

RETROSPECTIVE REVIEW OF MANAGEMENT ADVICE AND TAC's FOR SOME STOCKS

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ABSTRACT

During the past 20 years fisheries management in the Barents Sea and adjacent waters has been based on annual advice provided by The International Council for the Exploration of the Sea, ICES. In the present paper the discrepancies between advised, agreed and actual annual catches were investigated for some stocks in the period 1978-1998. The study showed that the agreed, and particularly the actual catches have frequently exceeded the advised ones. In addition the annual advice, particularly for northeast arctic cod, was found to be based on stock assessments which have given biased results; the annually estimated mortalities have as a rule been too low.

These findings call for considerably more caution when TACs are decided on in future as compared with past and present experience.

INTRODUCTION

During the past 20-25 years management advice has been given annually for all main stocks in the Barents Sea and adjacent areas, largely based on stock monitoring and science carried out at IMR and PINRO. The stock assessments and predictions which form the basis for advice are undertaken within the framework of ICES (assessment working groups and ACFM) and advice is forwarded to Norwegian and Russian management authorities each year in May or/and November by ICES. Nakken (1998) reviewed the exploitation and management of marine resources in the area and attempted to answer two questions:

1. Has the advice been used properly by the managers?
2. Has the advice been based on reliable stock assessments and communicated to the managers in a way that forwards adequate management measures?

In the present paper a brief summary of his findings regarding the first of these questions is given. The second question is addressed in some more detail than in the original paper, particularly regarding the stock of Northeast Arctic cod. The main purpose is to give some guidelines to managers on how the advice ought to be used.

Has the advice been used properly?

In order to throw light on the question, table 1 was prepared. The table shows advised, agreed and actual catches as tabled in the annual reports of ACFM. The figures need some comments. ICES has not directly provided advice on TAC every year. In some years a certain fishing mortality rate which should not be exceeded has been recommended and the TAC corresponding to that mortality rate has been calculated at a later stage and on the basis of slightly revised stock size. This will to some extent invalidate the comparability between advised and agreed catches.

The wording "agreed" catches is not strictly correct for saithe and redfish, nor in many of the years for herring since Norway alone has set the TACs. For some years it is unclear whether a TAC was decided on particularly for saithe and the two redfish stocks. The figures for actual catch are the ones used by ICES. In most years these figures correspond to the reported landings for haddock, saithe, redfish and capelin. For cod and herring ICES has in some years used actual catches which were higher than the reported landings. Discards are not included although substantial amounts of discarding of small specimens at times have taken place, particularly of small sized redfish in the shrimp fisheries, a matter that certainly contributed to the decline in redfish stocks and fisheries about a decade ago.

In order to investigate to which extent the advice has been used tables 2A and 2B were made from the data in table 1. Table 2A shows how the agreed TACs relate to the advised ones; i.e. to which extent the advice was used when the quota was decided on. It appears that there has been a general tendency to decide on TACs at or above the advised level for all stocks. This is particularly pronounced for cod and herring (Table 2A). For herring zero catch was recommended for quite a number of years, yet Norway decided to fish a limited quantity. However, the apparent "negligible" fishery which took place in the 1970s and early 1980s contributed to delay the recovery of the spawning stock (Gjøsæter 1995, Nakken 1998).

For cod the Norwegian-Russian mixed commission quite often has agreed that catches should be higher than the stock could sustain. Even in the early 1990s when the spawning stock was recovering from its record low level, the agreed TACs (1992, 1993, 1994) were substantially higher than those which would have made the stock sufficiently robust to fishing at the end of the 1990s: Was the advice misunderstood in the early 1990s? ICES changed its advisory practice in 1991-1992, from recommending a certain TAC regardless of stock size to a presentation of options of catch and future stock development. Thus leaving managers to decide which option to choose when the stock was considered to be within "safe biological limits". I have the impression that many people involved in the discussion prior to the decision on TAC, have held - and still hold - the opinion that any option given by ICES can be considered an ICES recommendation, which it can not. Since one or more of the TAC options presented were above the level that would have been recommended based on sustainability considerations, this might have contributed to TACs in excess of the advisable ones for cod in the early 1990s. On the other hand, the distributions in table 2A are all clearly skewed towards the right hand side for all stock. Thus indicating that the agreed TACs were based on a

perception that the advised figures generally were too low. In other words, managers usually have assumed that the scientists have underestimated either the stock size or the production capacity of the stock.

The distributions in table 2B might be taken as an indication of the managers capability to limit the catches to the level they found necessary when the TAC was decided on. Except for capelin and haddock, overfishing of TACs has taken place for all stocks. To some extent this may reflect the lack of jurisdiction in parts of the area, but in most cases it is caused by lack of enforcement in the national zones. The relatively high number of "belows" for cod and haddock simply shows that the fleets have not managed to take the agreed and/or advised TAC because of lack of fish in many of the years, indicating that advised TACs might have been too high or too optimistic.

Has advice been too optimistic?

Fortunately, this question can be investigated since ICES each year produces an updated and corrected version of the main results of previous years stock assessments. In table 3 are listed two estimates of spawning stock biomass each year for cod, haddock, saithe and herring. The figures generated by the 1998 assessment (1999 for herring) are regarded the most reliable ones. The ratios between the two yearly estimates are shown in Fig. 1. For all 4 stocks the ratio varies in a rather systematic manner with time and it deviates quite substantially from unity. Spawning stocks of haddock and saithe were grossly overestimated in the annual assessments in the 1980s. In the 1990s the amount of spawning haddock has been underestimated while saithe appears to be adequately assessed with exception of 1993. The spawning stock of cod has been overestimated in nearly all assessments which have been carried out in the period while the annual assessments of herring have generated considerably lower spawning stocks estimates than the 1999 assessment in all years since the 1983-yearclass recruited and caused an extensive growth in spawning stock biomass at the end of the 1980s.

Estimates of spawning stock biomass depend on number at age and weight at age as well as percentage mature at age. Which of these three variables have contributed to the discrepancies appearing in table 3 and Fig. 1? Fig. 2 shows a plot of estimated annual fishing mortalities for cod for the period 1982-1997. The straight line has slope 1 and runs through origin. If there were no differences between the two estimates of fishing mortality all points would appear on the line, which they do not. The 1998 assessment which is considered to be the most reliable one for the years 1995 and backwards, but not necessarily for more recent years - generated fishing mortalities which were systematically higher than those produced in the annual assessments. Thus, it seems reasonable to conclude that the annual assessments of cod have underestimated the fishing mortality and overestimated stock numbers available for the fishery. Hence, the annually advised TAC which has been based on these figures has been too optimistic, i.e. too high.

How much is the mortality rate biased?

In Fig. 3 are shown the time series of the same data as used in Fig. 2. Fig. 3 indicate that the underestimation of \bar{F}_{5-10} in the annual assessments is more pronounced in the periods, 1982-1986 and 1991-1995, when the mortality was increasing, than in 1987-1990, when the mortality was reduced. The figure (Fig. 3) also demonstrate that the fishing mortality rate

during most of the investigated period has been far in excess of the levels recommended for maximum sustainable yield (Nakken et. al. 1996).

The time series of the ratio between the two estimates of fishing mortality, $F(\text{Ass})/F(98)$, is given in Fig. 4. The tendency towards lower ratios in the mid-1980s and early 1990s than for the years in between is early seen. However, it should be noted that the mortalities arrived at in the assessments for 1990-1992 were based on too low catches. The catches for 1990-1994 were raised in order to compensate for underreporting in those years, and this was done in autumn 1994 when the assessment for 1993 was carried out.

Fig. 5 is an attempt to illustrate the development of the range and average of the "underestimation" in successive assessments (years). It takes 5-6 years before the mortality estimate for a certain year converge and stabilizes and the average underestimation in the actual assessment year (year 0) is about 20 percent, which corresponds to a similar overestimation of the stock of fish aged 5-10 years..

Consequences for future advice and management

In the scientific literature focus is often directed towards the uncertainties related to the prediction of stock size (Ulltang 1996); i.e. to the recruitment in coming years. The brief comparisons made above indicate that at least for the gadoid stocks and in particular for northeast arctic cod, TACs are often based on wrong perceptions of current mortality in the stock. Fish are removed from the stock at a higher rate than the scientists expect from their analyses at the time the advice is given. In order to throw light on this problem in-depth investigations of the reliability of catch statistics as well as careful reviews of the assessment methodology are needed.

However, until the causes of the discrepancies are known management authorities ought to take a more precautionary approach when setting TACs than hitherto. The general tendency for northeast arctic cod as well as for the other demersal stocks has been to decide on TACs at or above the advised level. The finding above call for a change in this practice towards deciding on TACs at and below the advised level. This would lower the rates of exploitation and increase and stabilize the yields for most stocks as demonstrated for the Barents Sea cod by many authors (see Nakken et. al. 1996 for references).

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Table 1. Advised (Adv), agreed (Agr) and actual (Act) catches (000 tonnes) from 6 stocks in the Barents Sea and adjacent waters from 1978 to 1999. (Source: ICES - Reports of the Advisory Committee for Fisheries Management, 1978-1999).

Year	Cod		Haddock		Saithe		Redfish		Herring		Capelin	
	Adv.	Agr.	Adv.	Act.	Adv.	Act.	Adv.	Act.	Adv.	Act.	Adv.	Act.
1978	850	850	150	699	160	154	150	125	0	7	1800	1783
1979	600	700	206	441	153	166	157	113	0	0	1600	1649
1980	390	390	75	382	122	145	100	103	0	10	1900	1987
1981	-	300	110	399	123	172	89	101	0	9	1600	1759
1982	<432	300	110	365	130	175	84	130	0	12	2300	2309
1983	<380	300	77	290	130	155	85	125	0	21	1100	1434
1984	150	220	20	278	103	150	85	101	38	38	1000	851
1985	170	220	50	308	85	107	100	92	50	60	1100	123
1986	<446	400	100	430	74	70	100	53	150	126	0	0
1987	<645	560	160	518	90	92	-	34	150	115	0	0
1988	(530) ¹	590	<240	459	<83	114	26	42	150	120	0	0
1989	335	300	69	351	120	123	36	47	100	100	0	0
1990	172	160	-	212	93	95	41	63	80	80	0	0
1991	215	215	-	319	90	107	36	68	0	76	1000	933
1992	250	356	35	513	115	128	47	32	0	98	1030	1123
1993	256	500	56	582	132	154	30	29	119	200	600	586
1994	649	700	97	771	158	142	R.C.	28	334	450	0	0
1995	681	700	122	740	221	169	L.p.	25	513	None	0	0
1996	746	700	169	732	158	171	L.p.	25	- ⁶	None	0	0 ^x
1997	<993	850	<242	766	107	143	L.p.	25	- ⁶	1500	0	0
1998	514	654	120	561	117	153	N.d.f.	30	≤Hcr	1300	0	0
1999	360	480	74	-	N.a.	-	N.d.f.	-	1263	1302	79	-

¹ Revised advice May 1988: 320-360, Agr: May 1988: 451.

L.p.: Lowest possible, N.d.f.: No directed fishery, N.a.: No ICES advice, Hcr: Harvest control rule

² Keep SSB > 2.5 mill. tonnes

Table 2A. Occurrence of cases when agreed TAC was set below, at or above the advised one. The two TACs were considered to be equal (i.e. At) when the ratio between them was in the range 0.9-1.1. Data from table 1.

Stock	Below	At	Above	Total
N-E Arctic cod	3	10	8	21
N-E Arctic haddock	0	12	5	17
N-E Arctic saithe	1	6	4	11
Redfish (two stocks)	0	6	1	7
Nss Herring	3	6	11	20
Capelin	0	19	2	21
Total	7	59	31	97
Total (Herring excl.)	4	53	20	77

Table 2B. Occurrence of cases when the actual catch was below, at or above the agreed TAC. Catch and TAC were considered equal (i.e. At) when the ratio between them was as in 2A.

Stock	Below	At	Above	Total
N-E Arctic cod	5	6	10	21
N-E Arctic haddock	10	7	1	18
N-E Arctic saithe	0	8	2	10
Redfish (two stocks)	1	3	3	7
Nss Herring	0	10	9	19
Capelin	1	19	0	20
Total	17	53	25	95
Total (Herring excl.)	17	43	16	76

Table 3. Estimates of spawning stock biomass (000 tonnes) for cod, haddock, saithe and herring 1984-1994. A 98: from the assessment carried out in 1998
Ann: from the annual assessments 1985-1997

Year	Cod			Haddock			Saithe			Herring		
	A 98	Ann	ratio	A 98	Ann	ratio	A 98	Ann	ratio	A 99	Ann	ratio
1984	259	354	0.73	37	87	0.42	150	179	0.84	593	840	0.71
1985	212	407	0.52	32	69	0.46	121	171	0.71	492	579	0.85
1986	166	393	0.42	47	77	0.61	89	157	0.57	414	477	0.87
1987	112	275	0.41	32	32	1.00	90	539	0.17	1011	491	2.06
1988	187	189	0.99	55	110	0.50	125	193	0.65	3268	1336	2.45
1989	196	151	1.30	70	89	0.79	139	255	0.54	4151	1497	2.77
1990	350	327	1.07	76	141	0.54	122	186	0.66	4848	1482	3.27
1991	679	680	1.00	94	79	1.19	108	102	1.06	5119	2183	2.34
1992	882	1047	0.84	117	82	1.43	103	79	1.30	5016	2396	2.09
1993	751	1024	0.73	163	117	1.39	120	56	2.14	4868	2314	2.10
1994	604	774	0.78	94	78	1.21	195	174	1.12	5605	3841	1.46
1995	537	704	0.76	146	100	1.46	231	238	0.97	5948	5041	1.18
1996	651	832	0.78	212	242	0.88	231	211	1.09	6652	5557	1.20
1997	727	839	0.87	215	255	0.84	226	223	1.01	11998	12585	0.95

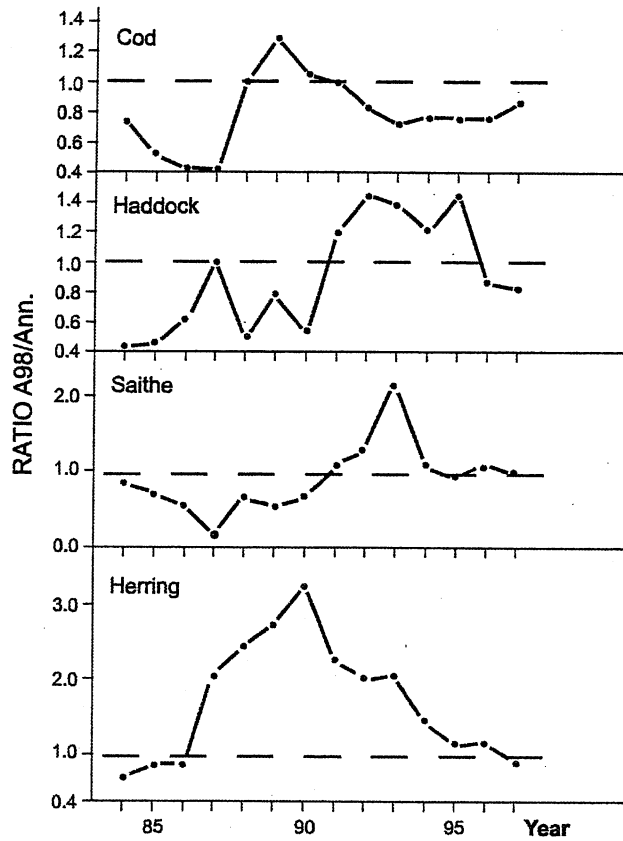


Fig. 1. Ratio between corresponding estimates of spawning stock biomass for northeast arctic cod, haddock and saithe and Norwegian spring spawning herring. A98: Estimates from the assessment carried out in 1998. Ann: Estimates from the annual assessments 1985-1998.

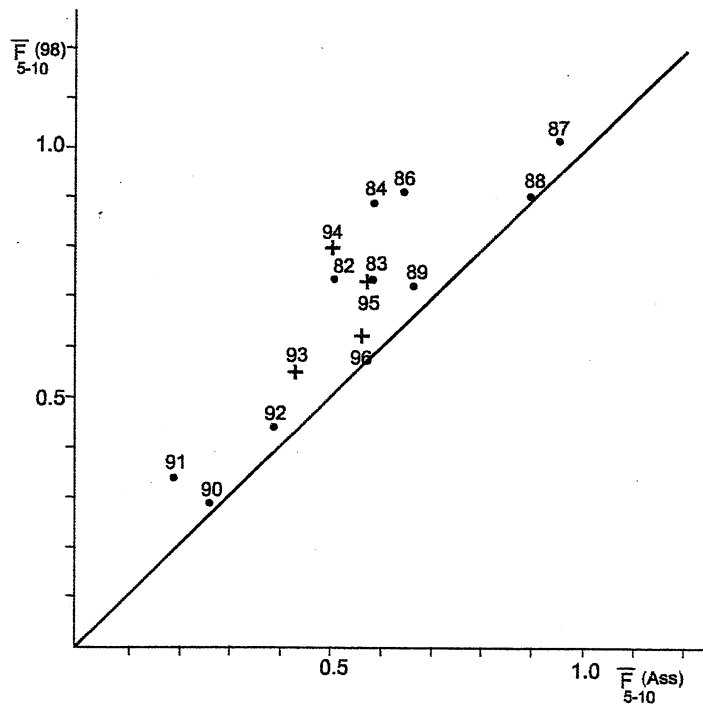


Fig. 2. Northeast arctic cod. Annual fishing mortality rates (F_{5-10}) in 1982-1996 for 5-10 year old fish. The values estimated in the 1998-assessment (ordinate) are plotted against the corresponding values arrived at in the annual assessments 1983-1998.

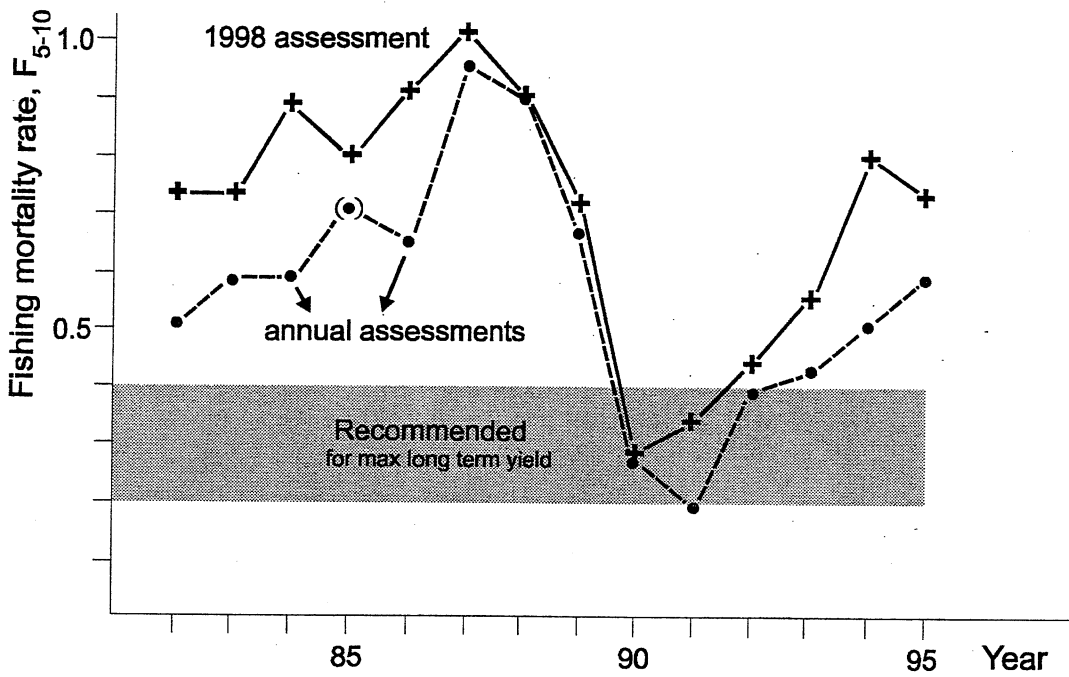


Fig. 3. Northeast arctic cod. Annual fishing mortality rates, F_{5-10} , in 1982-1995 for the cohort aged 5-10 years. Estimates from the assessment made in 1998, compared with those obtained in the annual assessments 1983-1996. The shaded area shows levels of F_{5-10} corresponding to maximum long term yield.

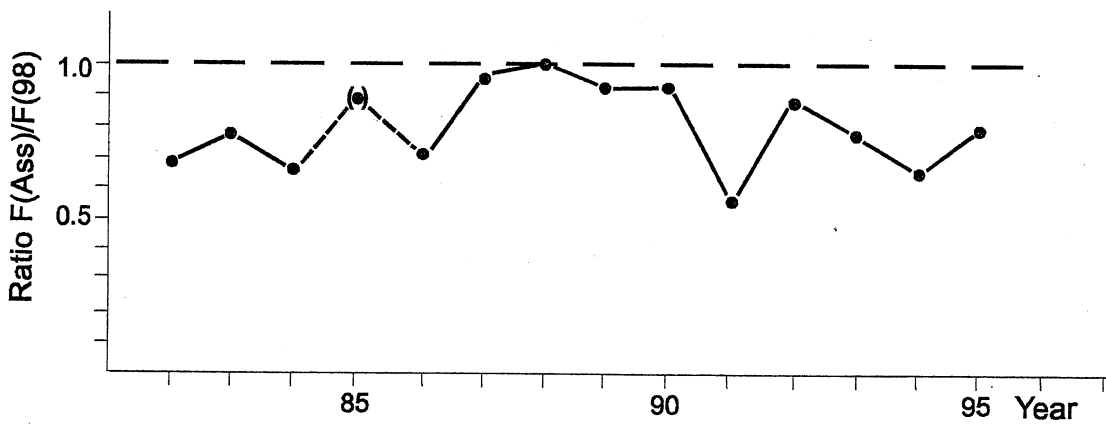


Fig.4 Northeast arctic cod. Ratio between corresponding estimates of annual fishing mortalities. $F(\text{ass.})$ is the estimate arrived at each year (1983-1996), $F(98)$ is from the 1998 assessment.

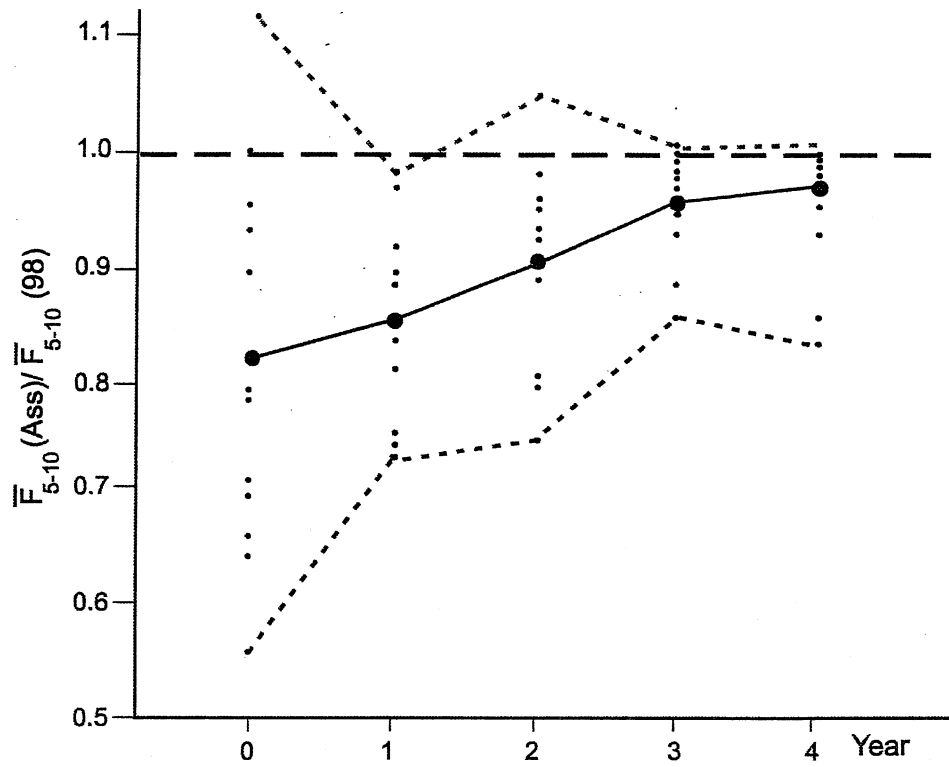


Fig. 5. North east arctic cod.
 Ratios between annual mean fishing mortality rates
 $F_{5-10}(\text{ass.})$: is estimated each particular year.
 $F_{5-10}(98)$: is estimated for the same years in 1998.