

The Decline of the Skrei Fisheries

(A review of the landing statistics 1866—1957 and an evaluation of the effects of the postwar increase in the total exploitation of the Arctic cod.)

By

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Introduction

This work which we now publish under the title “The decline of the Skrei Fisheries” is a summary of the results of an analysis made already in 1957. In nearly identical form, but under the title “The State of the Arctic Cod” it was submitted as a technical document to the sixth meeting of the Permanent Commission of the International Fisheries Convention held in London in October 1957. Its consideration by that meeting initiated the formation of “The Working Group on Arctic Fisheries” — an international team of fisheries biologists whose work has now brought our knowledge far beyond the stage of our analysis from 1957. The first steps towards a more rational utilization of the resources of the Arctic cod have already been taken, and efforts are being continued to improve further on the international regulation of the exploitation.

The following account is thus seemingly outdated and does not contain any new scientific evidence. When in spite of this it has been decided to put it on record in this series, it is because we believe it may be a document of some historical interest. It is the story of an old and famous fishery being drastically reduced by the increased competition for the riches of the sea in our days.

The yield of the skrei fisheries since 1866

In Norway a systematic exploitation of the migrating skrei can be dated back at least one thousand years. Official statistics are available from about 1860. They record the yield for each season and the number of men and vessels taking part in the fishery. Fig. 1 and Table 1 shows the total annual catch of skrei in numbers and the distribution by districts since 1866. The “southern district” comprises Vestlandet, Møre and Romsdal and Trøndelag. Nordland county including Lofoten is shown separately because it is the most important spawning district, and Troms

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Table 1. Annual catch of skrei. Numbers in 1,000 fish.

Year	Southern district	Nordland	Northern district	Total
1866	5.798	22.793	355	28.946
67	5.698	28.358	148	34.204
68	5.747	26.349	155	32.251
69	6.502	23.115	914	30.531
1870	7.386	25.291	2.061	34.738
71	4.369	22.166	412	26.947
72	9.269	25.147	741	35.157
73	7.960	23.324	1.850	33.134
74	7.558	21.936	350	29.844
1875	9.546	27.664	853	38.063
76	6.099	28.222	552	34.873
77	11.177	36.788	1.198	49.163
78	8.041	30.220	511	38.772
79	8.850	34.059	951	43.860
1880	12.199	32.099	349	44.647
81	5.835	35.847	623	42.305
82	8.529	34.078	503	43.110
83	6.205	22.744	997	29.946
84	9.040	24.171	1.242	34.453
1885	4.946	34.888	1.434	41.268
86	13.382	38.447	1.488	53.317
87	6.308	32.640	1.571	40.519
88	11.567	34.633	1.792	47.992
89	11.234	23.287	2.057	36.578
1890	11.558	36.387	1.705	49.650
91	9.562	25.337	1.209	36.108
92	13.689	25.635	3.448	42.772
93	13.576	37.004	4.169	54.749
94	13.882	37.245	3.226	54.353
1895	9.186	47.293	2.373	58.852
96	8.174	24.671	2.035	34.880
97	13.314	31.720	3.865	48.899
98	12.652	17.391	2.303	32.346
99	7.499	18.083	2.424	28.006
1900	9.425	11.615	3.027	24.067
01	8.879	16.554	5.545	30.978
02	10.485	19.256	5.052	34.793
03	12.379	21.942	4.263	38.584
04	12.053	21.037	5.178	38.268
1905	10.172	19.540	709	30.421
06	7.326	24.333	2.681	34.340
07	10.567	21.955	872	33.394
08	12.367	18.259	2.620	33.246
09	11.947	21.540	3.384	36.871
10	8.582	18.849	4.327	31.758

Table 1. (Cont.).

Year	Southern district	Nordland	Northern district	Total
1911	13.641	16.948	4.210	34.799
12	25.128	28.614	8.545	62.287
13	19 136	17.454	3.645	40.235
14	30.811	22.803	2.384	55.998
1915	24.065	25.418	1.921	51.404
16	23.374	18.209	1.943	43.526
17	11.005	10.326	896	22.227
18	7.502	6.908	863	15.273
19	8.743	7.752	1.516	18.011
1920	14.326	13.417	3.041	30.784
1921	10.160	20.503	1.569	32.232
22	10.835	16.000	2.758	29.593
23	11.233	20.286	1.659	33.178
24	13.592	19.257	2.116	34.965
1925	6.599	25.047	2.531	34.177
26	15.966	32.736	2.794	51.496
27	9.498	40.719	2.564	52.781
28	9.565	39.829	4.209	53.603
29	7.507	50.937	6.989	65.433
1930	8.467	42.123	4.363	54.953
31	6.881	22.086	3.291	32.258
32	4.906	29.548	2.522	36.976
33	2.148	22.844	2.823	27.815
34	1.440	22.648	3.755	27.843
1935	1.288	15.275	3.227	19.790
36	953	15.376	6.007	22.336
37	1.676	25.735	8.623	36.034
38	905	26.932	6.705	34.542
39	1.107	34.886	13.318	49.311
1940	1.049	27.977	10.858	39.884
41	1.101	27.364	6.149	34.614
42	996	25.148	3.369	29.513
43	1.404	18.983	2.735	23.122
44	2.103	27.401	2.033	31.537
1945	2.734	22.583	1.032	26.349
46	1.886	40.461	3.795	46.142
47	1.161	45.195	7.801	54.157
48	1.233	21.308	5.317	27.858
49	855	17.999	2.926	21.780
1950	927	20.274	4.801	26.002
51	1.204	28.841	4.252	34.297
52	639	21.036	4.398	26.073
53	755	12.601	2.500	15.856
54	559	11.067	2.664	14.290
1955	846	12.699	5.586	19.131
56	1.534	19.840	6.042	27.416
57	1.921	8.617	3.807	14.345

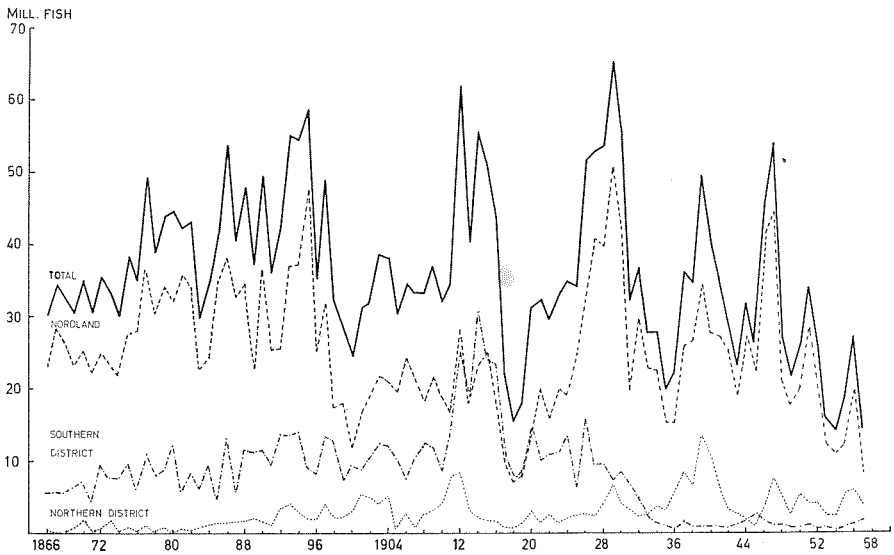


Fig. 1. Annual catch of skrei since 1866.

and Finnmark counties are given as the “northern district”. (Owing to lack of data, Finnmark has not been included in the statistics until 1908). Fig. 2 presents the same data, but here the short-time fluctuations have been smoothed out by a moving five-year mean. The figure for 1868 is thus the mean of the years 1866—1870, that for 1869, the mean of 1867—1871, etc. From figures 1 and 2 it is evident that both the total yield and the yields of the various districts have fluctuated greatly during the last ninety years.

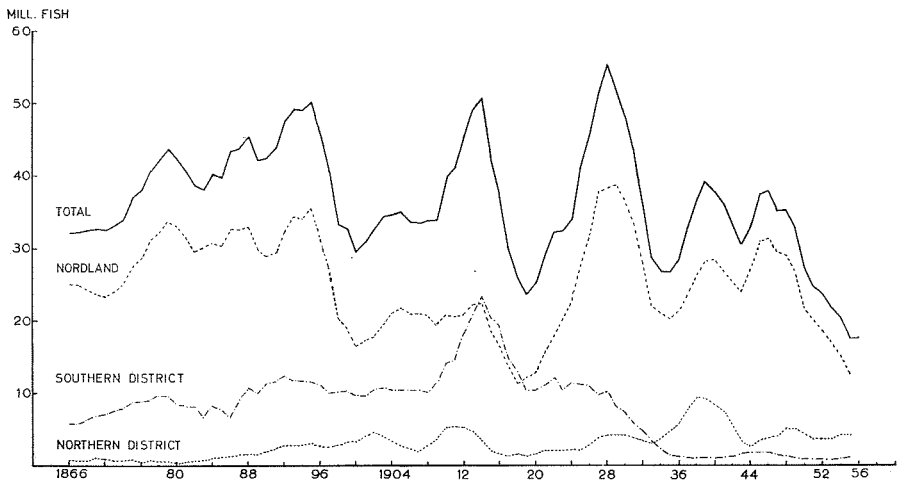


Fig. 2. Catch of skrei since 1866. Moving five-year mean.

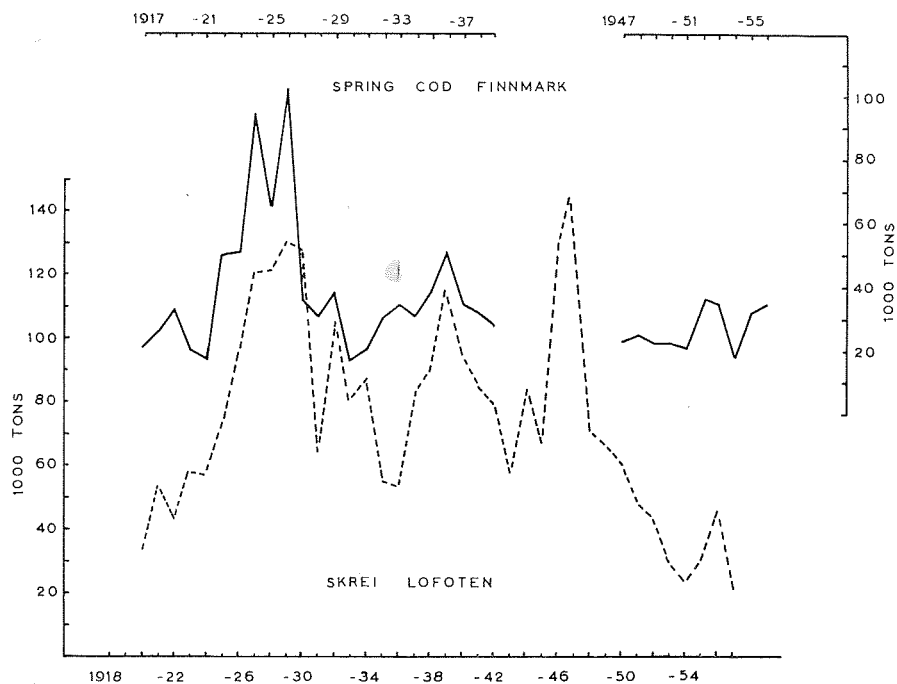


Fig. 3. Annual yield of spring cod in Finnmark and of skrei in Lofoten. Part of catch taken by trawl in Finnmark 1952–56 and by purse seine in Lofoten 1950–57 not included. Three years' displacement of time scales.

Causes of the fluctuations in yield

The size of the yield in the various years is determined by several factors of which the following three are probably the most important; the abundance of fish present on the fishing grounds, the availability of the fish to the various gears, and the magnitude of the fishing effort.

It is highly probable that, in some cases, variations in availability have had an important influence on the yield of the skrei fisheries. Thus in the Lofotens the skrei is in some years found farther from the shore and in deeper waters than usual. Especially in earlier times when the vessels were small and driven by oars and sails only, this factor must have been important. Today it is mainly the fishery with hand lines and purse seines which is influenced by variations in the vertical distribution of the fish shoals.

As shown in Fig. 2 there has also been some shifting of the yield by districts in the last ninety years. In the southern district the skrei fishery has been insignificant since about 1930. This is not due to lack of interest in the fishery in this area, but probably to a displacement of the spawning

district northwards. We believe, however, that at present such geographical variations in the migrations of the skrei can have but little influence on the yield. In the skrei season, fishing takes place all along the coast. Major concentrations of skrei cannot escape notice, and with our modern mobile fishing fleet they would soon be effectively exploited.

The abundance of the skrei is undoubtedly the factor which, besides the fishing effort, has the greatest influence on the yield. Its dominating influence comes out in a simple way in Fig. 3. This diagram is a comparison of the catch of the spring cod fishery in Finnmark and the skrei fishery in Lofoten for some years. The spring cod fishery is mainly based on young immature Barents Sea cod. A difference of three years has been applied in the time scale of the two curves because this is the average age difference between the spring cod and the skrei.

There is a fair agreement between the fluctuations of the curves; the tendency of the variation in the Finnmark fishery is later repeated in the Lofoten one. And there is only one feature that can be said to be common to the Finnmark fishery in one year and the Lofoten fishery three years later, namely that they are based on mainly the same year classes of the arctic cod. Thus, the fluctuations in yield must in a great measure have been caused by variations in the abundance of the stock of skrei. Probably these variations are largely so-called natural fluctuations of the population. It is a well-known phenomenon in fishery science that the abundance of the various broods may vary greatly.

Unfortunately detailed information on the abundance of the stock of skrei in various periods is difficult to obtain. If we suppose that variations in availability have had only a comparatively insignificant influence on the yield of the skrei fishery, a relative measure of the abundance could be obtained by dividing the yield by the total fishing effort. But our knowledge of the effort in the skrei fishery is incomplete. Mostly it consists of only a seasonal census of the number of men and vessels taking part in the fishery. The relation between the number of men or vessels and the actual fishing effort is complicated and has changed considerably over the years. It is influenced by a number of factors, such as the size of the vessels, their seaworthiness and engine power, further, by the type and the number of units of gear used, by the operation of the gears, by the ability of the fishermen to set their gear in the best concentrations of fish, by the quality of the bait, and by several other factors, all of which we know have changed markedly during the period we consider. For these reasons the catch per fishermen or per vessel will not give us comparable values of abundance over longer periods.

Fig. 4 shows the variations in the number of men taking part in the skrei fisheries since 1876. There is a considerable drop in the total number

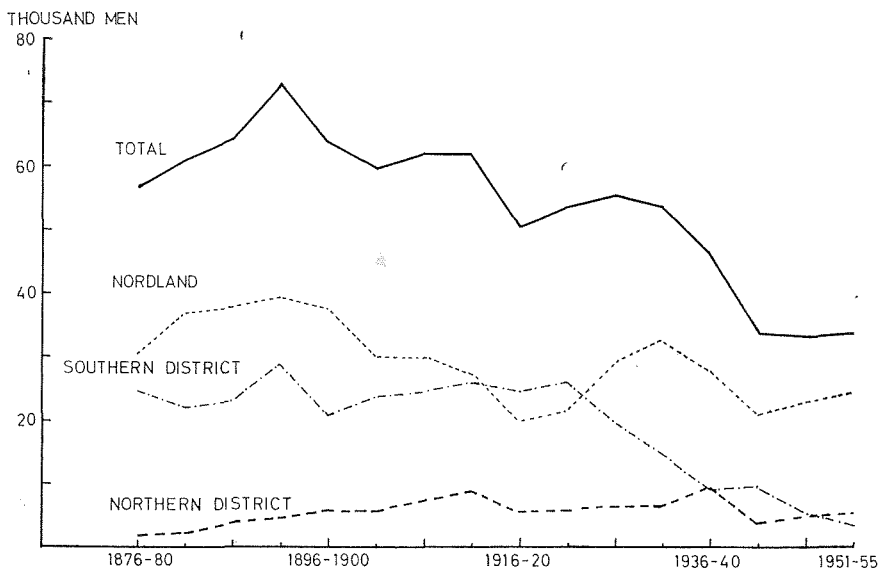


Fig. 4. Number of men engaged in the Norwegian skrei fisheries. Seasonal averages of five-year periods based on the official censuses.

of men from the nineteen-thirties till the postwar years. This drop is the sharpest in the southern district where, as already mentioned, the concentrations of skrei have been thin since 1930. As for North Norway (i.e. Nordland, Troms and Finnmark), which in the last 25 years has been the most important skrei district, the average seasonal number of fishermen for the period 1951—55 is 20 per cent lower than for the 1936—40 period. During this same period, however, a significant increase has occurred in the efficiency of the fleet through improvement in machinery, increased mechanization and the introduction of new instruments such as echo sounders and radio telephones. Changes have also occurred in the types of gear used. Thus in the course of the last few years, gill nets made of artificial fibers (nylon and perlon) have almost completely replaced the earlier conventional nets which were made of cotton and hemp. Comparative experiments have shown that the fishing power of these new types of net is from three to four times greater than the cotton or hemp nets (SÆTERS DAL 1957). In the long line fishery also, materials made of artificial fibres have to a large extent replaced the old types. Here too a change in the fishing power has been observed, not indeed as marked as that due to the gillnets, but still significant (OPPEDAL 1956). Even the characteristics of the hand line, the simplest of the gears, have probably changed as a result of the change-

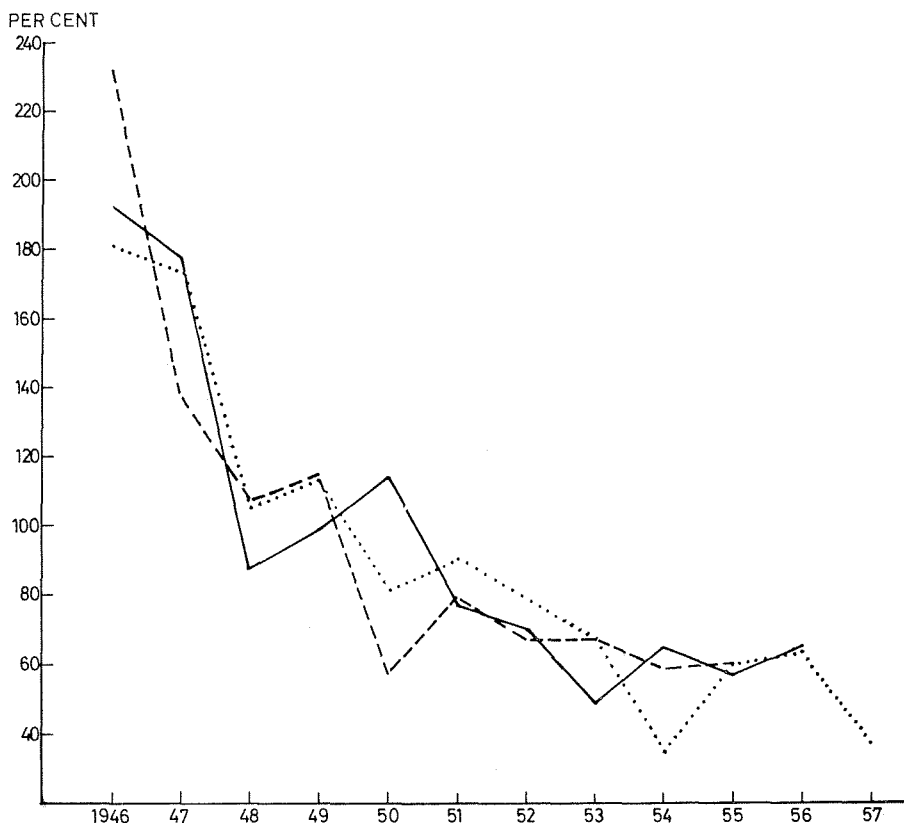


Fig. 5. Comparison of data showing mean annual catch of cod per unit of fishing effort expressed as a percentage of mean values for the period 1946—1955. English data from official statistics. Soviet data from Maslov (1956).

over to nylon filament and the Swedish tin-bait. Finally, since 1950 a new and efficient gear, the cod purse seine, has been used in the Lofoten fishery.*

This increased efficiency of the fishing fleet and of the gears has probably more than compensated for the reduced participation in the skrei fisheries in North Norway over the last twenty years.

The abundance of the population of skrei in recent years

As shown in figures 1 and 2 the yield of the skrei fisheries has been unusually low in recent years. The averages of the last three five-year periods, 1951—55, 1952—56, 1953—57, have all been lower than in any similar period since 1866. In view of what has already been said of the

* The purse seine has not since 1958 been used in the commercial Lofoten fishery.



Fig. 7. Annual mean age of the skrei caught on long lines in Lofoten since 1932 and the total mean of the period 1932—1957.

intensity increases, fewer fish will reach the higher age groups and the mean age will be reduced. We are not able to present a comprehensive picture of the changes in the age of the total population of the arctic cod, but we have a series of observations of the age of the Lofoten skrei for each year since 1932.

Fig. 7 shows the variations in the mean age compared with the total mean for the period 1932—57. There has been a considerable and almost continuous reduction since 1949. Undoubtedly the course of this curve is in part determined by the natural fluctuations in the abundance of the broods, but this factor alone should cause only relatively short fluctuations above and below a mean value. There is also the possibility that a physiological change in the maturity age has occurred, but the fact that this striking reduction of the mean age has taken place simultaneously with a serious reduction in the abundance of the stock of skrei (but not of the young fish) is to us an indication that the change in age is an effect of an increased exploitation.

The total annual catch of the arctic cod

Up to about 1920 Norway was almost alone in the cod fisheries in northern waters; but at that time British and German trawlers started fishing in the Barents Sea. About 1930 a trawl fishery also developed on

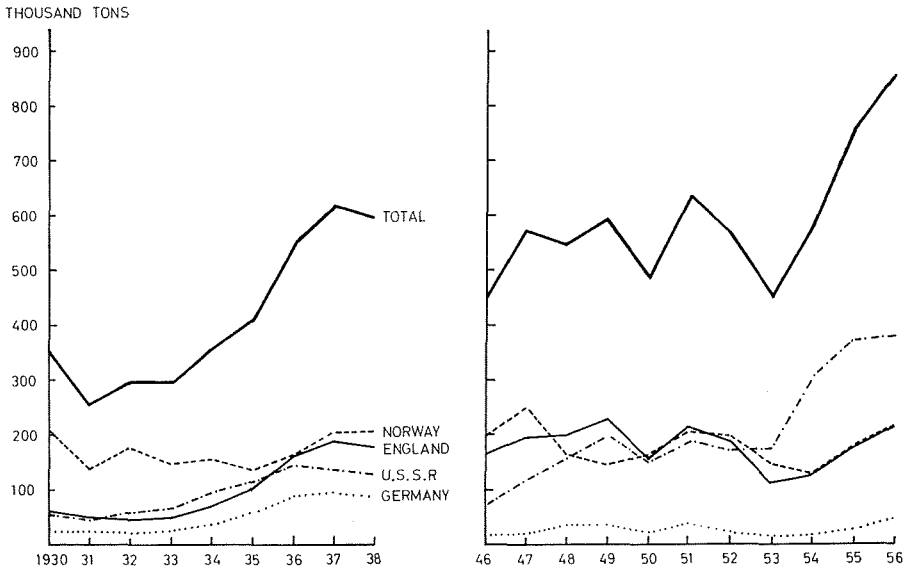


Fig. 8. Total catch of arctic cod and by nations (Gutted Weight). See text for comments on data given for U.S.S.R.

the Bear Island Grounds and along the coastal banks off Lofoten and Troms. During the last war there was a decline in the fishing, as it was confined mainly to a Norwegian exploitation of the stock of skrei. Since the war there has been a considerable and probably almost continuous increase of the total fishing effort in northern waters.

Unfortunately we have not had complete information of the catch of the arctic cod by all the nations which take part in this fishery. In spite of this we venture to present a diagram of the total catch (Fig. 8); but we wish to stress that the figures relating to the Soviet-Russian catch and to its proportion of the total are given with reservations. For most of the years before 1952 our data of the Russian catch are estimates based on scarce information of the size of the fleet and its efficiency. For the years 1952 to 1956, however, there are more exact data. Records of the total Russian catch of Gadidae taken by trawlers in the Barents Sea are available (ANON 1957). Now, from MASLOV (1955) it seems probable that the cod forms some 80 per cent of these catches. As the figures refer to round weight a conversion factor of 1.33 has been used to get the gutted weight shown in Fig. 8. There has been a great increase in the total yield of the arctic cod fisheries since the middle of the nineteen-thirties, probably to twice or three times as much. This higher yield has been obtained by an increase in the fishing effort of trawlers, mainly in the Barents Sea and Bear Island areas.

Table 2. *Selective properties of lines and trawls.*

	Characteristics of fish when fully vulnerable to gear. (Mean values).		
	Age	Length	Weight
	Lines (Hook No. 7)	5 years	55 cm
Trawl (Mesh size 11 cm)	3 years	40 cm	0.6 kilos

The change in the character of the exploitation

The increased yield in terms of weight does not, however, reveal the real change in the exploitation which has taken place in the last two decades. The change in the character of the fishery may be of equal importance. While previously long lines, hand lines and gill nets were the most frequent gears, by far the largest part of the catch is now taken by trawl. There has also been a shifting of the most important fishing areas from the Norwegian coastal banks, populated mainly by old and large fish, to the more distant fishing grounds of the Barents Sea which form the feeding grounds of the young cod.

The effect of these changes has been to reduce the mean age of exploitation. We are not in the position to show the actual magnitude of this reduction; but Table 2, which compares the selectivity of long lines and of trawls (of a mesh size of 11 cm), shows that the age at first capture is about two years lower for the trawl. We know that part of the trawler fleet in these waters use a mesh size of 11 cm, but the mean effective mesh size of the whole fleet is probably lower than that.*

The change in the character of the exploitation is essential because *the number* of fish caught is very important from the point of view of conservation. As a result of the smaller mean weight of the trawl-caught fish, the yield of arctic cod in terms of numbers must have increased considerably more than that in terms of weight shown by statistics.

The decrease of the yield of the Norwegian skrei fishery is nearly concurrent with this increase in total yield. When we consider the evidence which we presented in the first chapter of this report we think it is reasonable to relate these two phenomena to each other.

Summary

The shoals of skrei (i.e. large mature cod) which migrate to the spawning grounds on the Norwegian coast have always formed an important part of the natural resources of the cod fisheries of Norway. The official statistics of the yield of the skrei fishery which are available since

* Note that this refers to the situation in 1957.

1866 show that, during the last 90 years, considerable fluctuations have occurred. These have mainly been due to variations in the fishing effort and to the differing abundance and availability of the fish. The general opinion is that the fluctuations up to recent years have probably been chiefly caused by the natural variation in the abundance. The average yield of the skrei fishery over the last seven years is, however, unusually low. This is not a result of a decrease in the fishing effort, but it is probably caused by a reduction in the abundance of the skrei in later years. A main part of this reduction is not of the same nature as the natural fluctuations because a similar reduction has apparently not taken place in the young immature part of the arctic cod population.

A striking decrease in the mean age of the skrei has occurred at the same time as the abundance has dropped. Although detailed statistics of the total international catch of arctic cod is not available, there is no doubt that there has been a great increase of late years. The change-over to trawl as the main fishing gear has brought about a considerable decrease in the mean age of exploitation. If we therefore consider the total yield in terms of numbers, the increase of the exploitation is far greater than that shown by the statistics of the catch in terms of weight. It is concluded that the decrease of the yield of the skrei fisheries in recent years must be related to the increased total exploitation.

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