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REPORT OF THE SAITHE (COALFISH) WORKING GROUP

Charlottenlund, 2-6 February 1976

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CONTENTS

	<u>Page</u>
1. Participants .....	1
2. Terms of Reference .....	1
3. Landings .....	1
4. Virtual Population Analysis .....	1
5. The State of the Stocks .....	2
6. Estimation of Total Allowable Catches (TACs) .....	2
7. Spawning Stock Size .....	3
8. Exploitation Patterns .....	3
Tables 1 - 29 .....	4
Appendix .....	33
Appendix Figure 1 .....	34

REPORT OF THE SAITHE (COALFISH) WORKING GROUP

1. Participants

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Mr T Jakobsen	Norway
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Mr Yu Riazantsev	U.S.S.R.
Mr J Richards	U.K. (Scotland)
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2. Terms of Reference

The Working Group was asked (C.Res.1975/2:25) to assess TACs for 1977 for the saithe fisheries.

3. Landings

Landings for each country from the main fishing areas for the period 1962-74 are given in Tables 3-7, and preliminary estimates of 1975 landings are given in Table 2 for those countries for which data were available. Catches from the NE Arctic have remained relatively stable over the last five years at about 220 000 tons except for 1974 when the catch was 260 000 tons. In the North Sea the catch has remained steady at about 220 000 tons. At Iceland, however, catches have begun to decline after a period (1969-73) of high catches. At Faroe landings increased to a maximum in 1973 and have since been declining. The trend in the West of Scotland area is similar to that at Faroe. It is possible that the preliminary data for 1975 are underestimates of the landings for some areas.

4. Virtual Population Analysis

Assessments made at the previous meeting of the Working Group (Doc. C.M.1975/F:2) have been updated using provisional age compositions of catches in 1975 and incorporating, where necessary, revisions to the data for earlier years. Revised age compositions for the USSR North Sea catches for 1968-72 have been supplied to the Working Group, and these new data have resolved the problem described in Section 4 of the Report of the 1975 meeting of the Working Group. For the NE Arctic age compositions of USSR catches since 1972 were not available, and there was no preliminary estimate of landings in 1975. The Working Group was informed that the 1975 catch was very low and a value of 2 000 tons has been assumed for the USSR. A catch of 5 000 tons in the NE Arctic was also assumed for Spain.

Age compositions of the catches used as input data for the VPA are given in Tables 8, 11, 14, 17, and 20. (Data for the last 10 years only are tabulated). Calculated estimates of fishing mortality, F, are given in Tables 9, 12, 15, 18, and 21. These tabulations also show the values of F assumed for 1975 which were used to initiate the computation. For the NE Arctic, the North Sea and the Iceland areas the F values for 1975 were chosen on the assumption

that fishing effort had remained at approximately the same level as in the preceding two or three years. For the Faroe and West of Scotland areas there were indications that fishing effort was at a lower level in 1975 compared with preceding years and accordingly the 1975 F values were set at lower levels. The natural mortality coefficient, M, has been taken as 0.2 throughout. Calculated estimates of stock size for 1966-75 are given in Tables 10, 13, 16, 19, and 22.

5. The State of the Stocks

- 5.1 North-East Arctic. Fishing mortality appears to have remained at a fairly constant level in recent years. Maximum rates of fishing mortality are sustained by age groups 3-5 ( $F = 0.4$ ) with lower levels of fishing mortality on the younger and older age groups. Recruitment of 2 year old fish to this stock (Table 29) was at a high level in the period 1968-72 (year classes 1966-70). The following two year classes were below the long-term average. The indications are that the 1973 year class is very abundant in the southern part of the area.
- 5.2 North Sea. Fishing mortality again appears to have remained relatively constant in recent years at about  $F = 0.45$  on age groups 3 and 4 with lower fishing mortality levels on the older age groups and the partially recruited age groups. Recruitment at two years old was high in 1968-70 when the abundant year classes 1966-68 joined the exploited stock. Subsequently recruitment has been below the long-term average.
- 5.3 Iceland. In this stock fishing mortality increases with age reaching a maximum on age groups 10 and older. Currently the fishing mortality on these age groups is about  $F = 0.65$ . After a series of abundant year classes (1962-67) recruitment has been at a much lower level and the declining trend in landings is associated with this reduced level of recruitment.
- 5.4 Faroe. Fishing mortality at Faroe increased during the period 1972-74 but it seems likely that a reduced amount of fishing, particularly by U.K. trawlers, has resulted in a lower level of fishing mortality in 1975. Currently fishing mortality on the fully exploited age groups is probably about  $F = 0.45$ . Recruitment appears to have remained relatively constant and at a high level for year classes 1966-72.
- 5.5 West of Scotland. With the development of the Scottish Clyde fishery there has been an increase in fishing mortality on the younger age groups. In 1973-74 the fishing mortality on 3 and 4 year old fish reached about  $F = 0.6$  but it is likely that it became somewhat reduced in 1975. Recruitment in recent years has remained stable at a high level.

6. Estimation of Total Allowable Catches (TACs)

Estimates of catches in 1976 and 1977 have been calculated using the parameters given in Tables 23-27. The F values used were maintained constant in 1976 and 1977 at about the 1975 level. The derivations of the F values are given in the footnotes to the tables. The F values used are close to those which give maximum yield with the current exploitation pattern. For all areas except Iceland the size of the recruiting year classes has been taken as average. For Iceland there is some evidence to suggest that the 1973 year class is a very poor one, and the size of this year class has been set at a low level.

In recommending TACs the objective has been to stabilise the fisheries at the current level of fishing mortality but, although these levels are close to the optimum for the present exploitation patterns, in some of the fisheries yields could be improved in the long term by changing the exploitation pattern to reduce the fishing mortality on the youngest age groups. In all areas, except Iceland, catches in 1976 and 1977 are expected to remain close to the 1975 level. At Iceland, however, the declining trend in catches, due to the lower level of recruitment, is expected to continue.

Area	Estimated catch (tons)		Recommended TAC for 1977 (tons)
	1976	1977	
NE Arctic	192 000	195 000	200 000
North Sea	213 000	202 000	210 000
Iceland	67 000	58 000	60 000
Faroe	38 000	38 000	40 000
W. of Scotland	22 000	21 000	20 000

The current estimates of catches expected in 1976 do not differ to any large extent from those prepared at the 1975 meeting of the Working Group except for the Faroe area. The difference at Faroe is due to the present estimate being calculated with the assumption that fishing mortality in 1976 will be at the lower 1975 level rather than the higher level prevailing in 1972-74 which was used as the basis of last year's prognosis.

In making these calculations some difficulties were experienced with the weight-at-age data in that for the recent years the recorded weight of total landings was not always in agreement with the sum of the products of numbers landed at age x weight at age. It is recommended that members of the Working Group should research this problem before any further meetings of the Group.

7. Spawning Stock Size

Spawning stock biomass has been estimated for each area for the period 1960-77. These estimates are derived from the tables of stock size (Tables 10, 13, 16, 19, and 22) and the weight-at-age data given in Tables 23-27. Only limited data on the average age of first maturity were available to the Working Group, and it is recommended that members of the Group obtain additional information on this subject. It should also be pointed out that the weight-at-age data used in the calculations for each area were unchanged throughout the period under review. Because of changes in growth rate (Doc. C.M.1973/F:10) it is unlikely that the same weight-at-age relationship applies over the whole period. Also, in respect of the general increase in apparent spawning stock size in most of the areas during the first 10 years it is uncertain whether these reflect real changes or are just an artefact introduced by the expansion of the fisheries or the improved reporting of age composition data.

There is no indication in any of the fisheries that the spawning stock is being reduced below levels at which recruitment might be adversely affected. Only in the Iceland area is the spawning stock declining, and by 1977 it is expected to be at the same level as in the early 1960s before the abundant year classes of 1962-67 recruited to the spawning stock.

8. Exploitation Patterns

In the fisheries in the North-East Arctic, the North Sea and West of Scotland the sustainable yield could be increased if the exploitation pattern was changed to reduce the fishing mortality on the younger age groups (see Appendix). In all three areas, however, there are specialised coastal fisheries which exploit the younger fish which have a more inshore distribution. If these fisheries were prevented from exploiting the young fish, it is unlikely that the vessels employed would be able to go further offshore to divert their effort onto the older fish. Where this is the case any change in regulations designed to increase the average at first capture could result in some local hardship.

Table 1. Summary of total landings of saithe from the main fishing areas (metric tons, whole weight). This table is based on the biological data supplied to the Working Group and used in the assessments. These figures differ to some extent from the official "Bulletin Statistique" data, which are used for Tables 3-7.

Year	Fishing Area					Total
	NE-Arctic	IV+IIIa	Va	Vb	VI	
1960	136 006	31 515	48 120	11 845	8 349	235 835
1961	109 821	35 489	50 826	9 592	6 723	212 451
1962	122 841	24 559	50 514	10 454	7 159	215 527
1963	148 036	30 300	48 011	12 693	6 609	245 649
1964	198 110	58 669	60 257	21 893	13 596	352 525
1965	184 548	73 274	60 177	22 181	18 395	358 575
1966	201 860	95 025	52 003	25 563	18 534	392 985
1967	191 191	76 759	75 712	21 319	16 034	381 015
1968	107 181	98 179	77 549	20 387	12 787	316 083
1969	140 379	115 550	115 853	27 437	17 214	416 433
1970	260 404	179 296	116 601	29 110	14 538	599 949
1971	244 732	219 731	136 764	30 933	19 246	651 406
1972	214 386	219 264	111 301	46 580	24 003	615 534
1973	214 153	191 200	110 888	56 606	35 834	608 681
1974	261 223	228 659	97 568	46 159	33 683	667 292
1975*	207 530	212 896	85 690	39 339	22 030	567 488

\* Preliminary estimate.

Table 2. Preliminary estimates of saithe landings in 1975 (metric tons, whole weight).

	I	IIa	IIb	IIIa	IV	Va	Vb	VI	VII	Other	Total
Belgium	-	37	-	-	26	1 350	-	20	30	-	1 463
Denmark				8 624	5 268						13 892
Faroe Isl.	-	-	-	-	249	1 015	2 723	-	-	-	3 987
France	110	51	160	-	22 102	22	23 201	13 796	964	-	60 406
German Dem. Rep.	7	28 215	295	5 882	-	-	26	8	-	204	34 637
Germany (Fed. Rep.)	188	41 527	389	-	17 669	13 281	4 037	206	-	-	77 297
Iceland	-	-	-	-	-	60 002	-	-	-	-	60 002
Ireland*											
Netherlands	-	-	-	-	9 934	-	375	836	110	-	11 255
Norway	14 153	107 631	20	1 018	13 184	-	829	-	-	-	136 835
Poland	34	3 748	78	-	35 304	-	815	168	74	-	40 221
Spain*											
Sweden	-	-	-	-	1 000	-	-	-	-	-	1 000
U.K.:											
(England)	←	2 868	→		3 097	8 645	2 405	1 562			18 577
(N.Ireland)	-	-	-	-	-	-	-	11	320		331
(Scotland)	←	140	→	-	7 980	1 052	4 928	5 458			19 558
U.S.S.R.					87 630						87 630
Total		199 651		218 967		85 367	39 339	22 065	1 498	204	567 091

\* No data.

Table 3. Landings of saithe from the NE-Arctic (I + IIa + IIb) by country, for the years 1962-74. Metric tons, whole weight. (Data from Bulletin Statistique).

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Belgium	4	-	-	-	-	-	-	-	-	-	-	-	5
Faroe Isl.	2	-	-	-	-	-	-	20	1 097	215	109	7	46
France	544	1 110	1 525	1 618	2 987	9 472	-	193	-	14 536	14 519	11 320	7 119
German. Dem.Rep.*	-	-	-	-	813	304	1 248	6 744	29 200	16 840	7 474	12 015	29 466
Germany, Fed.Rep.	12 651	8 108	4 420	11 387	11 269	11 822	4 753	4 355	23 466	12 204	24 558	30 338	33 155
Netherl.	-	-	186	181	41	48	-	23	-	-	-	-	-
Norway	101 895	135 297	184 700	165 531	175 037	150 860	96 641	115 140	151 759	128 499	143 775	148 789	152 623
Poland	-	-	-	-	-	-	-	-	-	6 017	1 111	23	2 521
Spain	-	-	-	-	-	-	-	-	-	13 097	13 125	609	7 075
UK: (England and Wales)	4 699	4 112	6 591	6 741	13 078	8 379	8 780	13 585	15 469	10 361	8 223	6 503	3 001
(Scotland)	-	-	-	5	-	-	2	-	221	106	125	248	103
USSR	912	-	84	137	563	441	-	-	43 550	39 397	1 278	2 411	28 931
Total	120 707	148 627	197 506	185 600	203 788	181 326	111 424	140 033	264 762	241 272	214 334	212 263	264 045

\* German Democratic Republic catch data from national sources.



**Table 4.** Landings of saithe from the North Sea, Kattegat and Skagerrak (IV + IIIa), by country for the years 1962-74. Metric tons, whole weight. (Data from Bulletin Statistique).

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Belgium	154	132	140	126	161	74	94	135	36	44	59	55	33
Denmark	2 679	3 599	3 795	4 934	4 310	5 495	7 756	5 566	17 595	14 200	19 323	10 190	8 388
Faroe Isl.	-	-	-	-	-	-	-	2	-	18	182	552	581
France	-	-	26 082	23 678	19 282	13 559	34 139	24 631	38 873	37 442	26 060	30 595	28 094
German Dem.Rep.*	1 937	1 351	1 783	4 595	6 634	901	903	5 998	4 250	6 398	10 674	7 668	5 816
Germany, F.R.	2 960	2 773	3 391	7 736	7 462	7 036	6 066	7 242	6 022	4 217	8 665	12 003	20 589
Iceland	-	-	-	-	-	-	5	2	18	97	4	24	-
Netherl.	2 656	4 455	4 552	9 000	8 177	13 395	16 482	18 214	20 460	18 136	12 532	9 232	14 504
Norway	8 358	9 982	9 602	12 330	14 183	10 842	8 683	8 159	11 201	15 184	23 256	15 219	7 147
Poland	112	3	-	-	655	104	43	-	-	4	186	7 512	22 203
Spain	-	-	-	-	-	-	-	-	-	-	-	-	308
Sweden	2 670	3 206	3 356	6 574	3 643	6 318	8 212	4 322	1 921	4 523	3 899	1 876	1 187
UK: (England + Wales)	3 407	3 821	4 143	5 573	6 172	5 408	3 925	3 819	2 664	3 162	3 744	3 378	4 353
(Scotland)	1 520	2 207	3 099	3 199	3 254	3 911	6 001	3 838	5 293	6 106	10 797	10 834	10 956
USSR	-	-	-	10	22 388	11 527	11 405	32 830	68 062	110 200	99 883	83 333	104 500
Total	26 453	31 529	59 943	77 755	96 321	78 570	104 074	114 758	176 395	219 731	219 264	192 471	228 659

\* German Democratic Republic catch data from national sources.

Table 5. Landings of saithe from Iceland (Va), by country for the years 1962-74.  
Metric tons, whole weight. (Data from Bulletin Statistique).

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Belgium	2 505	2 830	2 144	1 999	2 282	2 739	3 155	3 995	4 153	3 490	2 250	2 131	2 371
Faroe Isl.	590	491	45	285	100	39	101	119	2 386	2 046	857	1 467	1 712
France	409	-	-	... <sup>1)</sup>	500	5 803	6 701	8 122	2 046	3 951	-	-	62
German Dem. Rep.*	-	-	-	-	154	202	634	357	3 527	2 637	3 471	-	-
Germany, Fed.Rep.	24 015	17 622	21 130	16 708	17 204	24 037	17 327	34 732	27 806	40 628	30 918	38 565	18 627
Iceland	13 469	14 758	21 665	24 866	21 022	29 021	38 027	53 988	63 882	60 080	59 945	56 567	65 220
Netherl.	87	401	309	409	25	-	-	52	-	-	-	-	-
Norway	-	11	4	-	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	-	113	150	-	-
Spain	-	-	-	-	-	-	-	-	-	59	13	-	-
UK: (England & Wales)	8 767	11 262	13 899	14 472	9 857	13 694	11 561	13 665	10 634	21 767	13 152	11 874	8 845
(Scotland)	563	1 074	1 221	1 365	920	901	982	1 605	2 402	1 743	545	509	731
USSR	-	-	-	3	258	35	90	65	-	5	-	-	-
Total	50 385	48 449	60 417	60 107	52 322	76 471	78 578	116 700	116 836	136 519	111 301	111 113	97 568

1) Inc. in Vb<sub>1</sub>

\* German Democratic Republic catch data from national sources.

**Table 6.** Landings of saithe from Faroese grounds (Vb), by country, for the years 1962-74. Metric tons, whole weight. (Data from Bulletin Statistique).

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Faroe Isl.	2 494	2 431	1 338	1 000	1 167	2 242	2 629	4 835	2 694	5 653	5 646	2 973	3 726
France	620	2 207	6 458	8 565 <sup>1)</sup>	9 967	5 555	424	7 899	11 036	10 621	28 346	22 241	19 428
German Dem.Rep.*	-	-	-	-	66	193	53	-	-	-	-	-	130
Germany, Fed.Rep.	985	1 415	6 459	3 557	4 963	5 797	7 433	4 676	2 211	2 254	3 440	9 329	6 661
Netherl.	-	-	-	-	-	-	-	-	-	63	-	-	-
Norway	-	-	+	-	2 498	-	-	378	1 495	1 839	470	355	1 660
Poland	-	-	-	-	-	-	-	-	-	-	-	4 050	1 925
Spain	-	-	-	-	-	-	-	-	-	-	-	-	500
UK: (England & Wales)	3 724	3 177	4 329	5 265	3 321	3 536	5 123	4 303	3 066	3 305	2 453	7 527	3 827
(Scotland)	2 631	3 463	3 309	3 794	3 581	3 996	4 778	5 346	8 608	7 198	6 225	10 131	8 302
Total	10 454	12 693	21 893	22 181	25 563	21 319	20 440	27 437	29 110	30 933	46 580	56 606	46 159

1) Va included.

\* German Democratic Republic catch data from national sources.

**Table 7.** Landings of saithe from West of Scotland and Rockall (VIIa + VIIb), by country, for the years 1962-74. Metric tons, whole weight. (Data from Bulletin Statistique).

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Belgium	15	61	10	-	168	31	27	40	34	29	125	191	209
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-
Faroe Isl.	-	-	-	-	-	-	-	-	-	-	-	4	6
France	434	415	2 780	5 059	7 550	7 092	3 481	8 109	5 140	3 300	6 268	20 972	21 691
German Dem.Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-
Germany, Fed.Rep.	155	15	135	119	62	368	368	1 988	545	1 068	350	52	16
Iceland	-	-	-	-	-	-	-	-	1	1	-	-	-
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	290
Netherl.	-	-	+	12	+	54	59	14	7	32	638	67	124
Norway	-	-	-	-	-	-	-	-	-	-	-	2	22
Poland	-	-	-	-	-	-	1	-	-	2	-	394	125
Spain	-	-	-	-	-	-	-	-	-	-	-	-	1 862
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-
UK: (England & Wales)	4 359	4 072	7 455	9 012	7 693	5 796	5 704	4 015	3 615	1 965	2 268	2 138	1 333
(N.Ireland)	9	20	22	36	31	17	21	13	19	24	6	14	3
(Scotland)	2 187	2 026	3 194	4 157	3 005	2 676	2 483	3 035	5 175	4 620	6 706	11 330	9 527
USSR	-	-	-	-	-	-	-	-	-	105	112	670	269
Total	7 159	6 609	13 596	18 395	18 509	16 034	12 504	17 214	14 536	11 146	16 473	35 834	35 477

Table 8. North-East Arctic Saithe.  
Age compositions of catches 1966-75 used as input data for Virtual  
Population Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	1	1	281	110	1	497	1	194	1	1
2	7 450	6 952	5 297	4 090	25 952	19 842	11 608	13 840	21 248	39 281
3	22 392	29 664	25 196	77 333	43 540	77 019	65 192	73 366	37 178	42 401
4	54 537	24 836	18 384	11 949	62 846	59 280	52 551	25 053	45 437	12 379
5	13 124	35 956	5 101	16 939	13 987	26 961	29 617	28 027	16 472	24 310
6	12 899	4 125	8 282	4 747	16 189	9 556	10 615	16 352	21 192	5 522
7	4 652	5 616	787	4 798	5 122	9 592	5 832	6 646	12 516	7 853
8	1 374	2 916	1 913	1 126	7 950	2 901	3 667	3 558	4 503	7 231
9	933	1 413	900	1 711	2 504	4 352	1 954	2 765	3 041	3 046
10	965	1 397	577	675	3 697	2 195	2 229	2 383	2 335	1 974
11	472	849	391	202	1 096	3 136	1 294	1 438	1 275	1 299
12	560	629	239	140	757	1 303	840	682	1 359	911
13	597	550	141	31	323	354	350	776	370	497
14	443	408	131	48	276	232	273	454	243	209



Table 10. North-East Arctic Saithe.  
 Estimates of stock size 1966-75 calculated by Virtual Population  
 Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	252 013	197 886	380 532	398 332	415 946	234 822	332 615	126 247	195 568	454 674
3	145 066	199 605	155 740	306 770	322 433	317 132	174 361	261 843	90 887	140 964
4	198 181	98 605	136 706	104 823	181 679	224 760	190 429	84 375	148 507	41 155
5	51 279	113 285	58 416	95 363	75 052	92 421	130 771	108 722	46 596	80 820
6	58 229	30 193	60 499	43 227	62 830	48 860	51 468	80 439	63 836	23 390
7	27 512	36 076	21 004	42 071	31 112	36 897	31 406	32 591	51 148	33 264
8	11 509	18 337	24 479	16 486	30 120	20 861	21 592	20 465	20 705	30 629
9	7 282	8 185	12 387	18 316	12 482	17 520	14 466	14 377	13 552	12 902
10	5 255	5 122	5 429	9 330	13 453	7 967	10 433	10 084	9 283	8 362
11	1 954	3 434	2 939	3 925	7 030	7 695	4 552	6 538	6 114	5 502
12	2 176	1 176	2 049	2 054	3 031	4 769	3 495	2 565	4 059	3 859
13	2 767	1 278	403	1 462	1 555	1 801	2 734	2 106	1 487	2 105
14	1 876	1 728	555	203	1 169	983	1 156	1 923	1 029	885

Table 11. North Sea Saithe.  
 Age compositions of catches 1966-75 used as input data for Virtual  
 Population Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	1	1	130	1 628	1 463	987	460	3 276	2 010	5
2	12 937	7 606	5 615	19 813	5 748	16 076	19 918	23 736	11 339	40 550
3	11 485	13 874	15 409	19 285	30 356	41 492	33 087	30 503	33 053	34 859
4	27 279	12 787	19 025	12 488	43 424	39 492	93 478	18 217	18 156	15 182
5	4 367	13 104	9 668	9 889	11 516	29 067	23 279	24 849	12 541	9 591
6	3 579	2 085	5 725	6 045	10 116	4 472	20 966	15 485	20 779	6 863
7	727	1 450	571	3 952	4 018	3 985	3 659	8 107	14 625	10 963
8	272	470	446	730	2 336	2 605	3 134	1 803	5 059	6 474
9	193	294	346	489	774	1 748	1 914	1 273	1 431	2 513
10	101	143	164	192	330	374	1 118	1 035	811	899
11	78	82	123	62	98	267	267	585	414	575
12	61	43	70	40	67	53	126	263	224	332
13	35	19	69	33	24	27	25	82	132	299
14	34	33	53	23	24	18	68	37	31	85





Table 13. North Sea Saithe.  
 Estimates of stock size 1966-75 calculated by Virtual Population  
 Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	156 663	126 242	298 198	346 485	441 405	167 679	150 545	138 723	141 165	245 996
3	97 680	116 597	96 496	239 073	265 800	356 201	122 789	105 311	92 210	105 349
4	91 252	69 622	82 958	65 129	178 343	190 258	254 237	70 816	58 841	45 882
5	17 572	50 230	45 494	50 817	42 087	106 991	120 249	124 426	41 613	31 886
6	10 505	10 463	29 354	28 553	32 708	24 116	61 493	77 506	79 517	22 816
7	3 367	5 392	6 690	18 882	17 940	17 703	15 720	31 553	49 526	46 437
8	2 083	2 103	3 113	4 963	11 905	11 076	10 911	9 582	18 550	27 423
9	906	1 460	1 299	2 147	3 406	7 645	6 726	6 120	6 222	10 645
10	579	568	931	753	1 318	2 092	4 688	3 789	3 866	3 808
11	395	383	337	615	444	782	1 376	2 833	2 173	2 436
12	355	253	240	165	447	275	401	887	1 793	1 406
13	239	236	169	134	99	306	178	216	490	1 267
14	169	164	176	76	80	60	226	123	103	283

Table 14. Iceland Saithe.  
Age compositions of catches 1966-75 used as input data for Virtual  
Population Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	31	196	1	20	18	7	49	25	111	1
3	940	1 116	836	1 572	287	476	565	219	1 269	496
4	2 090	3 400	2 605	4 395	5 622	3 031	3 786	1 768	3 404	2 782
5	3 283	5 591	3 563	5 706	4 999	10 221	6 524	5 155	2 348	2 437
6	4 117	4 326	6 318	6 518	6 126	6 736	8 646	7 077	3 164	1 780
7	1 285	4 931	3 207	9 136	6 178	6 694	4 178	7 372	3 452	3 452
8	739	1 200	3 008	2 796	5 934	5 045	3 320	2 616	3 384	2 938
9	390	550	621	1 843	1 689	4 272	2 098	1 635	1 303	1 451
10	235	330	343	461	1 191	959	1 421	871	824	712
11	133	169	215	100	299	887	361	412	351	318
12	69	73	103	110	171	349	328	231	141	183
13	102	104	79	32	92	96	79	80	43	100
14	73	65	41	44	70	63	68	22	13	32

Table 15. Iceland Saithe.  
 Estimates of fishing mortality coefficients for 1966-74 calculated  
 by Virtual Population Analysis, and values assumed for 1975.

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	0.02	0.02	0.02	0.01	0.01	0.03	0.01	0.03	0.02
4	0.03	0.07	0.06	0.11	0.10	0.07	0.12	0.13	0.19	0.10
5	0.13	0.11	0.09	0.17	0.17	0.25	0.21	0.24	0.25	0.20
6	0.18	0.25	0.17	0.25	0.27	0.36	0.35	0.38	0.22	0.30
7	0.22	0.35	0.29	0.41	0.40	0.53	0.40	0.57	0.32	0.40
8	0.26	0.32	0.37	0.44	0.51	0.66	0.55	0.48	0.56	0.50
9	0.22	0.31	0.28	0.41	0.53	0.86	0.64	0.59	0.46	0.50
10	0.23	0.30	0.33	0.34	0.51	0.66	0.82	0.61	0.67	0.50
11	0.23	0.26	0.32	0.15	0.39	0.94	0.57	0.60	0.54	0.60
12	0.17	0.19	0.25	0.27	0.41	1.12	1.20	0.90	0.42	0.60
13	0.29	0.43	0.32	0.12	0.39	0.42	0.84	1.18	0.40	0.60
14	0.30	0.30	0.30	0.30	0.40	0.50	0.60	0.60	0.60	0.60

Table 16. Iceland Saithe.  
Estimates of stock size 1966-75 calculated by Virtual Population  
Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	80 545	72 574	103 477	73 155	56 140	25 154	32 873	49 775	33 867	1 104
3	70 601	65 917	59 241	84 719	59 876	45 948	20 588	26 870	40 730	27 628
4	74 711	56 954	52 960	47 748	67 943	48 763	37 189	16 346	21 801	32 201
5	30 241	59 281	43 562	41 009	35 129	50 556	37 189	27 034	11 789	14 784
6	26 941	21 799	43 494	32 452	28 435	24 259	32 198	24 576	17 495	7 540
7	7 219	18 349	13 956	29 919	20 706	17 772	13 813	18 596	13 768	11 476
8	3 561	4 754	10 595	8 543	16 298	11 408	8 556	7 560	8 628	8 171
9	2 144	2 251	2 814	5 974	4 487	8 028	4 832	4 033	3 845	4 035
10	1 236	1 404	1 348	1 745	3 237	2 162	2 768	2 081	1 840	1 980
11	713	800	853	796	1 015	1 584	913	1 000	925	770
12	474	464	503	505	562	563	508	424	450	443
13	448	326	314	319	315	306	151	125	142	242
14	309	275	174	186	233	175	165	53	31	77

Table 17. Faroe Saithe.  
Age composition of catches 1966-75 used as input data for  
Virtual Population Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	1	2	1	1	2	1	1	4	5	5
2	68	154	222	55	774	683	240	1 620	133	43
3	488	595	614	1 191	1 445	2 702	2 997	2 469	3 424	1 457
4	1 540	796	1 689	2 086	6 277	3 136	1 959	6 138	3 991	3 244
5	1 201	1 364	1 116	2 294	1 558	5 282	2 858	6 946	3 880	3 691
6	1 686	792	1 095	1 414	1 478	947	3 027	3 414	2 727	1 969
7	806	1 192	548	1 118	899	784	1 689	1 604	1 388	1 084
8	377	473	655	589	730	444	1 440	681	635	760
9	294	217	254	580	316	308	1 123	540	365	325
10	205	190	128	239	241	155	821	395	339	200
11	156	97	89	115	86	94	364	211	195	196
12	94	75	59	100	48	51	148	101	123	128
13	52	38	40	36	46	12	31	25	45	67
14	34	11	29	30	15	17	31	21	44	42

Table 18. Faroe Saithe.  
 Estimates of fishing mortality coefficients for 1966-74 calculated by  
 Virtual Population Analysis, and values assumed for 1975.

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.01	0.01	0.00	0.02	0.02	0.01	0.05	0.01	0.02
3	0.03	0.03	0.04	0.04	0.06	0.11	0.12	0.11	0.15	0.10
4	0.11	0.06	0.11	0.18	0.30	0.18	0.10	0.39	0.26	0.20
5	0.17	0.14	0.11	0.22	0.20	0.45	0.25	0.64	0.46	0.40
6	0.27	0.16	0.15	0.20	0.21	0.18	0.51	0.53	0.56	0.45
7	0.33	0.31	0.16	0.23	0.19	0.17	0.54	0.56	0.43	0.45
8	0.30	0.33	0.28	0.26	0.24	0.13	0.51	0.43	0.46	0.45
9	0.32	0.29	0.30	0.43	0.21	0.15	0.58	0.37	0.43	0.45
10	0.44	0.35	0.27	0.51	0.32	0.15	0.72	0.42	0.41	0.45
11	0.40	0.38	0.27	0.42	0.35	0.20	0.64	0.40	0.37	0.45
12	0.36	0.34	0.42	0.56	0.31	0.36	0.56	0.37	0.43	0.45
13	0.69	0.25	0.31	0.50	0.55	0.12	0.39	0.17	0.28	0.45
14	0.30	0.30	0.30	0.40	0.40	0.40	0.50	0.50	0.50	0.45

Table 19. Faroe Saithe.  
 Estimates of stock size 1966-75 calculated by Virtual Population  
 Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	27 263	21 974	41 096	32 942	37 066	35 806	32 486	35 748	20 745	2 395
3	19 035	22 260	17 852	33 446	26 921	29 648	28 699	26 381	27 805	16 865
4	16 076	15 144	17 688	14 061	26 308	20 737	21 837	20 795	19 372	19 680
5	8 483	11 773	11 680	12 959	9 634	15 898	14 154	16 112	11 516	12 271
6	7 805	5 863	8 410	8 557	8 545	6 485	8 280	9 017	6 983	5 951
7	3 122	4 874	4 087	5 899	5 733	5 665	4 456	4 068	4 326	3 276
8	1 584	1 832	2 919	2 852	3 823	3 884	3 932	2 136	1 895	2 297
9	1 188	958	1 075	1 801	1 805	2 474	2 780	1 930	1 138	982
10	634	708	589	652	955	1 194	1 748	1 271	1 095	604
11	519	335	409	367	320	565	838	698	686	592
12	337	285	187	255	197	185	378	360	382	387
13	114	192	166	100	119	119	105	177	204	202
14	144	47	123	100	50	57	86	58	122	127



Table 20. West of Scotland Saithe.  
Age compositions of catches 1966-75 used as input data for  
Virtual Population Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	1	1	2	1	1	1	79	110	482	1
2	67	385	49	337	32	371	5 309	4 093	4 459	2 522
3	2 831	2 053	2 435	1 993	2 857	1 342	4 798	9 786	8 075	7 870
4	4 896	2 885	2 287	4 643	2 335	4 305	1 868	7 820	2 851	3 136
5	1 217	1 934	1 198	1 506	1 805	1 833	1 435	1 797	1 780	1 327
6	632	269	621	509	599	1 051	846	1 772	870	891
7	135	454	148	571	241	450	625	855	1 079	467
8	38	91	126	106	196	350	349	496	493	630
9	26	44	29	80	41	290	256	208	444	297
10	12	28	22	22	57	50	232	158	276	157
11	12	14	11	18	20	89	84	199	307	62
12	7	11	7	8	20	21	107	48	302	62
13	5	8	4	8	12	29	31	61	40	57
14	5	6	2	4	4	10	23	27	62	33

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Table 21. West of Scotland Saithe.  
 Estimates of fishing mortality coefficients for 1966-74 calculated by  
 Virtual Population Analysis, and values assumed for 1975.

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
2	0.00	0.02	0.00	0.01	0.00	0.01	0.19	0.16	0.14	0.20
3	0.21	0.17	0.13	0.13	0.13	0.11	0.22	0.63	0.53	0.40
4	0.39	0.33	0.28	0.39	0.21	0.29	0.23	0.67	0.38	0.40
5	0.39	0.26	0.22	0.31	0.26	0.26	0.15	0.35	0.31	0.30
6	0.19	0.14	0.13	0.14	0.19	0.24	0.18	0.28	0.29	0.25
7	0.15	0.20	0.11	0.16	0.09	0.22	0.22	0.28	0.27	0.25
8	0.07	0.15	0.08	0.10	0.08	0.18	0.26	0.27	0.26	0.25
9	0.10	0.11	0.06	0.07	0.05	0.16	0.20	0.24	0.41	0.25
10	0.12	0.15	0.07	0.06	0.06	0.08	0.18	0.18	0.59	0.25
11	0.18	0.21	0.08	0.08	0.07	0.13	0.20	0.24	0.64	0.25
12	0.24	0.26	0.15	0.08	0.11	0.10	0.22	0.16	0.67	0.25
13	0.12	0.46	0.14	0.26	0.16	0.24	0.22	0.19	0.20	0.25
14	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.25

Table 22. West of Scotland Saithe.  
Estimates of stock size 1966-75 calculated by Virtual  
Population Analysis (thousands of fish).

Age group	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	17 959	26 987	22 637	32 086	16 927	32 992	33 796	30 845	36 865	15 300
3	16 765	14 643	21 747	18 489	25 965	13 829	26 677	22 889	21 566	26 164
4	16 554	11 177	10 140	15 611	13 341	18 683	10 113	17 523	9 992	10 426
5	4 132	9 159	6 559	6 245	8 614	8 821	11 427	6 598	7 360	5 621
6	4 042	2 291	5 760	4 292	3 760	5 429	5 573	8 062	3 789	4 426
7	1 052	2 740	1 633	4 156	3 055	2 539	3 499	3 801	5 007	2 320
8	632	739	1 835	1 204	2 888	2 284	1 674	2 302	2 343	3 129
9	295	484	523	1 389	890	2 188	1 555	1 056	1 439	1 475
10	114	218	356	402	1 065	692	1 530	1 043	678	780
11	79	82	153	272	310	820	521	1 044	711	308
12	36	54	55	115	206	235	591	351	675	308
13	50	24	34	38	87	151	174	388	244	283
14	30	36	12	24	24	61	97	114	263	164

Table 23. North-East Arctic Saithe.  
Calculation of TAC.

Age	Catch 1975 ('000)	Fishing mortality <sup>1)</sup> (75, 76, 77)	Stock 1977	Average weight <sup>2)</sup> (kg)
2	21 416 <sup>3)</sup>	0.09	274 462 <sup>4)</sup>	0.32
3	42 401	0.34	205 298	0.67
4	12 379	0.39	119 731	1.05
5	24 310	0.31	52 148	1.55
6	5 522	0.27	13 964	2.21
7	7 853	0.26	37 529	3.00
8	7 231	0.23	10 105	3.83
9	3 046	0.24	15 491	4.63
10	1 974	0.32	16 205	5.35
11	1 299	0.36	6 017	6.12
12	911	0.33	2 683	6.75
13	497	0.29	1 557	7.43
14	416	0.30	1 125	8.50

Simulated catches

1975 = 200 610 tons  
 1976 = 192 220 tons  
 1977 = 194 708 tons.

- 
- 1) F values represent averages for 1970-73.
  - 2) Weights adjusted to give approximately correct 1975 catch figures.
  - 3) Based on average recruitment figure for 1965-74.
  - 4) Average recruitment 1965-74.

Table 24. North Sea Saithe.  
Calculation of TAC.

Age	Catch 1975 ('000)	Fishing mortality <sup>1)</sup> (75, 76, 77)	Stock 1977	Average weight <sup>3)</sup> (kg)
2	40 550	0.15	209 000 <sup>2)</sup>	0.51
3	34 859	0.41	151 336	0.84
4	15 182	0.42	123 932	1.28
5	9 591	0.30	328 898	2.06
6	6 863	0.35	16 106	2.95
7	10 963	0.34	14 242	3.93
8	6 474	0.32	8 478	4.58
9	2 513	0.31	14 482	5.48
10+	2 277	0.29	16 679	7.00

Simulated catches

1975 = 212 000 tons  
1976 = 213 000 tons  
1977 = 202 000 tons

- 
- 1) F values represent averages for 1972-74.
  - 2) Average recruitment figure 1963-72.
  - 3) Weights adjusted to give approximately correct 1975 catch figure.

Table 25. Iceland Saithe.  
Calculation of TAC.

Age	Catch 1975 ( '000)	Fishing mortality <sup>1)</sup> (75, 76, 77)	Stock 1977	Average weight (kg)
3	496	0.02	58 294 <sup>2)</sup>	0.89
4	2 782	0.16	16 426 <sup>3)</sup>	1.60
5	2 437	0.25	15 469	3.16
6	1 780	0.30	9 210	4.34
7	3 452	0.45	4 681	5.36
8	2 938	0.52	2 387	6.36
9	1 451	0.52	2 651	7.88
10	712	0.64	1 878	8.80
11	318	0.56	822	9.29
12	183	0.66	322	9.26
13	100	0.79	160	9.64
14	32	0.60	65	11.91

Simulated catches

1975 = 81 800 tons

1976 = 67 000 tons

1977 = 58 000 tons

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1) The fishing mortalities represent the averages for 1973 and 1974.

2) Average recruitment figure 1963-72.

3) Evidence is available that year class 1973 is very poor. Therefore the recruitment figure for this year class in 1976 has been set at the lowest recruitment value in recent years (20 468).

Table 26. Faroe Saithe.  
Calculation of TAC.

Age	Catch 1975 ( '000)	Fishing mortality <sup>2)</sup> (75, 76, 77)	Stock 1977	Average weight (kg)
2	(43) <sup>1)</sup>			0.67
3	(1 457) <sup>1)</sup>	0.09	29 019 <sup>3)</sup>	1.22
4	3 244	0.20	21 616	1.88
5	3 691	0.36	14 519	2.62
6	1 969	0.41	5 110	3.40
7	1 084	0.43	4 161	4.18
8	760	0.37	2 244	4.95
9	325	0.38	1 050	5.69
10	200	0.45	571	6.38
11	196	0.41	448	7.02
12	128	0.37	180	7.62
13	67	0.22	97	8.15
14	42	0.40	129	8.64
15	67	0.40	93	10.00

Simulated catches

1975 = 39 620 tons  
 1976 = 38 300 tons  
 1977 = 37 800 tons

- 
- 1) These catches have not been used to raise the stock at the beginning of 1976 but are replaced by the average recruitment figure.
- 2) The F values are based upon the average exploitation pattern in 1972 and 1973, but the level has been reduced in 1975 by a factor of 0.79 to take account of the apparent drop in total catch in 1975.
- 3) Average recruitment figure 1969-73.

Table 27. West of Scotland Saithe.  
Calculation of TAC.

Age	Catch 1975 ( '000)	Fishing mortality <sup>2)</sup> (75, 76, 77)	Stock 1977	Average weight (kg)
2	(2 552) <sup>1)</sup>	0.2	24 898 <sup>3)</sup>	0.52
3	7 870	0.4	16 214	0.84
4	3 136	0.4	8 852	1.14
5	1 327	0.3	7 821	1.65
6	891	0.25	3 520	2.41
7	467	0.25	2 162	3.22
8	630	0.25	1 361	4.21
9	297	0.25	939	5.03
10+	371	0.25	2 609	6.50

Simulated catches

1975 = 24 000 tons  
1976 = 22 000 tons  
1977 = 21 000 tons

- 
- 1) The available catch data for 1975 do not reflect the recruiting 2-year old year class 1973 in the Scottish fishery during the second half of the year. Therefore this figure is likely to be an underestimate. In the calculations the number of 3-year old saithe in the stock at the beginning of 1976 is based upon the assumptions of the 1973 year class being of average strength and having been exploited in 1975 at an F value of 0.2.
- 2) The drop in total landings in 1975 as compared with 1974 and 1973 indicates a lower fishing mortality than in the preceding years. Therefore the same assumed values as used in the VPA have been applied for catch prediction.
- 3) Average recruitment figure for 1963-72.



Table 28. Spawning stock biomass ('000 tonnes).

	NE-Arctic	North Sea	Iceland	Faroe	W. of Scotland
Ages:	6+	5+	7+	7+	5+
1960	311	60	81	29	17
1961	289	60	77	33	15
1962	333	55	84	38	14
1963	331	68	92	41	15
1964	326	75	88	43	17
1965	349	95	96	41	26
1966	380	107	108	40	26
1967	363	184	177	46	38
1968	416	241	194	48	44
1969	470	310	294	59	51
1970	562	344	299	64	60
1971	523	478	275	64	69
1972	495	626	207	75	76
1973	563	714	213	56	76
1974	570	693	190	51	71
1975	456	564	177	44	60
1976	515	466	119	45	55
1977	418	406	91	45	57

Table 29. Estimates from Virtual Population Analysis of population size (millions) at 2-years old of each year class. (Estimates of year class size of the most recent year classes are less reliable).

Year class	NE-Arctic	North Sea	Iceland	Faroe	W. of Scotland
1958	116	37	41	10	8
1959	229	35	39	15	8
1960	337	50	103	25	19
1961	117	67	68	18	16
1962	368	165	114	25	29
1963	211	119	86	23	21
1964	252	157	81	27	18
1965	198	126	73	22	27
1966	381	298	103	41	23
1967	398	346	73	33	32
1968	416	441	56	37	17
1969	235	168	25	36	33
1970	333	151	33	32	34
1971	126	139	50	36	31
1972	196	141	34	21	37

APPENDIX

Appendix Figure 1 shows yield per recruit curves (solid lines) calculated for each fishery for the current exploitation patterns. These exploitation patterns are also illustrated. The yield curves were calculated by an analytical model<sup>1)</sup>, which allows F to vary with age and which uses weight-at-age data. Because of problems with the weight-at-age data, these curves can be relied upon only to give a general indication of the present situation. For the North-East Arctic, the North Sea and West of Scotland additional curves have been calculated\*. In calculating these curves (broken lines) fishing mortality has been taken as zero on all age groups up to the indicated age at first capture ( $t_c$ ) and from this age F is maintained constant. Although this exploitation pattern would not be achieved in practice it gives an approximate measure of the potential gains to be obtained from increasing the age at first capture in those fisheries.

$$1) \quad \frac{Y_W}{R} = \left[ \sum_{J=t_r}^{t_{(n-1)}} \left( \frac{N_J \bar{W}_J P_J F (1-e)^{-(P_J F + M)}}{(P_J F + M)} \right) + \frac{N_n \bar{W}_n P_n F}{(P_n F + M)} \right] \frac{1}{R}$$

where R = number of recruits

$t_r$  = age at recruitment

n = maximum age

$N_J$  = population number at age J

$\bar{W}_J$  = weight of fish at age J

F = fishing mortality on age groups subject to maximum exploitation

$P_J$  = proportion of F at age J

M = natural mortality

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\* For the appropriate optimum ages at first capture given in an earlier report (Doc.C.M.1975/F:2, Table 14).

Appendix Figure 1.

Yield per recruit curves calculated for the present exploitation patterns (solid lines, left-hand figures). For comparison alternative curves (broken lines) are given for areas where the present exploitation pattern gives reduced yield at current levels of fishing mortality. These alternative curves are calculated on the basis of knife-edge selection at the ages of first capture ( $t_c$ ) indicated. The present exploitation patterns are plotted in the right-hand figures.

