predict how many countries, not previously fishing at Faroe, might opt to do so and take a catch of saithe of up to 2 000 tons.

In the circumstances no detailed quantitative estimates can be given of the effect of the Arrangement on the saithe fishery. Landings from Faroe have increased in the last two years. However, within the terms of the Arrangement it is likely that, in the near future, any overall increase in saithe landings will be a moderate one, and would probably not exceed 10%. As indicated in Section 7 of this Report, the present fishery appears to be generating a fishing mortality within the range 0.2 to 0.5, and the present average age at first capture is consistent with that required to give a maximum yield per recruit at this level of F. Provided there is no change in the fishery towards increasing exploitation of the youngest age-groups, it is likely that the stock will be able to withstand a moderate increase in the amount of fishing.

9. Length-Weight Data

Table 13 in the 1973 Working Group Report gave length-weight data for the Iceland and Lofoten areas. The weight data were calculated from equations which fitted German length-weight observations. It was subsequently discovered that some of the calculated weights given in the table were incorrect and a revised version of the table is at Table 14 in this Report.

10. O-Group Saithe Survey

The representatives of the U.S.S.R. reported that a survey of O-group saithe was made last year in the northern North Sea by a U.S.S.R. vessel. No data from this survey were available at the present Meeting. The Working Group recommends that the Chairman of the Meeting to investigate the methodology of young fish surveys invites U.S.S.R. representatives to report to that Working Group the results and methods used in the U.S.S.R. O-group saithe survey.

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

Fishing Area Year	I	IIa	IIb	IV	Va	Vb	VI	TOTAL
1946	5 557	27 059	506	23 155	41 569	5 325	4 781	107 952
1947	15 498	46 560	958	31 929	43 379	8 759	5 596	152 679
1948	29 754	62 037	861	29 204	114 286	3 569	4 622	244 333
1949	33 551	61 449	357	27 079	87 045	6 114	3 730	219 325
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
1972	30 480	175 995	241	198 621	107 825	46 580	16 473	576 215
1973 ¹⁾	26 886	185 459	477	181 875	113 241	59 881	19 808	587 627

¹⁾ Provisional data.

Table 2. Catch per Unit Effort of Saithe by Statistical Areas for English and German Trawlers.
English data (E) and Icelandic data (I) tons per million ton-hours.
German (F.R.) data (G.) kg per fishing day.

Statistical Area	I		IIa		IVa		Va		Vb		VIa	
Country	E.		E.	G.	E.		E.	G.	E.	G.	E.	
1946	29	277			73		308		330		147	
1947	74	552			148		339		403		151	
1948	93	571			112		287		218		80	
1949	75	417		2 911	68		208	3 206	273		64	
1950	62	110		5 323	60		136	3 647	160		56	
1951	47	124		6 051	92		123	4 348	237		79	
1952	39	176		7 379	231		113	3 867	216		108	
1953	49	148		7 052	495		101	2 115	260		88	
1954	30	169		9 296	369		99	2 742	227	46	88	
1955	27	176		8 164	364		76	2 186	245	476	88	
1956	35	121		6 033	388		77	3 705	259	6 240	132	
1957	39	164		7 878	315		61	3 416	182	11 507	187	
1958	36	168		7 310	341		60	2 501	243	3 804	218	
1959	36	100		6 492	352		56	2 678	202	5 447	204	
1960	35	149		7 539	303	222	54	2 407	161	3 914	180	
1961	16	89		6 154	253	182	54	2 851	225	3 579	153	
1962	14	93		6 932	231	211	51	3 025	186	2 539	135	
1963	12	103		6 110	281	190	55	2 105	214	2 876	142	
1964	45	114		5 252	269	161	61	2 269	266	3 801	136	
1965	38	135		7 772	373	186	64	1 652	342	2 561	293	
1966	44	189		6 884	344	183	54	1 768	278	3 648	305	
1967	24	122		7 428	331	308	74	2 411	276	4 456	251	
1968	27	119		6 410	166	356	90	1 915	398	3 995	233	
1969	33	129		7 663	229	538	149	3 946	359	7 116	189	
1970	51	151		13 542	226	440	92	3 405	411	4 119	285	
1971	36	134		7 546	136		116	4 417	451	2 842	238	
1972	35	129		11 087	107		65	3 918	247	2 810	164	

Table 3. Estimates of Total Fishing Effort on Saithe in English, German and Scottish Units.

Total effort = $\frac{\text{Total landings}}{\text{National catch per unit effort}}$

English 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 (Trawl)		IV		Va			Vb			VIa	
	E.		E.		E.		E.		G.	I.	E.	G.	S.	E.
1946	192				317	135					16			33
1947	201				216	128					22			37
1948	320				261	398					16			58
1949	447				398	418					22			58
1950	472				352	406			27		34			59
1951	351				241	602			15		37			55
1952	364				101	778			17		32			62
1953	380				46	724			23		28			71
1954	372				98	703			35		27			76
1955	496				123	630			25		30			66
1956	438				132	881			22		42			62
1957	417				176	1			18		118			56
1958	432				148	886			21		53			63
1959	495				146	866			18		72			55
1960	504				104	891			20		74			56
1961	1 038				140	941			23	217	43			50
1962	818				106	990			17	279	56		594	50
1963	1 783				108	873			23	239	59		525	49
1964	1 238				218	988			27	253	77		528	68
1965	491				196	940			36	374	65		420	62
1966	386				264	963			29	323	88		470	61
1967	644				232	1 023			31	284	84		470	64
1968	404				591	862			41	246	50		329	54
1969	592				505	778			29	218	77		237	87
1970	708				795	1 267			34	215	71		383	51
1971	1 068				1 541	1 156			30	265	68		261	47
1972	871				1 856	1 659			28		189		260	100

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

Statistical Area	IIa		IV			Va		G.	Vb		VIa
	G.	E.	E.	G.	S.	G.	E.		E.	S.	
Country	(5-11)	(5-9)	(4-10)	(5-10)	(3-8)	(6-11)	(4-9)	(6-12)	(5-10)	(4-8)	(4-9)
Age Groups Years											
1949-50	-0.40					0.45					
1950-51	0.31					-0.34					
1951-52	0.16					0.92					
1952-53	0.44					1.00					
1953-54	0.52					0.51					
1954-55	0.65					1.17					
1955-56	0.93					0.20					
1956-57	0.91	0.57				0.63		-0.67			
1957-58	0.32	0.45				0.60		0.98	0.57		0.29
1958-59	1.30	1.11				0.79		-0.57	0.57		0.75
1959-60	-0.23	0.61				0.62		0.47	0.80		0.50
1960-61	0.77	1.61				0.70		0.68	0.03		0.71
1961-62	0.59	0.45	1.40			0.31	0.53	0.43	0.61		0.89
1962-63	0.02	1.24	0.65			0.34	0.79	-0.02	0.34		0.57
1963-64	0.33		0.75			1.27	0.77	0.51	0.54		0.26
1964-65	-0.31		1.31	1.66		1.25	0.29	0.24	0.00		1.28
1965-66	0.41	0.20	1.40	-0.90		0.53	0.42	0.04	0.92		0.65
1966-67	0.27	1.12	0.44	0.19		0.45	-0.26	0.06	0.65		0.82
1967-68	0.29	0.75	1.49	0.56		0.63	-0.10	0.63	0.34		1.00
1968-69	0.52	0.81	0.21	-0.56		0.15	-0.38	-0.48	0.87		0.46
1969-70	-0.56	0.42	0.53	-0.72		0.40	0.63	0.61	0.14		0.56
1970-71	0.68	0.80	1.70	1.24	0.77	0.22	-0.10	1.01	0.75	0.55	0.43
1971-72	-0.18	1.01	0.75	-0.68		0.90	0.72	0.19	0.66		

Table 5. North-East Arctic (I + II) Saithe

Estimates of Fishing Mortality from Virtual Population Analysis ($M = 0.2$)

Year Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 F _I
2	.08	.03	.00	.03	.07	.22	.04	.05	.02	.02	.08	.09	.2
3	.17	.28	.28	.19	.13	.17	.25	.22	.27	.41	.22	.43	.4
4	.20	.22	.29	.37	.46	.10	.40	.48	.21	.20	.69	.55	.5
5	.51	.30	.16	.24	.29	.38	.38	.51	.17	.31	.38	.51	.5
6	.28	.26	.34	.25	.17	.37	.32	.20	.21	.23	.54	.32	.5
7	.34	.11	.27	.26	.31	.26	.29	.22	.05	.18	.42	.51	.5
8	.28	.10	.12	.18	.28	.31	.20	.30	.11	.10	.49	.28	.5
9	.19	.09	.14	.17	.33	.53	.22	.32	.14	.14	.33	.41	.5
10	.22	.08	.11	.14	.30	.31	.36	.58	.21	.15	.49	.24	.5
11	.31	.17	.13	.15	.33	.43	.36	.62	.32	.10	.40	.65	.5
12	.39	.26	.19	.15	.41	.30	.46	1.17	.35	.18	.68	.59	.5
13		.18	.56	.34	.26	.43	.58	1.17	.94	.07	.80	.39	.5
14 = F _I			.2	.2	.2	.2	.3	.3	.3	.3	.5	.5	.5

Ages

Average values

4-10	.29	.17	.20	.23	.31	.32	.31	.37	.16	.19	.48	.41
------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 6. North Sea (IV) Saithe

Estimates of Fishing Mortality from Virtual Population Analysis ($M = 0.2$)

Year Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 F _I
1													
2	.03	.02	.03	.01	.03	.00	.04	.03	.00	.00	.00	.00	.01
3	.25	.14	.12	.03	.12	.07	.07	.07	.01	.05	.02	.12	.1
4	.28	.43	.27	.23	.16	.30	.29	.13	.15	.11	.19	.43	.4
5	.34	.28	.26	.37	.28	.28	.42	.21	.23	.30	.44	.63	.5
6	.26	.34	.15	.16	.24	.18	.34	.24	.37	.31	.69	.51	.6
7	.08	.22	.06	.08	.19	.19	.49	.53	.24	.50	.69	.40	.6
8	.02	.11	.03	.04	.21	.12	.35	.82	.23	.58	.46	.49	.6
9	.01	.09	.02	.04	.25	.06	.45	.67	.23	.49	.34	.56	.6
10	.01	.25	.03	.02	.17	.10	.47	.78	.33	.51	.29	.68	.6
11		.14	.08	.04	.15	.08	.56	.80	.53	1.09	.34	.62	.6
12	.02	.17	.07	.14	.08	.05	.42	.51	.93	.28	.69	.54	.6
13		.09	.03	.13	.36	.05	.21	.08	.59	.46	.27	.97	.6
14 = F _I			.1	.1	.2	.2	.3	.3	.78	.57	.45	.11	.6

Ages

Average values

4-9	.16	.24	.13	.16	.22	.18	.39	.43	.29	.45	.48	.54
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 7. Iceland (Va) Saithe
Estimates of Fishing Mortality from Virtual Population Analysis (M = 0.2)

Year Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 F _I
2		.01	-	.01	-	-	-	-	-	-	-	-	.001
3		.15	.05	.08	.06	.02	.01	.02	.02	.02	-	.01	.02
4		.20	.26	.11	.21	.13	.03	.06	.05	.11	.09	.07	.1
5		.34	.30	.21	.25	.21	.12	.10	.09	.15	.17	.23	.2
6		.33	.47	.39	.30	.23	.17	.24	.16	.22	.24	.37	.3
7		.20	.29	.45	.27	.28	.21	.32	.28	.36	.34	.44	.4
8		.13	.21	.38	.23	.23	.24	.30	.33	.42	.42	.50	.4
9		.13	.17	.26	.18	.23	.21	.29	.25	.34	.48	.60	.4
10		.22	.18	.24	.17	.19	.23	.28	.30	.31	.39	.55	.4
11		.26	.19	.29	.14	.18	.23	.26	.30	.13	.33	.55	.4
12		.54	.26	.42	.16	.16	.17	.18	.25	.25	.35	.79	.4
13		.29	.24	.39	.22	.21	.29	.43	.32	.12	.34	.33	.4
14 = F _I			.3	.3	.3	.3	.3	.3	.3	.3	.4	.4	.4

Ages

5-6	.33	.38	.30	.27	.27	.22	.14	.17	.12	.18	.20	.30
7-11	.19	.21	.27	.20	.22	.22	.22	.29	.29	.31	.39	.53

- 11 -

Table 8. Faroe (Vb) Saithe
Estimates of Fishing Mortality from Virtual Population Analysis (M = 0.2)

Year Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 F _I
2	.03	.01	.00	.01	.00	.01	.00	.01	.01	.00	.04	.01	.05
3	.19	.03	.05	.03	.05	.05	.03	.03	.04	.04	.07	.19	.2
4	.07	.06	.10	.04	.13	.08	.10	.05	.11	.17	.30	.21	.3
5	.12	.11	.13	.08	.24	.18	.15	.11	.10	.21	.19	.44	.5
6	.16	.14	.16	.12	.19	.26	.26	.13	.13	.19	.21	.17	.5
7	.15	.11	.14	.19	.23	.26	.34	.28	.14	.20	.17	.16	.5
8	.15	.11	.09	.14	.29	.28	.30	.32	.27	.23	.19	.12	.5
9	.16	.11	.16	.17	.17	.37	.32	.26	.30	.42	.18	.11	.5
10	.16	.11	.15	.29	.20	.31	.44	.32	.27	.55	.31	.13	.5
11	.24	.13	.14	.19	.28	.36	.40	.35	.26	.42	.39	.19	.5
12	.25	.36	.12	.56	.23	.69	.37	.31	.41	.56	.31	.43	.5
13		.08	.30	.38	.27	.45	.72	.24	.30	.50	.55	.12	.5
14 = F _I			.3	.3	.3	.3	.3	.3	.3	.4	.4	.4	.5

Ages

5-10	.15	.11	.14	.16	.22	.28	.30	.24	.20	.30	.21	.19
------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 9. West of Scotland (Vla) Saithe
Estimates of Fishing Mortality from Virtual Population Analysis (M = 0.2)

Year Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 FI
2	.04	.02	.04	.01	.01	.02	.01	.02	.00	.03	.01	.01	.3
3	.28	.16	.19	.13	.30	.21	.28	.22	.18	.24	.39	.22	.5
4	.50	.40	.40	.22	.40	.67	.56	.51	.39	.60	.51	.72	.5
5	.62	.34	.39	.19	.45	.46	.63	.45	.41	.47	.52	.47	.5
6	.36	.43	.30	.27	.38	.54	.33	.27	.25	.29	.37	.34	.35
7	.32	.35	.43	.20	.41	.46	.26	.37	.23	.36	.23	.27	.3
8	.23	.30	.28	.49	.21	.34	.11	.29	.16	.25	.21	.31	.3
9	.15	.41	.23	.25	.37	.49	.16	.17	.13	.14	.15	.29	.3
10	.04	.21	.51	.05	.37	.41	.15	.25	.12	.14	.15	.15	.3
11	.05	.40	.06	.32	.43	.85	.23	.25	.15	.13	.19	.20	.3
12	.02	.30	.40	.07	.19	.14	.28	.33	.19	.15	.23	.17	.3
13		.17	.26	.15	.11	.41	.16	.61	.19	.35	.35	.31	.3
14 = FI			.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3

Ages	Average values												
4-6	.49	.39	.36	.23	.41	.56	.51	.41	.35	.45	.47	.51	
7-10	.18	.32	.36	.25	.34	.42	.17	.27	.16	.22	.18	.25	

Table 10. Total North-East Atlantic (I, II, IV, Va, Vb, Vla) Saithe
Estimates of Fishing Mortality from Virtual Population Analysis (M = 0.2)

Year Age	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 FI
2	.05	.02	.00	.02	.04	.08	.03	.03	.01	.03	.04	.05	.2
3	.17	.20	.21	.14	.11	.11	.11	.12	.16	.20	.17	.29	.3
4	.19	.25	.26	.28	.35	.17	.28	.20	.18	.23	.44	.45	.4
5	.40	.29	.21	.24	.28	.31	.30	.29	.22	.27	.40	.44	.5
6	.25	.27	.31	.25	.21	.31	.28	.22	.23	.32	.47	.35	.5
7	.23	.14	.22	.24	.26	.24	.31	.30	.17	.24	.38	.45	.5
8	.17	.09	.10	.18	.25	.24	.23	.37	.20	.26	.41	.42	.5
9	.14	.08	.10	.14	.25	.34	.26	.33	.20	.24	.34	.49	.5
10	.12	.09	.09	.11	.22	.22	.32	.47	.24	.27	.44	.34	.5
11	.17	.10	.09	.11	.20	.25	.35	.45	.33	.13	.39	.58	.5
12	.15	.22	.09	.14	.18	.16	.31	.52	.28	.22	.41	.64	.5
13		.08	.23	.14	.15	.17	.27	.37	.41	.13	.47	.23	.5
14 = FI			.2	.2	.2	.3	.3	.3	.3	.3	.5	.5	.5

Ages	Average values												
5-10	.22	.16	.17	.9	.24	.28	.28	.33	.21	.27	.41	.41	

Table 11. Estimates from Virtual Population Analysis of Population Size (Millions) at 2 Years of Age of Each Yearclass. Estimates of Size of Yearclasses After 1966 are Less Reliable than for Earlier Yearclasses.

Yearclass Area	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
I + II	105	208	323	106	342	170	207	149	314	300	355	288	70
IV	47	44	53	68	178	156	167	124	360	268	293	131	184
Va	41	39	107	69	123	94	87	71	110	75	64	37	52
Vb	10	15	24	19	28	25	27	23	41	29	22	68	9
VI	7	7	17	14	23	16	14	20	12	12	5	20	
All areas combined	214	314	522	274	692	458	500	382	829	718	906	789	373

Table 12. von Bertalanffy Growth Parameters for Saithe
From English data (1960 - 1971)

	N.E. Arctic	North Sea	Iceland	Faroe	West of Scotland
L_{∞}	129	122	124	115	127
K	0.104	0.120	0.141	0.145	0.106
t_0	-1.26	-1.47	-0.50	-1.30	-1.91

From German data

	N.E. Arctic		North Sea		Iceland		Faroe	
	1947-55	1956-61	1962-72	1964-72	1946-54	1955-61	1957-61	1962-72
L_{∞}	114	112	118	120	112	119	114	119
K	0.123	0.160	0.151	0.161	0.176	0.155	0.172	0.149
t_0	-2.06	-0.82	-0.18	0.20	-0.23	-0.90	-0.36	-0.81

Table 13. Estimates of Catches from the Saithe Fisheries if Age at First Capture was Adjusted to the Optimum Value for Present Levels of Fishing Mortality.

Area	Present		Average number of recruits (millions)	Age at first capture for maximum yield at present F	Yield in weight (thousands of tons)	
	F	Average age at first capture (years)			Present	Maximum
I+II	.50	3.0	236	6.0	221	276
IV	.60	3.5	197	6.0	235	263
Va	.40	5.5	97	6.0	141	141
Vb	.40	5.0	29	5.0	41	41
VI	.40	3.0	17	5.0	20	22

Table 14. Length/Weight Relationship for Saithe Based on German data.
Fitted Relationship: Iceland $W = 13.12 \times 5.4 \times 10^{-6}$
Lofoten $W = 13.15 \times 4.4 \times 10^{-6}$

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	1.26	1.15
57.5	1.67	1.54
62.5	2.17	2.00
67.5	2.75	2.55
72.5	3.45	3.19
77.5	4.24	3.93
82.5	5.15	4.79
87.5	6.19	5.76
92.5	7.36	6.87
97.5	8.67	8.11
102.5	10.14	9.49
107.5	11.76	11.03
112.5	13.55	12.72

Figure 2.

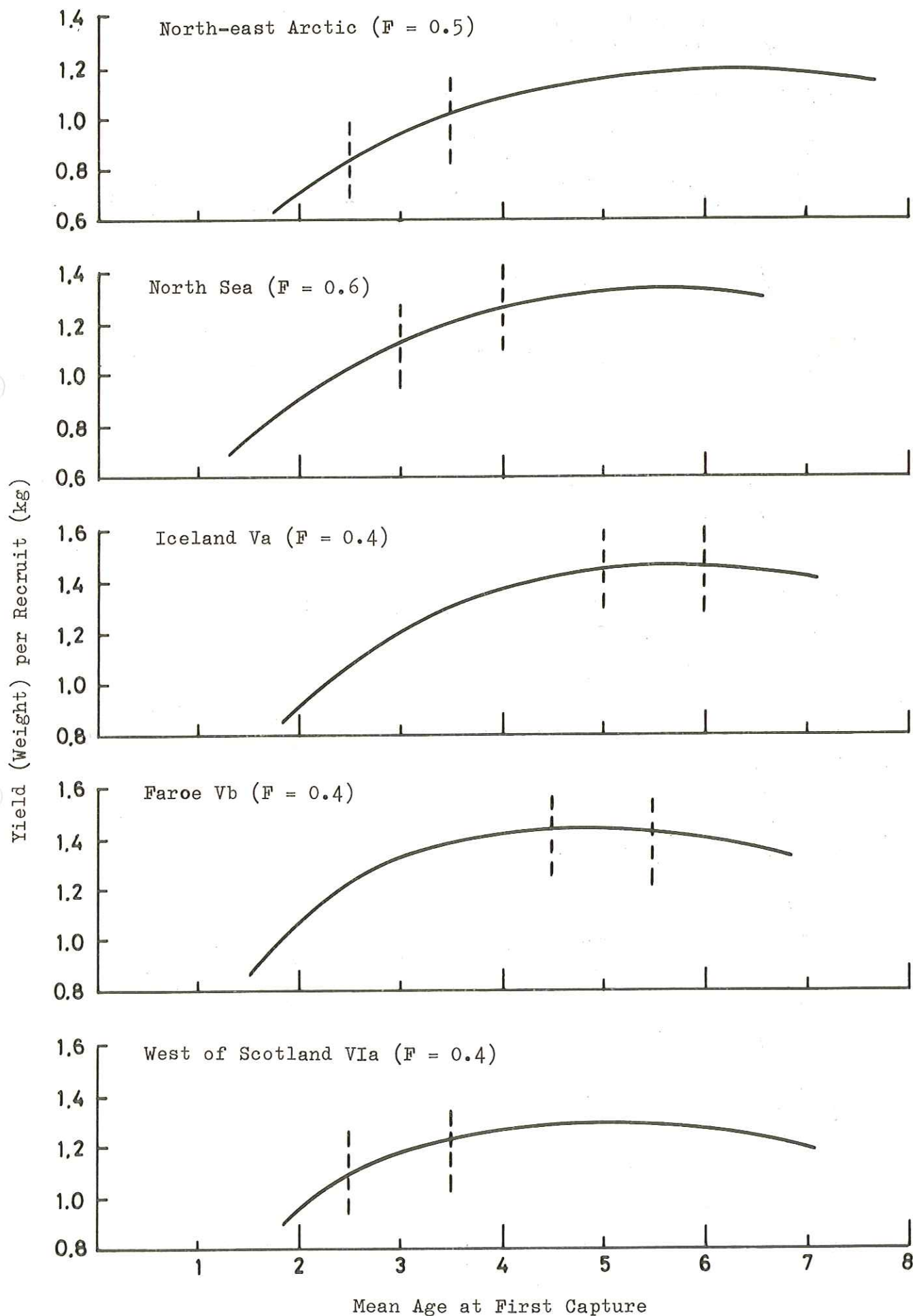


Figure 1.

