Northwest Atlantic Fisheries Organization

Serial No. N2301 NAFO SCR Doc. 93/108

SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1993

An Analysis of Scientific Advice and TAC Levels for the Scotian Shelf (Divisions 4VWX) Silver Hake Stock

by

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Introduction

The TACs for Scotian Shelf (Div. 4VWX) silver hake have consistently been close to the levels advised by STACRES of ICNAF and the Scientific Council of NAFO. Nominal catches have typically been well below TAC levels set. Nonetheless, the most recent assessment of this stock (Waldron *et al.* 1992) indicates that fishing mortality (F) has been approximately $F_{0.1}$ in each year from 1985. If the scientific advice given was in reference to the $F_{0.1}$ catch, these observations suggest that the advised TACs were overestimates. This inference is investigated in this report.

Comparison of advice, TACs and catches

The first stock assessment of silver hake in Div. 4VWX was completed in 1973 and served as the basis for establishment of TAC controls in 1974 (Table 1). Subsequent scientific advice, TACs and catches are listed in Table 1 along with references to the primary source documents and notes on the basis of advice.

The management strategy of ICNAF was to fish at F_{MAX}. Advice in 1974-76 was given in relation to this reference level, TACs were set as advised and reported catches were 96-97% of TACs. The Canadian management strategy was to fish at $F_{0.1}$ and, when possible, advice was given in relation to this reference level. In 12 of the 17 years 1977-93, TACs were set at advised levels. In one year the TAC was set higher than the advice (1982 - 80 kt vs. 75 kt) but in three cases TACs were set lower than the advised level (1980 - 90 kt vs. 100 kt; 1988 - 120 kt vs. 167 kt; 1989 - 135 kt vs. 235 kt) and, in 1990, when no advice was offered, the previous year's TAC was carried over. Thus, the advice was respected except when very high catches were advised in 1988-89. Catches reported against TACs from 1977 were on average 60% of the annual TAC levels (range 30% in 1992 to 83% in 1986).

Administrative influences on catch levels

Prior to extended jurisdiction the silver hake fishery was conducted year-round over an extensive area in the central Scotian Shelf without restriction, except on catch through TACs and a bycatch limit of regulated species of 10%. Mesh size in use was 40mm. From 1977, the small mesh silver hake fishery was restricted spatially to the edge of the shelf, i.e. seaward of the Small Mesh Gear Line, seasonally to the period March/April to 15 November, and a minimum codend mesh size of 60mm was imposed. Allowed bycatches were severely restricted and currently allowances are 1% by weight of the catch of licensed species (silver hake, argentine, squid, mackerel) for haddock and Div. 4X cod, and 5% for pollock and for cod in Div. 4W. These measures were designed to minimize bycatches while still allowing the silver hake fishery to be prosecuted in an efficient manner. The mesh size increase was also intended to increase the yield of silver hake. Representatives of fleets fishing for silver hake have pointed out that the restrictions reduced the opportunities for catching this species. There have indeed been occasions when the fishery has been closed because of bycatches beyond allowed percentages. Beyond this, however, there is no clear evidence that these regulations prevent catch allocations from being taken.

Canadian catch allocation procedures certainly had an influence on the extent to which TACs could be harvested. In a number of years Canada established substantial domestic allocations to encourage fishery development against which only small quantities were actually caught. In addition, reserves for foreign allocations were distributed through bilateral agreements during the year, and on occasion administrative difficulties may have restricted the opportunities of recipients to fully harvest their allocations. Nonetheless, an analysis by Waldron *et al.* (1990) for the 13 years 1977-89 indicated that the utilization of non-Canadian allocations was high. For all non-Canadian participants 77% of allocations were taken on average (range 53 - 90%). For the primary participant in the fishery, the USSR, the average utilization was 88% (range 63 - 101%). As overall utilization of the TAC in these same years was only 64%, it is clear that allocation had a significant effect on overall catch levels.

A policy change in 1991 which favoured private arrangements through Canadian companies for harvesting silver hake, rather than the previous situation of allocations to foreign governments, could also have influenced harvesting levels. In 1991 - 93, provisional statistics indicate 68%, 30% and 34% utilization respectively. However, other factors could equally well be responsible for these lower percentages and a review of these 1991 - 93 arrangements is required before inferences can be made.

In conclusion, persistent substantial underutilization of TACs set is not, in itself, evidence that the TACs were set too high. The most dedicated fishery participants were usually able to take high proportions of their allocations.

Basis for scientific advice

Yield-per-recruit: Except for the first assessment in 1973, when natural mortality was assumed to be M=0.50, an M=0.40 was used. This received some scientific justification in

1977 (Terré and Mari 1978). The primary influence on the calculation of the $F_{0.1}$ reference level has been assumptions about partial recruitment pattern. The first assessments used a dome-shaped PR which gave $F_{0.1}$ = 0.60 - 0.67. Assessments conducted from 1981 to 1989 used a flat-topped PR and $F_{0.1}$ = 0.42 - 0.47. Readoption of a domed-shaped PR in 1990 gave $F_{0.1}$ = 0.72, the currently used value. Fully-recruited age groups are ages 3 - 5 only.

Advice given: Uncertainties about the effect of mesh size change between 1976 - 77 created assessment uncertainty and advice on $F_{0.1}$ catch levels based on projected effects was discounted and higher catch levels advised for 1977 - 79. For the years 1980 - 82, $F_{0.1}$ levels were provided, and also for 1984, but in 1983 and 1985 - 87 $F_{0.1}$ catch could not be calculated and rollover of previous years' TAC was advised. For 1988 - 89, TAC advice at $F_{0.1}$ was offered but in 1990 no advice on catch level could be formulated. TACs in 1991 - 93 were based on $F_{0.1}$ catch advice. Thus, TAC advice was based on $F_{0.1}$ in nine of 17 cases, in three cases advice was modified to account for the transition between mesh sizes, and in the remaining five status quo TACs resulted from inability to adequately describe stock status.

Historical F levels and $F_{0.1}$ catches

The 1992 stock assessment (Waldron et. al 1992) provides the most recent perspective on stock history. That assessment indicates that the F on fully-recruited age groups (age 3 - 5) was below $F_{0.1}$ (0.72) in the period 1977 - 84 and approximately at that level from 1985 (Fig. 1). The most recent two years of data (1990 - 91) are discounted to minimize the influence of input values on the following comparison. The average F in 1985 - 89 was 0.83, slightly above $F_{0.1}$, whereas the average catch in these years was 76,000t. In contrast, the average scientific advice was 140,000t and the average TAC was 111,000t, 1.8 and 1.5 times the average catch in these years. Thus, the 1992 assessment indicates that recent scientific advice was high in relation to $F_{0.1}$.

To obtain a longer view of advice in relation to $F_{0.1}$, the catches in each year from 1977 were adjusted by the ratio of exploitation rate at $F_{0.1}$ to that at the F measured for ages 3 - 5 in the 1992 assessment, to give an estimate of the $F_{0.1}$ catch in that year. These $F_{0.1}$ catches were then compared with the advice given, and TACs set for each year (Table 2). Again discounting 1990 - 91, this comparison suggests that catch advice given, whether at $F_{0.1}$ or not, averaged 150% of the $F_{0.1}$ catch, whereas TACs averaged 132% of $F_{0.1}$ catch. A good correspondence between advice (and TAC set) and $F_{0.1}$ catch occurred in 1977 - 79 (86 - 123%) and also in 1982 - 84 (98 - 115% and 98 - 123% respectively). After 1984 correspondence worsened and the advice for 1989 is remarkable in its inconsistency.

Conclusions

From the perspective of the 1992 assessment it appears that scientific advice has consistently been above the level of $F_{0.1}$ after 1985. Prior to that, the tendency to overestimate was slight in most years. However, serious overestimation problems arose in

1988 - 89. Allocation procedures which resulted in underutilization of TACs countered their over-estimation in relation to $F_{0.1}$ resulting in Fs generally at or below $F_{0.1}$. Partial discounting, by Canadian management authorities, of the advice for 1988 - 89 also reduced the adverse effects of overestimation, although F in 1989 appears to have been very high as a result of the advice given.

The calculated $F_{0.1}$ catch levels in 1977 - 89 averaged 70,000t (range 62 - 88,000t). These 13 years included periods of poor fishing conditions in the late 1970s - early 1980s and good fishing conditions in the mid 1980s (Waldron *et. al* 1992) and thus these estimates may provide some general guidance on yield expectations from the stock. If so, the advice of the last nine years in the range 100 - 235,000t was above these expectations.

These conclusions do, of course, take the 1992 assessment at face value. However, the history of silver hake assessment amply illustrates how the addition of new data can substantially change perceptions.

References

Terré, J.J., and A Mari. 1978. Estimates of natural mortality for the silver hake stock on the Scotian Shelf. ICNAF Sel. Papers No. 3: 29-31.

Waldron, D.E., M.C. Bourbonnais, and M.A. Showell. 1990. Status of the Scotian Shelf silver hake (whiting) populations in 1989. NAFO SCR Doc. 90/20, Ser. No. N1737, 27p.

Waldron, D.E., M.A. Showell, and M.C. Bourbonnais. 1992. Status of the Scotian Shelf silver hake (whiting) population in 1991 with projections to 1993. NAFO SCR Doc. 92/50, Ser. No. N2102, 22p.

Table 1. Silver hake in Div. 4VWX: chronology of scientific advice on TAC levels, TACs set and catches taken, 1974 - 93.

Management Year	Sources	TAC Advice	TAC (catch)	Notes
		PART A: ICNAF Management		
1974	ICNAF Redbook 1973, Pt. 1: 76-77. Halliday, ICNAF Res. Doc. 73/103.	$F_{0.1}$= 50,000t F_{1972} = 100,000t	100,000t (96,000t)	M=0.50, $F_{0.1}$=0.60, F_{1972}=1.4
1975	ICNAF Redbook 1974: 90-91. (Working Papers)	120,000t (F=1.0)	120,000t (116,000t)	Calculations unpublished. F=1.0 gives approx. max. Y/R
1976	ICNAF Redbook 1975: 36. Doubleday and Halliday, ICNAF Res. Doc. 75/104; Sel. Papers No. 1 (1976).	F_{MAX}=100,000t	100,000t (97,000t)	M=0.40, F_{MAX}=0.70 Mean age at recr.=15 mo. New ageing technique.
		PART B: Canadian Management		
1977	ICNAF Redbook 1976: 89-90; 1977: 19-23. Doubleday *et al.*, ICNAF Res. Doc. 76/59; Doubleday and Hunt, ICNAF Res. Doc. 76/160; Noskov, ICNAF Res. Doc. 76/57 and 76/157.	70,000t ($F_{0.1}$=58,000t)	70,000t (37,000t)	Recommended catch above $F_{0.1}$ to minimize disruption caused by mesh size increase, i.e. to smooth catch over transition period. M=0.40, $F_{0.1}$=0.65
1978	ICNAF Redbook 1977: 57-58. Doubleday and Hunt, ICNAF Res. Doc. 77/44; Noskov, ICNAF Res. Doc. 77/34.	81,000t ($F_{0.1}$=61,000t)	81,000t (48,000t)	As for 1977, potential effects of mesh change discounted. Evidence presented that M less than 0.5 (Terré and Mari, ICNAF Res. Doc 77/6; Sel. Papers No. 3 (1978)). M=0.40 accepted thereafter.
1979	ICNAF Redbook 1978: 61-65. Halliday *et al.*, ICNAF Res. Doc. 78/62; Noskov, ICNAF Res. Doc. 78/31.	70,000t ($F_{0.1}$=35-84,000t)	70,000t (52,000t)	Uncertainty about effect of mesh change on PR created uncertainty about $F_{0.1}$ and projected catch.
1980	ICNAF Redbook 1979: 76-78; NAFO SC Reports 1979-80: 47-48. Clay, ICNAF Res. Doc. 79/48; Clay, NAFO SCR Doc. 80/21; Noskov, ICNAF Res. Doc. 79/99; Noskov, NAFO SCR Doc. 80/46.	$F_{0.1}$=100,000t	90,000t (45,000t)	$F_{0.1}$=0.67
1981	NAFO SC Reports 1979-80: 80-81. Clay and Beanlands, NAFO SCR Doc. 80/87; Noskov, NAFO SCR Doc. 80/74.	$F_{0.1}$=70-80,000t	80,000t (45,000t)	Depending on proportion of 1980 TAC taken. $F_{0.1}$=0.65
1982	NAFO SC Reports 1981: 40-41. Waldron, NAFO SCR Doc. 81/74.	$F_{0.1}$=75,000t	80,000t (60,000t)	$F_{0.1}$=0.447 with PR=1.0 for all ages 3+.
1983	NAFO SC Reports 1982: 24-25. Waldron and Harris, NAFO SCR Doc. 82/65; Noskov, NAFO SCR Doc. 82/49.	80,000t	80,000t (36,000t)	$F_{0.1}$ catch could not be calculated. Recommended 1983 TAC=1982 TAC.

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Table 1. (Continued)

Management Year	Sources	TAC Advice	TAC (catch)	Notes
1984	NAFO SC Reports 1983: 42-44. Waldron *et al.*, NAFO SCR Doc. 83/59; Noskov, NAFO SCR Doc. 83/44.	$F_{0.1}$=100,000t	100,000t (74,000t)	$F_{0.1}$=0.418 with PR=1.0 for all ages 3+.
1985	NAFO SC Reports 1984: 49-50. Waldron and Harris, NAFO SCR Doc. 84/85.	100,000t	100,000t (75,000t)	$F_{0.1}$ catch could not be calculated. Recommended 1985 TAC=1984 TAC.
1986	NAFO SC Reports 1985: 62-65. Waldron and Fanning, NAFO SCR Doc. 85/68; Noskov, NAFO SCR Doc. 85/36.	100,000t	100,000t (83,000t)	$F_{0.1}$ catch could not be calculated. Recommended 1986 TAC=1985 TAC.
1987	NAFO SC Reports 1986: 60-63. Waldron and Fanning, NAFO SCR Doc. 86/62; Noskov, NAFO SCR Doc. 86/60.	100,000t	100,000t (62,000t)	$F_{0.1}$ catch could not be calculated. Recommended 1987 TAC=1986 TAC.
1988	NAFO SC Reports 1987: 51-55. Fanning *et al.*, NAFO SCR Doc. 87/56; Noskov, NAFO SCR Doc. 87/42.	$F_{0.1}$=167,000t	120,000t (74,000t)	$F_{0.1}$=0.474 with PR=1.0 for all ages 3+.
1989	NAFO SC Reports 1988: 49-52. Waldron *et al.*, NAFO SCR Doc. 88/51; Rikhter, NAFO SCR Doc. 88/29.	$F_{0.1}$=235,000t	135,000t (88,000t)	$F_{0.1}$=0.474 with PR=1.0 for all ages 3+.
1990	NAFO SC Reports 1989: 71-76. Waldron *et al.*, NAFO SCR Doc. 89/48; Rikhter, NAFO SCR Doc. 89/14.	None	135,000t (69,000t - provisional)	1988 data gave radically different view of stock status (high Fs). Could not resolve differences.
1991	NAFO SC Reports 1990: 66-71. Waldron *et al.*, NAFO SCR Doc. 90/20.	100,000t ($F_{0.1}$=93,000t)	100,000t (68,000t - provisional)	$F_{0.1}$=0.72 with PR=1.0 on ages 3-5 only. TAC advice rounded up. ADAPT methodology used.
1992	NAFO SC Reports 1991: 64-68. Waldron *et al.*, NAFO SCR Doc. 91/42.	$F_{0.1}$=105,000t	105,000t (32,000t - provisional)	Assessment based on interpretation of several *ADAPT* formulations, but no single run accepted.
1993	NAFO SC Reports 1992: 96-100. Waldron *et al.*, NAFO SCR Doc. 92/50; Gasiukov, NAFO SCR Doc. 92/23.	$F_{0.1}$=75,000t	75,000t (29,000t - provisional)	ADAPT methodology used. The sum of initial allocations (87,000t) exceeded the TAC set.

Table 2. Comparison of advised catches and TACs set with retrospectively calculated catches at $F_{0.1}$ in each year based on the 1992 silver hake assessment (Waldron *et al.* 1992).

Year	Calculated $F_{0.1}$ catch (kt)	Advised catch (kt) at $F_{0.1}$ (or other)	% adv. catch of calc. catch	TAC (kt)	% TAC of calc. catch
1977	81	58(70)	72(86)	70	86
1978	66	61(81)	92(123)	81	123
1979	63	35-84(70)	56-133(111)	70	111
1980	65	100	154	90	138
1981	62	80	129	80	129
1982	65	75	115	80	123
1983	82	-(80)	-(98)	80	98
1984	88	100	114	100	114
1985	75	-(100)	-(133)	100	133
1986	70	-(100)	-(143)	100	143
1987	65	-(100)	-(154)	100	154
1988	77	167	217	120	156
1989	65	235	362	135	208
1990	70	-(-)	-(-)	135	193
1991	68	93(100)	137(147)	100	147
Mean 1979-89			150(149)		132
Number of observations			9 13		13
Mean 1977-87			110(124)		123
Number of observations			7 11		11

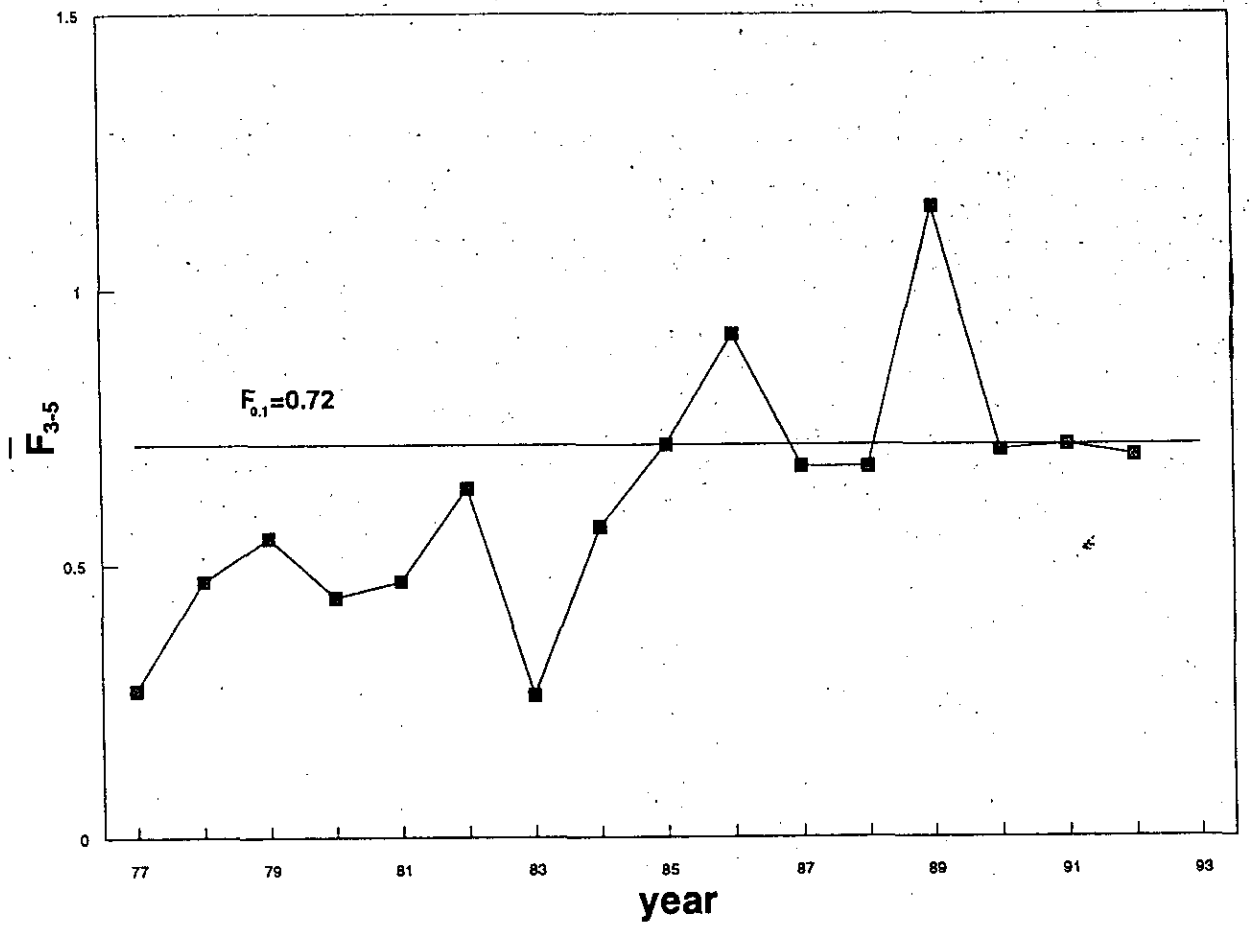

Fig. 1. Div. 4VWX silver hake: weighted mean F for ages 3 - 5 in 1977 - 92 based on 1992 assessment (Waldron *et al.* 1992).