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NORTHWEST ATLANTIC FISHERIES ORGANIZATION

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PREFACE

This eleventh issue of *NAFO Scientific Council Reports* containing reports of Scientific Council Meetings held in 1990 is compiled in three sections: **Part A** - Report of the Meeting of 6-20 June 1990 which addressed requests for scientific advice on fisheries management. The report of the *Working Group on Progress in Age Determination of Pandalus* held in Reykjavik, Iceland, during 16-19 October 1989 and the report of the *Workshop on Silver Hake Database* held in Copenhagen, Denmark, during 8-12 January 1990 are included in this report. **Part B** - Report of the Annual Meeting of 10-13 September 1990 and the preceding Special Session held during 5-7 September 1989. The report of the Special Session on "Management Under Uncertainties Related to Biology and Assessments, With Case Studies on Some North Atlantic Fisheries" is included in the report of the Annual Meeting, and **Part C** - the Agenda, List of Research and Summary Documents, List of Participants, and List of Recommendations relevant to Part A and B.

The *NAFO Scientific Council Reports* series replaced *ICNAF Redbook* series which terminated with the last issue in 1979. The first issue of this series was published in December 1980.

1 December 1990

Tissa Amaratunga
Assistant Executive Secretary

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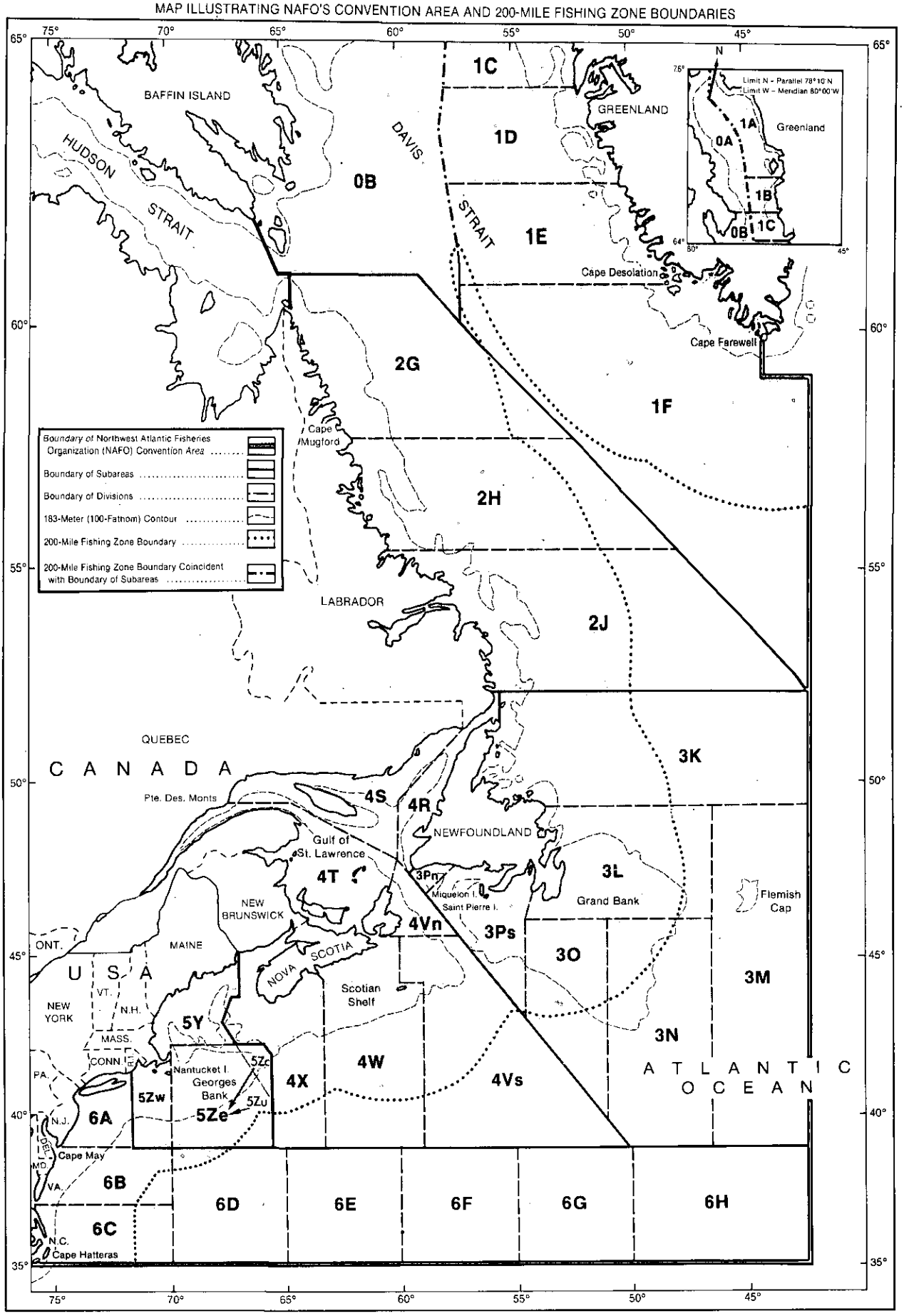
MAP ILLUSTRATING NAFO'S CONVENTION AREA AND 200-MILE FISHING ZONE BOUNDARIES



PART A

Scientific Council Meeting, June 1990

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REPORT OF SCIENTIFIC COUNCIL

June 1990 Meeting

Chairman: B. W. Jones Rapporteur: T. Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at the NAFO Headquarters at 192 Wyse Road, Dartmouth, Nova Scotia, Canada, on 6-20 June 1990, to consider the various matters listed in its provisional agenda.

The Executive Committee met briefly prior to the opening session of the Council, and the provisional agenda (see Part C, this volume) and work plan were reviewed.

Representatives attended from Canada, Cuba, Denmark (Faroe Islands/Greenland), European Economic Community (EEC), German Democratic Republic, Iceland, Japan and Union of Soviet Socialist Republics (USSR), and observers from Food and Agriculture Organization of the United Nations (FAO), Tanzania and the United States of America (USA). The NAFO Executive Secretary and Assistant Executive Secretary were in attendance.

The meeting was called to order at 1015 hr on 6 June 1990.

The Chairman welcomed everyone to the June 1990 Meeting of the Scientific Council and hoped that it would be a successful one with the Council working together in the cooperative spirit. Having been away since ICNAF times, the Chairman asked for the Council's patience as he acquainted himself of the current NAFO practices.

Before addressing matters of the Council, the Chairman called for a few moments of silence in remembrance of three colleagues and friends of the Scientific Council who recently passed away.

Lew Day, the previous Executive Secretary who was active in ICNAF and was involved in setting up NAFO, died on 7 May 1990.

Wilfred Templeman died on 5 April. He was well known in the scientific field and played a role in the establishment of ICNAF and at one time served as Chairman of STACRES.

Dick Wells, a well known scientist in NAFO especially in the field of cod and haddock research, died on 19 December 1989. Dick had at one time served as Chairman of the Scientific Council and had been due to act as Convener of the Special Session on Atlantic cod in 1991.

The Chairman then addressed the adoption of the provisional agenda. A question was raised as to why a review of the Annual Scientific Program was not proposed in the STACREC agenda. The point was made that the item was in the June 1989 agenda to address a specific request from the Fisheries Commission. The Chairman was of the view that there was no standing requirement for an annual review of the Annual Scientific Program. It was agreed to defer a decision on this point until the position could be clarified. The provisional agenda was adopted (see Part C, this volume) subject to a decision on including that item.

The Chairman informed the Council that three Tanzanian Government officials, who were presently studying in Canada had requested permission to attend the June 1990 Scientific Council meetings as observers. The Executive Secretary informed the Council that the Convention permits the Scientific Council to invite non-member government representatives as observers. It was also noted that, at previous Scientific Council meetings, the Council had accepted observers from USA and international organizations without formality. The Council agreed the three Tanzanians should be permitted to attend this specific meeting as observers and requested the Executive Secretary to convey the invitation to them. It also formally agreed on the participation of the USA observers and the expected FAO observer.

The Council was informed that the Executive Secretary held four proxy votes (Cuba, Iceland, Norway and Poland), and that two of those Contracting Parties were likely to have representatives during the course of the meeting.

The Chairman then set out a plan of work with the objective of having the Council report adopted before closing the meeting. A schedule proposed by the Chairman of STACFIS was generally accepted.

The Chairman informed the Council that consideration should be given to the nomination and election of the next STACFIS Chairman for the term of office beginning immediately after the Annual Meeting in September 1990. As the incumbent Chairman had been elected mid-term, as a result of a resignation, the Council may wish to give consideration to the period of appointment as well as seeking nominations for the post.

The session was adjourned at 1130 hr.

The Chairman confirmed that the Fisheries Commission reports referring to the Annual Scientific Program did not have a standing requirement for annual reviews or progress reports from the Scientific Council. Recognizing that STACREC could decide if annual reviews were necessary, the Council agreed that the STACREC agenda would remain as proposed.

The session was adjourned at 0930 hr.

The Council met again at 0910 hr on 8 June 1990.

The Council reviewed the minutes of the previous sessions and agreed on some modifications.

The Chairman observed that the Tanzanian observers arrived after the last session of the Council and took the opportunity to formally welcome them to the meeting.

The Chairman noted that two valuable meetings had been held since the September 1989 Meeting of the Scientific Council: "Working Group on Progress in Age Determination of *Pandalus*" was hosted by the Marine Research Institute, Reykjavik, Iceland and "Workshop on Silver Hake Database" was hosted by the Greenland Fisheries Research Institute, Copenhagen, Denmark. He extended the Council's thanks and appreciation to the Directors of the respective Institutes for hosting those meetings.

The session was adjourned at 0925 hr.

The Council subsequently convened for brief periods to address various agenda items as reported below under the relevant sections. The concluding session was convened at 0900 hrs on 20 June 1990. The Council then accepted the adopted reports of the Standing Committees, and considered and adopted the Scientific Council Report.

The reports of the Standing Committees are appended as follows: Appendix I, Report of Standing Committee on Fishery Science (STACFIS), Appendix II, Report of Standing Committee on Research Coordination (STACREC), and Appendix III, Report of Standing Committee on Publications (STACPUB).

The adopted Agenda, the lists of research (SCR) and Summary (SCS) documents and the list of participants are given in Part C of this volume. The Council's considerations on the Standing Committee Reports and the other matters addressed by the Council follow in Sections II-VII.

The meeting was adjourned at 1435 hr on 20 June 1990.

II. FISHERY SCIENCE (see STACFIS report, App. I)

1. General Fishery Trends

The Council noted that provisional nominal catch data for 1989 were not available for EEC-France (Metropolitan) and France (St. Pierre and Miquelon), in spite of this, the following general trends were noted. From provisional statistics for 1988 and 1989 the nominal catch of all fish and invertebrate species in the Northwest Atlantic (Subareas 0 to 6) remained basically unchanged in 1989 at 2.96 million tons and 2.95 million tons in 1988 (see Appendix 1, Table 1), although the "groundfish" catch decreased (4%) from 1.21 million tons in 1988 to 1.16 million tons in 1989, the "pelagic fish" catch decreased (6%) from 665,000 tons to 628,000 tons, the "finfish" catches increased very slightly (1%) to 189,000 tons in 1989 from 187,000 tons in 1988, and "invertebrates" catches increased significantly (10%) to 981,000 tons in 1989 from 890,000 tons in 1988. With respect to the nominal catches by Subarea, increases were noted for Subarea 0 (from 6,000 tons in 1988 to 13,000 tons in 1989), Subarea 1 (from 138,000 tons to 173,000 tons), Subarea 2 (from 95,000 to 103,000 tons), Subarea 6 (from 803,000 tons to 894,000 tons) and decreases were noted for Subarea 3 (from 678,000 tons in 1988 to 582,000 tons in 1989), Subarea 4 (from 806,000 tons to 793,000 tons) and Subarea 5 (from 425,000 tons to 398,000 tons).

2. Assessment of Finfish and Invertebrate Stocks

The Council noted that STACFIS had reviewed the status of certain stocks in Subareas 0 to 4, as requested by Canada, Denmark (Greenland) and the Fisheries Commission, and had advised on catch levels corresponding to reference levels of various fishing mortality according to the different requests. Management advice, based on the reference levels, could not be provided for several stocks due to insufficient data. Details of the stock assessments are given in the Report of STACFIS at Appendix I, while summaries of assessments are as follows:

SUMMARY SHEET - Cod in Subarea 1

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	Various options (see special comments)											
Agreed TAC	62	68.5	28.3	12.5	12.5	53	90	110	110	12.5	55	1982-90
Reported landings	58	33	15	7	16	60[1]	100[1]		100[1]	7	32	1979-89
Non-reported catches						3	3					
Sp. stock biomass	55	33	26	41	29	57						
Recruitment (age 3)	17	13	4	11	500	100	20	20				
Mean F(6-8)	1.05	0.73	0.53	0.13	0.22	0.63	0.40					

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: The increase since 1987 was caused by recruitment of the very strong 1984 year-class. Highest catch was in 1962: 451,000 tons.

Data and Assessment: Offshore trawl surveys (FRG) conducted since 1982 and Greenland inshore longline surveys since 1987. A standardized CPUE for the Greenland trawl fishery in the period 1975-89. Assessment by VPA.

Fishing Mortality: Estimated by VPA. The relative low fishing mortality in 1986 and 1987 caused by depleted stocks and restrictions on the fisheries.

Recruitment: 1987-90 as estimated from trawl surveys (FRG) and inshore young-fish survey (Greenland). Values prior to 1987 from VPA (SCR Doc. 90/55).

State of Stock: After record low level in the mid-1980s stock has increased by recruitment of the very abundant 1984 and a moderate 1985 year-class but thereafter very small year-classes of 1986-88.

Forecast for 1990: If the TAC of 110,000 tons is taken in 1990, it corresponds to an F of 0.729.

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ = 0.409	32 (000 tons)	66
F_{90} = 0.729	49	48
F_{max} = 1.363	73	26

Recommendation:

Special Comments: Since 1982, no specific TAC has been advised, but a number of management options to let the 1984 year-class grow up before exploiting it, have been advised, and catch levels for options as requested by Denmark (Greenland) have been calculated.

Both the West and the East Greenland stocks are concentrated in the southernmost areas, and in such a situation a combined assessment may be more appropriate and should be considered for future assessments.

SUMMARY SHEET - Cod in Division 3M

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	0	0	0	0	0	0	0	0	0	0	0	1983-90
Agreed TAC	12.4	13	13	13	13	0	0	0	40	0	13	1977-90
Reported landings	10	13	14	15	8	1[1]	1[1]		33	1	15	1977-89
Non-reported catches						7[2]	40[2]					
Sp. stock biomass												
Recruitment (age)	No estimate available											
Mean F												

[1] Provisional.
[2] Unreported catches in 1989 believed to be around 40,000 tons and in 1988 a value of the same order of magnitude is likely to have been taken.

Weights in '000 tons
Recruitment in millions

Catches: Catches ranged from 22,000 to 33,000 tons in late-1970s and have been stable around 12,000 tons for 1980-87. Reported nominal catches were less than 1,000 tons in 1988 and 1989. The 1989 catch was estimated to be around 40,000 tons.

Data and Assessment: Surveys conducted by the USSR since 1971 indicated that biomass and abundance had declined to a minimum in 1987. Both USSR and EEC surveys showed an increase in stock biomass from 1988 to 1989 due to a relatively abundant 1986 year-class.

Fishing Mortality:

Recruitment: Survey results indicated a relatively strong 1986 year-class. The 1985 year-class showed some strength in the 1989 EEC survey, but it was not as evident in the USSR survey.

State of the Stock: Exploitable stock biomass was estimated to be between 78,000 and 101,700 tons in 1989. The population is composed mainly of immature fish, with age 3 the most abundant age group.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation: A cessation of fishing for cod on the Flemish Cap to allow the spawning stock to rebuild.

Special Comments: Catch, effort and sampling data of the fleet fishing for cod on the Flemish Cap should be collected and made available to STACFIS.

SUMMARY SHEET - Cod in Divisions 3N and 3O

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC					Same as agreed							
Agreed TAC	17[2]	26	33	33	33	40	25	18.6	40	15	26	1977-90
Reported landings	29	27	37	51	42	43[1]	30[1]		227	17	67	1959-89
Non-reported catches												
Sp. stock biomass	177	176	176	180	173	105	80	76	180	25	107	1959-90
Recruitment (age 3)	35	47	33	7	4	9	25[3]	-	210	4	65	1959-89
Mean F (Ages 6-8)	.11	.19	.31	.36	.23	.59	.47	-	1.08	0.11	0.49	1959-89

[1] Provisional.
[2] Excludes expected catches by EEC-Spain.
[3] Geometric mean - 1977-88.

Weights in '000 tons
Recruitment in millions

Catches: Catches declined from a peak of 225,000 tons in 1967 to a low of 15,000 tons in 1978. Since 1974 the maximum catch occurred during 1986 but had subsequently declined. The 1989 catch was about 30,000 tons.

Data and Assessment: Analytical assessment of catch-at-age data using Canadian and Soviet survey indices in a formulation of the adaptive framework.

Fishing Mortality: Mean fishing mortality (weighted by population numbers) for ages 6-8 was about 0.47 during 1989. Fishing mortalities on ages 5 and 6 (the weak 1983 and 1984 year-classes) in 1989 were in excess of 1.0.

Recruitment: The 1983-85 year-classes were estimated to be the lowest observed in the 31 year time series. These three year-classes were all estimated to be less than 10 million fish. The next lowest year-class in the time series numbered about 21 million fish.

State of Stock: Population biomass at the beginning of the year was at its lowest level during 1976 (65,000 tons). It then increased to 267,000 tons in 1984 and currently estimated to be 93,000 tons. The reason for the large decline since 1984 is the size of the weak 1983-85 year-classes.

Forecast for 1991: Catch assumed for 1990 is the TAC of 18,600 tons (F = 0.37).

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ = 0.25	13,600	65,800
F_{max} = 0.40	20,800	60,200
F_{89} = 0.47	24,000	57,800

Recommendation:

Special Comments: The provisional nominal catch for Div. 3NO as reported in NAFO SCS Doc. 90/21 was somewhat higher than that used in the current assessment. The difference of approximately 10% resulted from an update of Spanish pair trawl catches from 15,277 tons to 17,904 tons. This information was not provided in sufficient time for incorporation in the current assessment, however, this omission is likely to have only a marginal effect on the estimation of population size for 1989.

SUMMARY SHEET - Redfish in Subarea 1

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC					No TAC							
Agreed TAC								19				
Reported landings	7	6	4	5	1	1[1]	1[1]		9	1	5	1978-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)					No estimates							
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Mainly by-catches of *S. marinus* in the cod fishery; peak catch in 1979 was 9,000 tons.

Data and Assessment: Stratified-random bottom trawl surveys since 1982, however, not especially designed for redfish.

Fishing Mortality: No estimates.

Recruitment: No direct estimates but biomass and abundance estimates of juvenile redfish from survey on nursery grounds.

State of Stock: Survey estimates indicate considerable decline of stock biomass and abundance in recent years.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation:

Special Comments: The removal of large amounts of juvenile redfish by the shrimp fishery may adversely affect redfish recruitment.

SUMMARY SHEET - Redfish in Division 3M

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	20	20	20	20	20	20	20	<50	<50	16	22	1974-90
Agreed TAC	20	20	20	20	20	20	20	50	50	16	22	1974-90
Actual landings	20	20	20	29	44	23[1]	27[1]		52	1	19	1959-89
Non-reported catches	No estimates											
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Averaged 20,000 tons or less from 1979 to 1985 and increased thereafter to 44,000 tons in 1987. Catches declined again in 1988 and 1989, but catches by non-member countries were increasing but unknown.

Data and Assessment: Catch-at-age data available, SPA carried out but difficult to evaluate. Catch rates appeared stable in recent years. General production analyses were not possible because of the lack of trends in these data.

Research vessel survey trawling data from both USSR and EEC indicated stability between 1988 and 1989. USSR trawl-acoustic results suggested relative stability from 1987 to 1989 at about 350,000-400,000 tons.

Fishing Mortality: No estimate available.

Recruitment: Relative strong year-class of 1980 now recruiting to fishery. A year-class, probably that of 1985 also appeared relatively strong.

State of Stock: Appears stable in recent years, based on both commercial catch rates and survey data.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =	No information available	
F_{89} =		
F_{max} =		

Recommendation: TAC for 1991 be set at 43,000 tons, equivalent to $F_{0.1}$ catch of 1987-89 average biomass from combined trawl-acoustic surveys by USSR.

Special Comments:

SUMMARY SHEET - Redfish in Divisions 3LN

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended	25	25	25	25	25	25	25	25	28	16	23	1974-90
Agreed TAC	25	25	25	25	25	25	25	25	28	16	23	1974-90
Reported landings	20	15	21	43	71	45[1]	24[1]	-	71	8	24	1959-89
Non-reported catches[2]	-	-	-	-	8	8	NA[3]		8	8	8	1987-88
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.
[2] Estimated by STACFIS for non-members who do not report to NAFO.
[3] NA - not available.

Weights in '000 tons
Recruitment in millions

Catches: Average catch was about 20,000 tons prior to 1985. In 1986, landings doubled to 43,000 tons and increased again in 1987 to 71,000 tons. Catches had declined since but were at or above TAC level.

Data and Assessment: Catch-at-age available from 1978-89. SPA results could not be calibrated due to short time series. Catch rates in both divisions showed no trend with time but this may not be indicative of stock status. Exploitation rates at reference levels applied to USSR trawl-acoustic data.

Fishing Mortality: No estimate available

Recruitment: No estimate available but in relative terms appeared to be poor in Div. 3L.

State of Stock: Considered to be in poor condition based on declining survey biomass estimates since 1983 to the present low levels as well as an indication of poor recruitment at least in Div. 3L.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =	No information available	
F_{89} =		
F_{max} =		

Recommendation: TAC for 1991 be 14,000 tons corresponding to $F_{0.1}$ level applied to the 1987-89 average biomass estimate from USSR acoustic survey.

Special Comments:

SUMMARY SHEET - Silver Hake in Divisions 4VWX

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	80	100	100	100	100	167	235	-	235	75	126	1983-89
Agreed TAC	80	100	100	100	100	120	135	135	135	80	109	1983-89
Reported landings	36	74	75	83	62	74[1]	91[1]	-	91	36	70	1983-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age 1) (billions)	0.9	1.5	0.9	2.3	1.2	0.8	1.5	-	2.4	0.8	1.2	1984-88
Mean F age 3-5	0.2	0.5	0.4	0.8	0.6	0.5	0.56					

[1] Preliminary.

Weights in '000 tons
Recruitment in millions

Catches: 1989 catch of 91,000 tons was the highest in the recent history of this fishery.

Data and Assessment: An analytical assessment was possible this year. The results of calibrations using abundance indices from RV and standardized CPUE at age indicated that F in 1989 was 0.56 which was below the $F_{0.1}$ of 0.72.

Fishing Mortality: Fully recruited F in 1989 was estimated at 0.56.

Recruitment: Recruitment prospects for the 1986 (juvenile RV survey), 1987 and 1988 (July RV survey) year-classes were moderately good. The 1989 year-class was average and similar in size to the 1986 year-class. The magnitude of the 1988 year-class at age 1 in 1989 was not well estimated. It was the fourth largest in the CPUE, RV and Juvenile surveys and was set at 1.5 billion fish based on the population estimates from the SPA. The size of the 1990 year-class was set at the average for 1982-88 SPA population estimates (1.2 billion).

State of Stock: The stock biomass in 1989 (2+) is average and is slightly below that estimated for 1988.

Forecast for 1991: Catch in 1990 assumed at 60,000 tons (F = 0.54)

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ = 0.72	93,000 tons	290,000 tons
F_{89} =	N/A	N/A
F_{max} =	N/A	N/A

Recommendation: TAC for 1991 be set at 100,000 tons.

Special Comments: Noted success from otolith exchanges and a meeting between the age readers from USSR and Canada. STACFIS recommends the production of a manual documenting the established methods of ageing silver hake otoliths. Further, STACFIS encourages the continuation of the juvenile silver hake survey.

SUMMARY SHEET - American Plaice in Division 3M

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	2	2	2	2	2	2	2	2	2	2	2	1983-90
Agreed TAC	2	2	2	2	2	2	2					
Reported landings	1.9	1.3	1.7	3.8	5.6	2.8[1]	3.9[1]		5.6	1.3	3	1983-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Ranged between 600 and 1,900 tons from 1974-85, then increased in 1986-89 to between 2,861 and 5,600 tons as effort was directed on this stock.

Data and Assessment: No analytical assessment. Commercial data scarce in most years. Information from USSR survey (1972-88) and EEC survey (1988-89) used to evaluate stock status.

Fishing Mortality: No information available.

Recruitment: 1986 year-class could be a strong year-class. Information from EEC surveys (1988-89).

State of Stock: Appears to be relatively stable around 10,000 tons.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =	No information available	
F_{89} =		
F_{max} =		

Recommendation: 2,000 tons approximates the $F_{0.1}$ level.

Special Comments: STACFIS noted that there is now substantial survey data available at some national laboratories on this stock. It is therefore recommended that these data, particularly those on age composition, be presented at the June 1991 meeting in order to facilitate a more thorough evaluation of this stock.

SUMMARY SHEET - American Plaice in Divisions 3LNO

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	55	55	49	55	48	28	30.3	24.9	60	24.9	48.0	1974-90
Agreed TAC	55	55	49	55	48	40[1]	30.3	24.9	60	24.9	48.4	1974-90
Reported landings	38.5	37.6	49.5	60.3	55.0	41.4[2]	40.5[2]	-	60.3	38.5	47.3	1974-89
Non-reported catches	0	1.8	4.7	4.3	0	0.1	3.1	-	4.7	0	2.3	1984-89
Sp. stock biomass	136	148	143	136	109	94	96	100	181	94	141	1974-89
Recruitment (age 5)	168	186	201	210	195	218	213[3]		294	168	215	1974-89
Mean F (ages 9+)	0.24	0.29	0.37	0.48	0.49	0.38	0.38		0.49	0.19	0.32	1974-89

[1] Effective TAC was 33,585 tons.
[2] Provisional.
[3] Geometric mean (1974-88).

Weights in '000 tons
Recruitment in millions

Catches: Highest catches for this stock occurred in the late-1960s with a peak catch of 94,000 tons taken in 1967. Catches were stable at about 50,000 tons during the 1970s. Overall catches declined from an 18 year high of about 65,000 tons in 1986 to about 44,000 tons in 1989.

Data and Assessment: Analytical assessment of catch-at-age data using the Adaptive framework with Canadian CPUE and RV survey data both on an age-by-age basis.

Fishing Mortality: Age 9+ weighted F (by population numbers) increased from about 0.22 in 1977-80 to about 0.49 in 1986-87. The 1989 estimate of age 9+ F is 0.38.

Recruitment: Relatively stable throughout the 1974-88 period with a range of 168 to 294 million fish. Recent year-classes (age 5 in 1985-88) have averaged just over 200 million.

State of Stock: The age 8+ population has been declining steadily since 1979 (419 million) to its lowest level in 1988 (244 million). The 1989 estimate is about 7% higher than 1988 at about 261 million fish.

Forecast for 1990: a) assuming a catch in 1990 = 24,900 (1990 TAC) F = 0.31
b) assuming a catch in 1990 = 40,000 (likely catch) F = 0.54

A) Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ = 0.27	25,800	136,700
F_{89} = 0.60	51,700	113,400
F_{max} = 0.51	45,200	119,200

B) Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ = 0.27	22,900	124,600
F_{89} = 0.60	45,900	104,100
F_{max} = 0.51	40,100	109,200

Recommendation: Option B, which assumes catch in 1990 = 40,000 tons, should be used.

Special Comments: Because of the shift in exploitation to younger ages, a yield-per-recruit analysis was conducted to determine more appropriate reference fishing mortality levels. The average weights and partial recruitment values were from the 1987-89 period. The $F_{0.1}$ and F_{max} reference values are 0.27 and 0.51 respectively.

SUMMARY SHEET - Witch Flounder in Divisions 3N and 3O

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	5	5	5	5	5	5	5	5	10	5	7	
Agreed TAC	5	5	5	5	5	5	5	5	10	5	7	
Reported landings	4	3	9	9	8	6[1]	4[1]		9	2	6	1972-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)												
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: From 1970 to 1984, catches ranged from 2400 tons in 1980-81 to 9,200 tons in 1972. From 1985 to 1988, catches had exceeded the TAC by large margins but have been in a declining trend since 1986. It was believed that catches by non-member countries in the most recent years may not be significant.

Data and Assessment: Canadian catch rates in Div. 3O had declined since 1985 to a level in 1988 near the lowest seen in the series (1972) and remained relatively stable in 1989. Estimates of stock size from research vessel surveys were variable.

Fishing Mortality: Unknown

Recruitment: Unknown

State of Stock: Stock size could not be firmly established, however, it appears to have declined in recent years.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation: TAC of 5,000 tons to remain in effect.

Special Comments:

SUMMARY SHEET - Yellowtail Flounder in Divisions 3LNO

Source of Information:

	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	19	17	15	15	15	15	5	5	40	5	17.2	1974-90
Agreed TAC	19	17	15	15	15	15	5	5				
Reported catches	10.5	14.9	24.0	24.5	16.3	16.2	6.5	-	24.5	6.5	15.9	1974-89
Reported landings	10.5	16.7	29.0	30.2	16.3	16.3[1]	7.6[1]		30.2	7.6	16.7	1974-89
Non-reported catches	0	1.8	5.0	5.7	0	0.1	1.1	-	5.7	0	2.3	1984-89

Sp. stock biomass

Recruitment — No information available

Mean F

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Catches peaked in 1972 at 39,000 tons, declined rapidly, and stabilized at 10,000-15,000 tons for most of the 1970s and early-1980s, and were about double the TAC during 1985-86 as effort increased in the Regulatory Area in Div. 3N. The reduced catch of 7,600 tons in 1989, the lowest recorded in the time period observed, was due mainly to reduced allocations.

Data and Assessment: No analytical assessment possible. Data from Canadian catch rates and Canadian and Soviet RV surveys were used to determine trends in stock abundance.

Fishing Mortality: No information.

Recruitment: The 1984 and 1985 year-classes appeared to be stronger than the 3 preceding poor year-classes, but did not appear to be as strong in 1990 compared to 1989.

State of Stock: The information from 1989-90 in the RV survey and CPUE indices pointed to a slightly more optimistic view of this stock compared to the two previous assessments. The stock is still at a low level, however, there is improved recruitment from the 1984-85 year-classes, and the size of the 1982-83 year-classes appeared to be larger in 1989-90 compared to 1987-88.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$	No information available	
F_{89}		
F_{max}		

Recommendation: 7,000 tons TAC advised for entire stock.

Special Comments: STACFIS again expressed concern about the removals of large quantities of juvenile yellowtail in the Regulatory Area, particularly as it appears that small mesh gear is being used in some yellowtail directed fisheries. Although impossible to quantify, it was noted that continuation of the current exploitation pattern in these fisheries would result in a substantial decline in yield-per-recruit.

STACFIS also emphasized that this fishery will be impossible to manage if unregulated catches by non-member countries increase from the low levels of 1988-89 to the levels estimated in 1985-86.

SUMMARY SHEET - Greenland Halibut in Subareas 0 and 1

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	25	25	25	25	25	25	25	25	25	25	25	1983-90
Reported landings	9	7	10	9	8	9[1]	9[1]		10	7	9	1983-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: 86% of the catch was taken in an inshore longline and gillnet fishery, while the remaining part was taken in an offshore trawl fishery.

Data and Assessment: Results from two bottom-trawl surveys. No analytical assessments.

Fishing Mortality: No information available.

Recruitment: No information available.

State of Stock: Only a part of the inshore components in Subarea 1 is fully exploited, while the exploitation level of the offshore component is insignificant.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation: TAC be maintained at a level of 25,000 tons.

Special Comments: Considerations were given to the biological and practical implications of combining stock assessments for Subareas 0, 1 and 2 and Divisions 3KL. From a biological point of view, there is no reason to maintain the separate assessments for the area, but at present practical limitations impede such a combined assessment.

Advises was given that any expansion of the fishery should be directed towards areas outside the exploited areas.

SUMMARY SHEET - Greenland Halibut in Subarea 2 and Divisions 3KL

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	55	55	75	100	100	100	100	50	100	30	58	1974-90
Agreed TAC	55	55	75	100	100	100	100	50	100	30	58	1974-90
Reported landings	28	25	19	16	31	19[1]	20[1]		39	16	27	1974-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)												
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Peaked at 38,500 tons in 1978 and declined to an average of 20,000 tons during the last 5 years.

Data and Assessment: An analytical assessment was performed according to a STACFIS recommendation in June 1989 but was considered unacceptable until migratory patterns, at least, can be quantified.

Fishing Mortality: Unknown.

Recruitment: The 1984 and 1985 year-classes appear good and should contribute significantly to the 1991 fishery.

State of Stock: Stock biomass estimated to be relatively stable during 1987-89 at a level of about half that estimated in 1984 on which a TAC of 100,000 was recommended in 1986.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =	N/A	
F_{max} =		

Recommendation: A TAC of 50,000 tons would approximate fishing at $F_{0.1}$

Special Comments: For discussion on combined assessment for Greenland halibut in Subareas 0, 1 and 2 and Div. 3KL, see Summary Sheet for Greenland halibut in Subareas 0 and 1.

SUMMARY SHEET - Roundnose Grenadier in Subareas 0 and 1

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	8	8	8	8	8	8	8	8	14	8	8	1975-90
Agreed TAC	8	8	8	8	8	8	8	8	14	8	8	1975-90
Reported landings	0.07	0.05	0.06	0.09	0.32	0.12[1]	+[1]		12	+	0.4	1967-90
Non-reported catches												
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Since about 1980, landings have been only as by-catch in the Greenland halibut fishery.

Data and Assessment: No catch-at-age data available and no catch and effort data available for the recent period. Assessment is not possible at present.

Fishing Mortality: No estimate available.

Recruitment: No estimate available.

State of Stock: Not possible to evaluate. Research surveys by Japan and Greenland in 1987 and 1988 resulted in biomass estimates of about 45,000 tons. The 1989 estimate of 5,900 tons was not considered to be realistic.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =	No information available	
F_{89} =		
F_{max} =		

Recommendation: TAC for 1991 remain at 8,000 tons.

Special Comments:

SUMMARY SHEET - Roundnose Grenadier in Subareas 2 and 3

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	11	11	11	11	11	11	11	11	35	11	22	1974-90
Agreed TAC	11	11	11	11	11	11	11	11	35	11	22	1974-90
Reported landings	4	4	5	7	8	6[1]	5[1]		75	4	16	1967-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Catches have been below 10,000 tons since 1978. Landings increased somewhat in 1986-87, but declined again in 1988 and 1989.

Data and Assessment: Catch and effort data may indicate a gradual downward trend in catch rates in recent years. Decline in CPUE may be due to movement of fish deeper, beyond area where fishery is prosecuted. General production analysis is not possible because of positive slopes between catch rate and effort. Catch-at-age and weight-at-age data available from USSR/GDR fisheries 1979-89. SPA analyses resulted in estimates of exploitable biomass less than reported catches in recent years. SPA was considered to underestimate population due to relatively small area of fishery in relation to stock distribution.

Fishing Mortality: No meaningful estimate available.

Recruitment: No estimate available.

State of Stock: Not possible to evaluate.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =	No information available	
F_{89} =		
F_{max} =		

Recommendation: TAC for 1991 remain at precautionary level of 11,000 tons.

Special Comments: At present, SPA analysis does not appear to be possible for this stock because of inadequate calibration indices. Specialized surveys to include deeper waters are necessary.

SUMMARY SHEET - Wolffish in Subarea 1

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	5-6	5-6	5-6	5-6	5-6	5-6	5-6	5-6				
Agreed TAC												
Reported landings	3	2	2	2	2	2[1]	1[1]		4	1	2	1981-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Catches composed of two species. The fishery partly a small-scale directed fishery and partly a by-catch in the trawl fishery for cod.

Data and Assessment: As more biological data and separate catch statistics for the two species are needed, no assessment was carried out.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1990:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation: The TAC for 1991 should be 5,000-6,000 tons.

Special Comments:

SUMMARY SHEET - Capelin in Divisions 3N and 3O

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	0	0	0	0	10	10	28	30	30	0	7	1979-90
Agreed TAC	0	0	0	0	10	15	28	30	30	0	10	1979-90
Reported landings	0	0	+	0	1	7[1]	10[1]		15	0	31	1981-88
Non-reported catches												
Sp. stock biomass	244	85	169	522	227	544	29		522	29	303[2]	
Recruitment (age)	No estimates											
Mean F	No estimates											

[1] Provisional.
[2] In some years, these were averages of USSR and Canadian surveys and in other years only Canadian estimates were were available. See special comments.

Weights in '000 tons
Recruitment in millions

Catches: Peak catches in 1975 of 132,000 tons. Fishery was closed during 1979-86.

Data and Assessment: Acoustic surveys of the spawning stock.

Fishing Mortality: No information.

Recruitment: No direct estimates of recruitment but patterns of year-class strength have appeared to be similar to Div. 3L stock.

State of Stock: Mean stock size 1981-88 was about 303,000 tons. USSR acoustic surveys during 1975-77 indicated mean biomass of 912,000 tons.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation: An exploitation rate of 10% of mature biomass is recommended and this would indicate a catch of 30,000 tons in 1991.

Special Comments: Acoustic survey by Canada during 1989 recorded lowest biomass estimate on record (29,000 tons) but this was believed to be an underestimate since survey may have missed the peak of spawning.

SUMMARY SHEET - Squid in Subareas 3 and 4

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	150	150	150	150	150	150	150	150	150	25	122	1975-90
Agreed TAC	150	150	150	150	150	150	150	150	150	25	122	1975-90
Reported landings	+	1	1	+	2	1[1]	7[1]		162	+	30	1972-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Peaked in 1979 at 162,000 tons, declined to less than 2,000 tons during 1983-88. Increased to almost 7,000 tons in 1989.

Data and Assessment: Commercial fishery data available in recent years. No sampling or research data available for 1989.

Fishing Mortality: No information available.

Recruitment: No information available.

State of Stock: Dependent on one year-class only. Low availability in recent years.

Forecast for 1990:

Option *Basis*	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F89 =		
F_{max} =		

Recommendation: No advise.

Special Comments:

SUMMARY SHEET - Shrimp in Subareas 0 and 1

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC[1] ('000 tons)	29.5	29.5	36	36	36	36	44.5	50	50	29.5	37.5	1983-90
Agreed TAC[1]	34.6	34.9	42.1	42.1	40.1	40.1	40.1	44.9	44.9	34.6	40.5	1983-90
Reported landings[2]	46.8	43.4	54	63.1	63.7	60.1[3]	68.0[3]	-	68.0	43.4	57.0	1983-90

Non-reported catches

Sp. stock biomass

Recruitment (age) No information available

Mean F

[1] TAC for offshore fishery in Subareas 0 & 1 (south of 71°N). Effective TACs for Div. 1A north of 71°N were 11,500 tons for 1987 and 1988 and 8,000 tons for 1989.

[2] Including inshore catches in Subarea 1 of about 7,500 tons up to 1986 and 6,000, 9,900 and 14,400 tons in 1987-89.

[3] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Increased to about 50,000 tons in 1976, decreased to a level about 45,000 tons in 1980-84, then increased up to 68,000 tons in 1989.

Data and Assessment: Trawl surveys, general biological data and fishery data. No analytical assessment.

Fishing Mortality: No information available.

Recruitment: No information available.

State of Stock:

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =	No information available	
F_{89} =		
F_{max} =		

Recommendation: TAC for 1991 not to exceed 50,000 tons (for Subarea 0 and offshore Subarea 1 south of 71°N). TAC for 1991 not to exceed 2,500 tons north of 71°N.

Special Comments: Concern over possible increasing discard rates.

SUMMARY SHEET - Shrimp in Denmark Strait

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	4.2	4.2	5	-	-	-	10	10	10	4.2	6.7	1983-90
Agreed TAC[1]	5.7	5.3	6.1	7.5[2]	7.7[2]	8.7[2]	9[2]	14.1	14.1	5.2	8.0	1983-90
Reported landings	4.2	6.7	8.1	11	12.2	12.5[3]	10.7[3]	-	12.6	4.2	9.3	1983-89
Non-reported catches												
Sp. stock biomass												
Recruitment (age)	No information available											
Mean F												

[1] On Greenland side of midline only.
[2] Not including Greenland fishery north of 66°30'N.
[3] Provisional.

Weights in '000 tons
Recruitment in millions

Catches: Increased from less than 400 tons in 1978 to around 12,500 tons in 1988, then decreased to approximately 10,700 tons in 1989

Data and Assessment: General biological data and fishing data, biomass estimates from trawl surveys, and general production model. No analytical assessment.

Fishing Mortality: Not known

Recruitment: Not known

State of Stock: Biomass estimate at the 1985-88 average in 1989. No apparent trends observed in biomass estimates. Shift in size composition toward smaller (male) shrimp.

Forecast for 1991:

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation: TAC of 10,000 tons advised for 1991.

Special Comments: STACFIS expresses its concern over the lack of information on discard levels, which may have increased in recent years.

3. Responses to Questions by the Fisheries Commission

a) Cod in Divisions 2J, 3K and 3L (SCR Doc. 90/23)

The Scientific Council was requested to: *continue to provide information, if available, on the stock separation in Div. 2J+3KL and the proportion of the biomass of the cod stock in Div. 3L in the Regulatory Area and a projection if possible of the proportion likely to be available in the Regulatory Area in future years. Information is also requested on the age composition of that portion of the stock occurring in the Regulatory Area.*

A comprehensive study of stock discrimination of Div. 2J+3KL cod was reviewed at the 1986 annual meeting (NAFO Sci. Coun. Rep. 1986, pages 121-124). The conclusions derived from that review were reiterated during the June 1989 meeting (NAFO Sci. Coun. Rep. 1989, page 111). No new analyses were currently available on this subject and hence previous conclusions remain unchanged. The Council noted, however, that analyses on the structure of the Div. 2J+3KL stock as well as the potential for assessing the entire management unit in smaller areas are ongoing.

Estimates of the proportion of the biomass of cod in Div. 3L in the Regulatory Area were updated with the 1989 Canadian RV survey information. Results were similar to those previously reported and are included in the following table:

Season RV survey conducted	Years RV survey conducted	Range of proportions of biomass occurring in the Regulatory Area (%)	Average proportion (%)
Winter	1985-86	23.8-26.8	25.3
Spring	1977-89	0.4- 6.1	2.7
Autumn	1981-89	0.5- 7.7	2.9

Autumn surveys in all three Divisions (2J, 3K and 3L), conducted by Canada since 1981, continued to indicate that the proportion of the cod biomass in the Regulatory Area at that time of year was less than 1%, on average, of the entire Div. 2J+3KL cod biomass. The average Divisional proportion of cod biomass derived from these surveys is as follows:

Division	Relative Proportion (%)
2J	41
3K	31
3L	28

With the assumption that the relative distribution between Divisions in autumn was similar to that of other times of the year, it was previously concluded that "the proportion of the entire Div. 2J+3KL cod biomass estimated to occur in the Regulatory Area is less than 10% in winter and less than 5%, on average, throughout the year". With the previous data series updated, this conclusion remains unchanged. *It might also be reasonable to assume that,* because proportions of cod biomass occurring in the Regulatory Area in Div. 3L exhibit no annual trends, proportions expected to occur would be about the same as those observed.

Age compositions derived from Canadian RV surveys in areas inside and outside 200 miles were also updated. The results of those comparisons were the same as those reported last year: during spring and autumn, when only a small portion of the Div. 3L cod biomass occurred outside 200 miles, a proportionately larger number of younger fish occurred in the Regulatory Area than the area inside 200 miles. During winter, when the maximum proportion of the Div. 3L biomass occurred in the Regulatory Area, age compositions for the area inside and outside the 200-mile zone were similar.

b) Cod in Div. 3M

The Fisheries Commission asked the Scientific Council, with respect to cod in Div. 3M, to comment on: *the appropriateness of establishing a minimum target level for the biomass, and to comment on the role of exploratory fisheries in providing data for stock assessment purposes.*

Establishing a minimum level for the exploitable biomass is not an appropriate target to judge the status of a stock, while spawning stock biomass is the relevant variable to be taken into account. The question on the spawning stock biomass was considered in last year's response to Fisheries Commission (NAFO Sci. Coun. Rep., 1989, page 112). The spawning stock biomass estimated for 1989 was judged to be below any desirable size, despite available survey data indicating that exploitable biomass could be at a level of 85,000 tons, which was the target previously chosen by the Fisheries Commission (FC Doc. 83/IX/4). The present stock is composed mainly of immature fish and a substantial increase of the spawning biomass is not expected to occur before 1991, when the relatively abundant 1986 year-class becomes partially mature. This may never occur if fishing effort continues at the present level.

On the role of exploratory fisheries in providing data for the stock assessment purposes, the Scientific Council response given last year was in the light of moratorium on the Flemish Cap cod fishery which was expected to be effective (NAFO Sci. Coun. Rep., 1989, page 138). The Council notes that a cod fishery took place in 1989 estimated at 40,000 tons and, presumably, is also taking place in 1990. In the light of this, catch-effort and sampling data of the fleets operating in the Flemish Cap need to be collected. If these data are available to the Council, together with the present survey data, they would be the bulk of the input for future analytical assessments of the Flemish Cap cod. The time series data on longline CPUE for Faroe Island vessels for the years 1973-88 were supplied as SCR Doc. 90/43, however, those values were not used in determining stock status.

c) Flounders in Divisions 3L, 3N and 3O

With respect to flounders in Div. 3LNO, the Scientific Council was requested to: *provide advice on management options that would reduce the extent to which the fisheries reduce the potential yield due to harvest of small fish.*

The Council noted that there were large numbers of juvenile flatfish removed in the Regulatory Area in 1989. The following tables show the comparison between the Canadian, Spanish and USA fisheries for 1) yellowtail flounder and 2) American plaice in Div. 3LNO in 1988 and 1989.

Yellowtail flounder

	1988			1989		
	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch
Canada	10,614	19.6	0.54	5,007	9.8	0.51
EEC-Spain	3,205	24.0	0.13	1,126	12.4	0.09
USA	861	1.8	0.48	319	0.7	0.44

American plaice

	1988			1989		
	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch
Canada	26,900	37.9	0.71	27,900	39.9	0.70
EEC-Spain	8,900	15.9	0.56	10,600	38.2	0.28
USA	1,400	1.7	0.82	1,100	1.3	0.85

The peak lengths in the Spanish catches of flatfish in Div. 3NO in some months in 1989 were 18-22 cm. Selectivity studies for American plaice indicate that the 25% retention length for 130 mesh is 27 cm. The Scientific Council concluded that the effective mesh size used in the Spanish fishery for flatfish in Div. 3NO was probably much smaller than the NAFO regulation minimum size, and may have been as small as 60 mm.

Information from the Canadian fleet in 1988 showed that the discard rate of yellowtail flounder was less than 3% in all areas and that the discard rate for American plaice was at a similarly low level in almost all areas. The mesh size used by the Canadian offshore fleet is 135 mm, and the minimum acceptable size for flatfish is 28 cm.

The obvious way to reduce the loss in potential yield due to the harvest of small fish is to ensure that the regulations determining the minimum effective mesh size are adhered to. Juvenile flatfish surveys have repeatedly shown that small flatfish are concentrated on the southern Grand Bank, with a high proportion of these small fish occurring in the Regulatory Area. At the present time, closed areas and/or seasons are not possible to define without detailed information on the time, place and length frequency distribution of catches of juvenile flatfish in the Tail of the Bank area. *This information was requested by* Scientific Council in 1989 (NAFO Sci. Coun. Rep. 1989, page 137). With the exception of some information on the location of Canadian catch in 1986-88 and the discard rate in the Canadian fleet in 1988, both on a scale larger than 1° by 1° squares, there were no data provided at the June 1990 meeting.

d) On Catches Exceeding TACs

The Scientific Council was asked: *with respect to stocks from which catches have recently been significantly in excess of the NAFO TACs, analysis is requested on the effect such catches have had in determining present stock status.*

The Scientific Council noted that TACs had been significantly exceeded in recent years for the following stocks occurring in the Regulatory Area and where TAC advice was provided by the Scientific Council:

	1986		1987		1988		1989**	
	TAC agreed	Catch	TAC agreed	Catch	TAC agreed	Catch	TAC agreed	Catch
Cod 3M	13	15	13	8*	0	40*	0	40*
Cod 3NO	33	51	33	42	40	43	25	33
Redfish 3M	20	29	20	44	20	23	20	27
Redfish 3LN	25	43	25	79*	25	53*	25	24
A. plaice 3M	2	3.8	2	5.6	2	2.8	2	3.9
A. plaice 3LNO	55	65*	48	55	40	42*	30.3	44*
Yellowtail 3LNO	15	31	15	16	15	16	5	7.6*
Witch 3NO	5	9	5	8	5	6	5	4

* Includes an estimate of non-reported catches.
** Provisional, apart from those with an asterisk.

The above catches are the nominal catches as officially reported to NAFO together with non-reported catches where these are available. Non-reported catches occurred in other years and stocks than those with an asterisk but no estimates could be made.

Exceeding TACs has little effect on the ability to conduct the assessments provided that information on total catch and effort together with sampling data is made available.

The catches of non-members are difficult to both qualify and quantify. For instance, for cod in Div. 3M, although reported catches give the appearance that the moratorium has been respected, a figure of 40,000 tons has been estimated from catch and effort data of non-member countries pair trawlers fishing for cod in Flemish Cap, and from sightings of fishing boats reported by the Canadian Department of Fisheries and Oceans including single and pair trawlers. But due to the lack of precise knowledge on catches-at-age by fleet component for several years, an analytical assessment was not possible. The present status of that stock was evaluated from research survey data. Simultaneously, it is believed that in 1989 some proportion of the cod catches actually taken in Div. 3M are reported in Div. 3L, despite the moratorium in Div. 3L.

For other stocks, such as redfish in Div. 3M, the lack of data concerning the fishery activities of non-member countries hampered the usefulness of an analytical assessment. For determining the present stocks status, the effect of under/over-reporting and misallocating catches to areas will consequently bias the analytical stock assessments like sequential population analysis.

It is therefore recommended that *initiatives should be taken to obtain more accurate catch and effort data as well as sampling data from the fisheries in the Regulatory Area in order to assess the stocks.*

e) Stocks of Mesopelagic Species and Atlantic Saury

The Scientific Council was asked to: *review available data on stocks of mesopelagic species and on Atlantic saury that might occur in the Regulatory Area, and to provide advice on possible management measures for these stocks.*

With respect to Atlantic saury, the Council noted investigations conducted in late-1960s and 1970s revealed that some stock of Atlantic Saury (*Scomberesox saurus*) existed in the southern part of the NAFO area. During the June 1990 Scientific Council Meeting, no information was presented on the assessment and biology of this fish. Specialized investigations were needed to find out to what extent the Atlantic saury stock could sustain a pelagic fishery within and outside the 200-mile zone. The Council could provide no management advice at the present time.

With respect to mesopelagic species, the Council noted that several USSR investigations were done on the distribution of mesopelagic fish (mainly four species: *Benthosema glaciale, Maurolicus muelleri, Notoscopelus elongatus, Ceratoscopelus maderensis*) in the continental shelf slope area off Labrador and Newfoundland in 1981-87. Some results of those investigations on the species and length-age composition of the catches and on the density of the species distribution in Subareas 2 and 3 covered by surveys in 1981-87 were presented to the Scientific Council NAFO SCR documents during 1983-88. No information on the mesopelagic species were presented during the June 1990 Meeting of the Scientific Council. The Council agreed that the available information on the stocks of the mesopelagic species seemed to be insufficient to provide advice on possible management measures.

4. Environmental Research

The Council noted that the Environmental Subcommittee of STACFIS had met on 12 June 1990 with M. Stein as Chairman. The total number of documents specifically addressing environmental issues had increased substantially from the previous year and the Subcommittee had additionally reviewed biologically oriented papers which had environmental data. The Subcommittee had discussions on a wide range of subjects including a special consideration on the present state of climate models and possible implications for fish and fisheries if global warming occurred.

The Council noted that the term of office of the Chairman of the Environmental Subcommittee ends after the September 1990 Meeting, and endorsed the results of the election held by STACFIS which re-elected M.Stein for another two-year term.
The full report of the Subcommittee is given in the STACFIS Report (Annex 1).

5. Ageing Techniques

The Council was pleased to note that the ageing of silver hake otoliths by Canadian and USSR readers was now in good agreement and endorsed the STACFIS recommendation that a manual on established methods of ageing be prepared by the age readers.

The Council noted the 1990 exchange of American plaice otoliths from Div. 3L and 3M and the different levels of inter-reader agreements. The Council agreed with the STACFIS recommendation that further exchanges of American plaice otoliths from Div. 3L and 3M be conducted.

The Council noted the problems of discrepancies between scale and otolith age determinations found by Greenland halibut age readers from Canada, EEC-Portugal, EEC-Spain, Greenland, GDR and USSR and agreed with the STACFIS recommendation that future exchanges should include both otoliths and scales accompanied by photographs to identify and resolve discrepancies.

6. Gear and Selectivity

The Council noted a preliminary study of selectivity in shrimp trawls was discussed.

7. Review of Scientific Papers

The Council noted that two papers which were not reviewed by STACFIS during the general assessments, were reviewed and summarized separately.

8. Other Matters

a) Review of Current Arrangements for Conducting Stock Assessment with Respect to Designated Experts

The Council noted that STACFIS would review the current arrangements at the September 1990 Meeting, particularly with respect to the status of preliminary assessment reports prepared by Designated Experts.

b) Working Group on Shrimp Ageing

The Council noted that the meeting was held in Reykjavik, Iceland in October 1989 as planned and the report was reviewed by STACFIS. The Council was pleased with the progress made on analytical types of assessment.

c) CAFSAC Special Invertebrate Subcommittee Meeting

The Council noted that STACFIS received the conclusions from the CAFSAC review of assessments of some shrimp stocks.

d) Special Session in September 1990

The Council was pleased that submissions for the Special Session on "Management under Uncertainties Related to Biology and Assessments", with J. Shepherd as convener, had improved recently with 20 in hand at present.

e) Special Session in September 1991

The Council was pleased that, after the sad untimely death of R. Wells (Canada), the plans for the Special Session on "Atlantic Cod: the Understanding on Physiology, Dynamics, Ecology and Environmental Relationships" was progressing well. The Council noted that H. Hovgård (Denmark) had agreed to convene the session and new ideas on theme and specific topics were being considered.

The Council endorsed the decision by STACFIS to dedicate the Special Session in memory of R. Wells.

f) Special Session in September 1992

The Council agreed that the theme would be decided at the September 1990 Meeting.

III. RESEARCH COORDINATION (See STACREC report, App. II)

1. Fishery Statistics

a) The Council again noted with concern that the timeliness of the submission of STATLANT 21A and 21B data reports was not improving. This meant that the most recent catch and effort data were often not available for stock assessment. This also meant the severe delay in the publication of the Statistical Bulletin and of the availability of confirmed data for use as required by the scientists.

The Council noted that the updating of catch and effort database by the Secretariat was proceeding well, but that the usefulness of continuing this exercise with data prior to 1960 was questionable because of the occurrence of catches grouped under various collections of species.

The Council agreed that the work proposed by EEC (EUROSTAT) to eliminate discrepancies between the NAFO, FAO and EEC (EUROSTAT) databases was necessary and would involve collaboration with the NAFO Secretariat.

b) The Council observed that an EEC proposal to harmonize the computer file format for presentation of STATLANT data would have implications to NAFO and that STACREC would be updated on the progress of this proposal.

c) The Council endorsed the recommendations by STACREC that a) an invitation be extended to the Coordinating Working Party (CWP) to hold the Fifteenth Session of CWP at NAFO Headquarters from 8-14 July 1992, and b) in order to prepare for that meeting, the Assistant Executive Secretary attend the *Ad hoc* Inter-Agency Consultation meeting which precedes the 79th Statutory Meeting of ICES, in October 1991.

2. Biological Sampling

The Council noted that the next publication of the list of Biological Sampling Data would cover the period 1985-89.

3. Biological Surveys

a) It was noted that STACREC was presented with the inventories of surveys conducted in 1989 and of surveys proposed for 1990 and early 1991. The Council noted that the stratified-random surveys conducted by FRG at West Greenland in 1988 had been omitted inadvertently from the inventory of biological surveys for 1988 (NAFO Sci. Coun. Rep., 1989, page 126).

The Council also noted that STACREC had reviewed a list of surveys, by stock, which had been tabled for discussion with respect to the format for such an inventory. It was agreed that the list would be published as an SCS document (SCS Doc. 90/22) and similar compilations would be made annually by the designated experts for stocks reviewed by STACFIS.

b) The Council took note of the 6 new strata which had been added to the Gulf of St. Lawrence in Div. 4RST.

c) The Council was pleased the final report of the STACREC Working Group on Survey Design and Procedures was prepared and presented by the convener of the Working Group, and recognized its value as a reference document.

4. Other Matters

The Council observed that the List of Fishing Vessels for 1989 was to be published this year, but that data are outstanding from 12 countries or components.

IV. PUBLICATIONS (see STACPUB report, App. III)

1. Review of STACPUB Membership

The Council supported STACPUB in expressing gratitude to J. Messtorff for his long standing and valuable contributions to STACPUB, and joined in wishing him well in his retirement.

The Council nominated and elected M. Stein (EEC) to join STACPUB as his replacement.

2. Review of Scientific Publications

The Council noted that Journal Volume 9(1) and 9(2) were published as planned with publication dates of September 1989 and December 1989 respectively, and that Studies Number 13 and Number 14 were published as planned in November 1989 and May 1990 respectively. The Council was also pleased to note that the Scientific Council Reports was once again published and distributed on schedule in December 1989.

3. Production Costs and Revenue for Scientific Council Publications

The Council noted that, compared to 1989, at least one additional issue of the Journal is due to be published within the next year and agreed that possible extra production costs should be considered during fiscal planning, particularly in view of the additional cost of the new cover of the Journal.

4. Promotion and Distribution of Scientific Publications

The Council was pleased to note that the turn-around time of publication of papers in both the Journal and Studies had improved. Along with the new appearance of the Journal the Council hoped distribution would improve. The Council noted that the new cover for the Journal will begin with the next issue, representing a decade of NAFO Journal publications.

The Council was encouraged that the invited paper by A. T. Pinhorn and R. G. Halliday was in its final stages of review for publication, and was also pleased that both J. Messtorff and Sv. Aa. Horsted had agreed to write invitational papers in the near future. The Council agreed with STACPUB that future special status issues of the Journal should use the format of Journal Vol. 4 issued in 1983.

5. Editorial Matters

The Council noted that all September 1989 Special Session papers were under editorial consideration for publication in a special issue of the Journal by M. J. Fogarty (Convener), and hoped the publication would be completed in the near future.

The Council agreed with STACPUB that the general editorial process should be reviewed in relation to turn-around times. The Council also agreed with the STACPUB decision to defer consideration of the appointment of an additional Associate Editor for Vertebrate Fisheries Biology until the September 1990 meeting.

The Council noted that M. J. Grosslein had expressed his wishes to end his service as Associate Editor due to other commitments. The Council took the opportunity to extend the expression of gratitude and appreciation for his years of service and devotion to Scientific Council matters.

The Council endorsed the invitation to Dr. R. K. Misra, Department of Fisheries and Oceans, Science Branch, Halifax, Canada to join the Editorial Board.

6. Papers for Possible Publication

The Council noted that submission of papers in 1989 had improved substantially.
The Council noted that STACPUB had considered all 91 SCR documents and 22 SCS documents presented to this meeting and invited authors of 6 papers to submit them in a suitable form for consideration for publication in the Journal or Studies. The Council reiterated that authors whose papers were not selected by STACPUB could still submit their papers for consideration.

The Council also noted that STACPUB had agreed to invite the convener of the STACREC Working Group on Survey Design and Procedures to consider preparing the "Final Report of the STACREC Working Group on Survey Design and Procedures" (SCS Doc. 90/20) for publication in Studies.

7. Microfiche Projects

The Council noted that 13 sets of ICNAF microfiche documents had been sold (7 in 1987, 3 in 1988 and 3 in 1989) and the ICNAF Microfiche Project would require that seven more sets be sold to recover its full cost.

8. Other Matters

The Council noted that STACPUB had reviewed a proposal from the conveners of a USSR-Canada Scientific Bilateral agreement on a symposium entitled "Biology and Fishery for Capelin in the Northwest Atlantic" to be held in St. John's, Newfoundland, during 27-30 November 1990, and, because of its relevance to NAFO, decided to invite the conveners to submit suitable papers with the objective of publishing them in a single issue of the Journal. The Canadian convener, J. Carscadden, would be invited to serve as a special editor to expedite peer-review and editing of the papers.

V. COLLABORATION WITH OTHER ORGANIZATIONS

1. Joint ICES/NAFO Working Group on Harp and Hooded Seals

As was decided at the September 1989 meeting of the Scientific Council, the Chairman conveyed the Council's agreement to the ICES proposal for a joint Working Group on harp and hooded seals. As a result, a resolution was passed at the 1989 Statutory Meeting of ICES to establish such a joint ICES/NAFO Working Group. This will replace the existing ICES Working Group.

The Working Group administration will be coordinated by ICES with respect to membership, appointment of chairmen, printing and distribution of reports, etc.

No meeting of the Working Group has been scheduled for 1990. Contracting Parties to either NAFO or ICES or to regulatory commissions which might desire advice on harp and/or hooded seals in a particular geographical area would be required to refer their requests to the organization having jurisdiction over or interest in that area. Advice based on reports of the Joint Working Group would be provided by the Advisory Committee on Fisheries Management in the case of the ICES Fishing Area and by the Scientific Council of NAFO in the case of questions pertaining to the NAFO area.

2. Fourteenth Session of CWP, February 1990

The Council was pleased to note that the Assistant Executive Secretary, Chairman of STACREC, and representatives from USSR attended the CWP Session held in Paris in February 1990. The Council noted that a Report on NAFO Statistical Program, Publications and ADP had been presented at the CWP Session by the Assistant Executive Secretary and that STACREC had reviewed the Report of the Fourteenth Session of the CWP issued by the CWP Secretary.

VI. FUTURE SCIENTIFIC MEETINGS

1. Annual Meeting and Special Session in September 1990

The Council would meet in conjunction with the Annual Meeting of NAFO in Halifax, Canada, during 10-14 September 1990. The meeting would be preceded by the Special Session on "Management under Uncertainties Related to Biology and Assessments" which would be held during 5-7 September 1990 at the same location.

The Council was hopeful more papers would be submitted for that meeting.

2. Scientific Council Meeting in June 1991

The Council noted the tentative dates (from Friday, 7th to Friday, 21st June) proposed at the September 1989 Meeting would be inconvenient for overseas travellers.

The Council instead proposed, subject to confirmation at the September 1990 Meeting, that the Scientific Council together with its Standing Committees and Subcommittee would meet during 5-19 June 1991 in Dartmouth, Canada. The meeting would deal with requests for scientific advice on fisheries management and with other fishery-related research, publication and statistical activities.

3. Special Session 1991

The Council could not confirm the dates nor the place for the Special Session which was scheduled to be held in conjunction with the Annual Meeting of NAFO in September 1991. The Council agreed to postpone the decision to September 1990 until the dates and the place for the Annual Meeting were finalized.

VII. NOMINATION AND ELECTION OF OFFICERS

1. Chairman of STACFIS

The Chairman had requested Sv. Aa. Horsted to solicit views of Council members on the appropriate period of service for the next STACFIS Chairman appointment and to obtain possible names for nomination. Sv. Aa. Horsted reported that he had consensus on both aspects. The preferred term of appointment of two years beginning at the end of the September 1990 Annual Meeting of the Scientific Council was accepted by the Council. He also brought the nomination of D. B. Atkinson for the office. The Chairman, noting there were no other nominations, declared D. B. Atkinson as duly elected next Chairman of STACFIS.

2. STACPUB Membership

The Council was informed that a nomination was required for a person to replace J. Messtorff when he retired after this meeting. The Chairman of STACPUB proposed that M. Stein be considered. There being no other nominations, M. Stein was appointed to fill the vacancy. Having discussed this matter with him before, the Chairman was happy to announce that M. Stein would fill that post.

VIII. ADJOURNMENT

The Chairman observed that the Scientific Council would be losing the two most senior representatives, J. Messtorff and Sv. Aa. Horsted, as they were retiring this year.

On behalf of the Council, the Chairman thanked J. Messtorff for his long and dedicated services extending back to ICNAF times, and for the many valuable contributions he had made to the Council, both as a senior scientist and while he was an office holder. The Council joined the Chairman in wishing J. Messtorff the very best wishes for a long and happy retirement.

While he expressed hope that Sv. Aa. Horsted would attend the next Scientific Council Meeting in September 1990, he noted that some of the participants present were not likely to come to that meeting, and on their behalf conveyed the same thanks and best wishes to Sv. Aa. Horsted.

The Chairman adjourned the meeting thanking the Chairmen of the Standing Committees, especially H. Lassen for effectively conducting the long and stressful STACFIS meetings, the Secretariat for their hard work associated with the meetings, and all the participants for their contributions.

Sv. Aa. Horsted personally extended his appreciation to J. Messtorff and thanked everyone at the meeting for their well wishes.

J. Messtorff, as the senior member of the Council, congratulated the Chairman for running the meetings successfully, and personally thanked everyone for their kind wishes.

APPENDIX 1. REPORT OF STANDING COMMITTEE ON FISHERY SCIENCE (STACFIS)

Chairman: H. Lassen Rapporteur: Various

The Committee met at NAFO Headquarters, Dartmouth, Nova Scotia, Canada, 6-20 June 1990, to consider and report on matters that were referred to it by the Scientific Council, particularly with regard to provision of scientific advice on the management of certain finfish and invertebrate stocks (see Agenda I). Representatives attended from Canada, Cuba, Denmark (Faroe Islands/Greenland), European Economic Community (EEC), German Democratic Republic (GDR), Iceland, Japan and Union of Soviet Socialist Republics (USSR) and observers from the Food and Agriculture Organization of the United Nations (FAO), Tanzania and the United States of American (USA).

Various scientists assisted in the initial preparation of draft reports that were considered by the Committee. The report of the Subcommittee on Environmental Research (Chairman: M. Stein) is summarized in Section IV and given in detail in Annex 1 below. The report of the Working Group on Progress in Age Determination of *Pandalus* (Chairman: D. G. Parsons) held at the Marine Research Institute, Reykjavik, Iceland, during 16-19 October 1989 is given in Annex 2 below. The report of the Workshop on Silver Hake Database (Chairman: H. Lassen) held at the Fisheries Research Institute, Copenhagen, Denmark, during 8-12 January 1990 is given in Annex 3 below.

I. GENERAL REVIEW

1. Opening

The Chairman welcomed the participants to the 1990 June meeting of STACFIS.

STACFIS was informed of a minor computer bug found and corrected in the software for catch-rate standardization (APL STANDARD). The bug was in a seldomly used option in the output procedure and STACFIS noted that it had not used this option until the bug was discovered.

SCR 90/48 which discusses the ADAPT methods and was considered together with the assessment of silver hake in Div. 4VWX. However, the discussion was general, concerning linear or logarithmic residuals, which age-groups should be included in the analysis, etc. STACFIS agreed that underlying assumptions should be addressed whenever the ADAPT or any other tuning method was used.

STACFIS discussed the use of multiplicative models in standardizing catch-rate data with reference to SCR Doc. 90/50. Using the silver hake database as an example, the paper suggested that when the design matrix was ill-conditioned, the estimated standardized catch rates can vary grossly with just minor changes in the input data. STACFIS noted that in such cases, the numerical method used to find the solutions should be specially tailored. Much more seriously, even if the correct numerical solutions were obtained, the usefulness of such estimates was doubtful.

2. Provisional Catch Data

STACFIS noted that provisional nominal catch data for 1989, submitted to the Secretariat in STATLANT 21A reports showed data were not available for EEC-France (Metropolitan) and France (St. Pierre and Miquelon). The Committee agreed that a table containing provisional nominal catches for 1989 should be compiled by the Secretariat with indications of its deficiencies. STACREC agreed that an addendum to the document be issued when these data become available.

STACREC noted that the tabulation of provisional data for 1989 indicating its deficiencies was presented to the Scientific Council in SCS Doc. 90/21.

3. General Trends for the Northwest Atlantic

While recognizing EEC-France (M) and France (SP) data were missing, the following provisional observations from STATLANT 21A reports were noted in the reported catches. The provisional overall catch (round fresh weight) of all finfish and invertebrate stocks was 2.96 million (metric) tons in 1989, generally similar to the 1988 catch of 2.95 million tons. The total "groundfish" catch which represented 39% of the overall catch in 1989 was 4% less than in 1988 (1.21 and 1.16 million tons in 1988 and 1989 respectively). Decreases were noted for cod (2%), haddock (17%), redfish (10%), pollock (10%), witch (19%), and yellowtail (33%) and increases noted for silver hake (16%) and American plaice (3%). The total "pelagic" catch which represented 21% of the overall catch in 1989 decreased (6%) from 665,000 tons in 1988 to 628,000 tons in 1989, where herring decreased 17% and menhaden increased 4%. The total "finfish" catch which represented 6% of the overall catch in 1989 increased very slightly (1%) to 189,000 tons in 1989 from 187,000 in 1988, while increases were noted for capelin (7%), "other finfish" declined generally (8%). The total catch of "invertebrates", which represented 33% of the overall catch in 1989 increased

Table 1. Provisional nominal catches ('000 tons) by subarea for 1988 and 1989. (+ indicates less than 500 tons.)

Species	SA 0		SA 1		SA 2		SA 3		SA 4		SA 5		SA 6		Total	
	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989
Cod	-	-	61	100	59	56	303	262	158	153	47	43	+	1	628	615
Haddock	-	-	-	+	-	-	11	9	16	16	9	5	+	-	36	30
Redfishes	-	-	1	1	1	+	95	74	54	62	1	1	+	-	153	138
Silver hake	-	-	-	-	-	-	+	+	74	88	11	10	5	7	91	106
Red hake	-	-	-	-	-	-	+	+	+	+	1	1	+	+	2	2
Pollock	-	-	+	-	-	-	5	3	41	42	17	12	+	+	63	57
American plaice	-	-	-	-	+	3	47	49	12	11	3	2	+	+	63	65
Witch flounder	-	-	-	-	+	+	12	10	6	5	3	2	+	+	21	17
Yellowtail flounder	-	-	-	-	-	-	15	7	1	2	4	5	+	1	21	14
Greenland halibut	+	1	10	9	6	6	13	15	8	5	-	-	-	-	36	35
Other flounders	+	-	+	+	+	+	6	1	7	7	13	11	12	6	38	26
Roundnose grenadier	+	+	+	+	1	+	6	5	-	-	-	-	-	-	5	7
White hake	-	-	-	-	-	+	4	3	9	11	6	6	+	+	19	19
Wolffishes	-	-	2	1	+	+	1	1	1	1	1	1	-	-	6	4
Other groundfish	-	-	3	1	+	+	2	1	4	4	14	16	6	5	28	25
Atlantic herring	-	-	-	-	+	+	16	9	254	208	40	41	1	+	311	257
Atlantic mackerel	-	-	-	-	-	-	4	2	20	18	5	3	38	49	67	72
Atlantic menhaden	-	-	-	-	-	-	-	-	-	-	20	9	252	275	272	284
Other pelagics	-	-	-	-	-	-	2	2	1	1	4	6	8	6	15	15
Capelin	-	-	+	+	17	22	90	90	5	7	-	-	-	-	111	119
Other finfish	-	-	2	+	1	2	27	18	17	19	9	12	21	18	76	70
Squids	-	-	-	-	-	-	+	4	1	3	11	11	11	19	22	37
Clams	+	-	-	-	-	-	-	2	7	12	47	44	311	344	365	402
Scallops	-	-	-	-	+	+	8	3	33	50	94	93	54	69	190	216
Other molluscs	-	-	-	-	-	+	-	+	2	2	35	29	44	34	81	66
Shrimp	6	12	59	60	9	13	2	3	14	15	3	4	1	1	95	109
Crabs	-	-	-	-	+	+	9	8	22	15	4	5	36	55	71	83
Lobsters	-	-	-	-	-	-	1	1	39	37	20	21	2	3	62	63
Other invertebrates	-	-	-	-	-	-	-	-	+	+	3	5	1	1	4	6
Total	6	13	138	173	95	103	678	582	806	793	425	398	803	894	2952	2955

4. Fishery Trends by Subarea

a) Subarea 0

The total nominal catch of all species in 1989 was 13,000 tons, over double the 6,000 tons caught in 1988. The catch consisted mainly of shrimp.

b) Subarea 1

The total catch of all species increased (25%) to 173,000 tons in 1989 from 138,000 tons in 1988. Cod and shrimp were the dominant species with 58% and 35% of the catch respectively and Greenland halibut (5%) the next highest.

c) Subarea 2

The total nominal catch of all species increased (8%) to 103,000 tons in 1989 from 95,000 tons in 1988. This was due to increases in capelin (29%) and shrimp (44%) although there was a slight decline in cod (5%).

d) Subarea 3

The total catch continued to decline in 1989 (14%) to 582,000 tons from 678,000 tons in 1988. This was due mainly to a decrease in cod (14%) which represented 45% of the Subarea 3 catch. Declines were also noted for redfish (22%), yellowtail flounder (53%), herring (44%), "other finfish" (33%) and scallops (62%) but there were slight increases in American plaice (4%), Greenland halibut (15%) and squid (from 272 tons to 3,888 tons) and clams (from no catch to 1,759 tons).

e) Subarea 4

The total nominal catch of all species decreased slightly (1.6%) to 793,000 tons in 1989 from 806,000 tons in 1988 . Decreased catches were noted for cod (3%), herring (18%), crabs (32%) and increased catches were noted for redfishes (15%), silver hake (19%), scallops (52%). Cod (19%) and herring (26%) continued to be

f) Subarea 5

The total nominal catch declined (6%) in 1989 to 398,000 tons from 425,000 tons in 1988. There were decreases noted for "groundfish" (8%), "pelagics" (14%) due mainly to decreases in menhaden (55%), and "invertebrates" (2%). Increases were noted for "other finfish" (33%) but these species did not represent substantial portions of the catch.

g) Subarea 6

The total nominal catch increased (11%) in 1989 to 894,000 tons from 803,000 tons in 1988. Increases were noted for mackerel (29%), menhaden (9%), clams (11%), scallops (28%) and crabs (53%), and decreases were noted for "other flounders" (50%) and "other molluscs" (33%).

II. ASSESSMENTS

1. Cod in Subarea 1 (SCR Doc. 90/28, 29, 30, 31, 32, 33, 34, 55, 74; SCS 90/14).

a) Introduction

The fishery for cod in Subarea 1 is partly an offshore fishery carried out by large trawlers, and partly a coastal and fjord fishery, in which the main part of the landings usually is taken by pound nets.

During the 1955-68 period, when the major part of the catch was taken by non-Greenlandic vessels, catches fluctuated between 234,000 and 451,000 tons (1962). Catches declined gradually after 1968 to a low of 33,000 tons in 1976, after a number of years of recruitment failure. Recruitment of the very abundant 1973 year-class in 1976-77 resulted in increased catches up to 1979. During 1980-83, catches fluctuated between 53,000 and 58,000 tons but decreased thereafter by about 50% each year to a low level of only 6,600 tons in 1986, the lowest catch on record since ICNAF began compiling statistics. Catches and TACs in recent years are given in Table 2. After 1987 when no directed trawl fishery was allowed in the first ten months, fishing by trawlers was allowed in 1988 under quotas set by the Greenland Home Rule authorities.

The nominal catch in 1989 was about 103,000 tons, which is a 78% increase compared to the 1988 catch and nearly fifteen times the record-low catch of 1986. The increase during the period 1987 to 1989 reflects the recruitment of the very abundant 1984 year-class.

Table 2. Cod in Subarea 1: catches and TACs for the entire area and catch-per-unit-effort for Greenland trawlers (500-999 GRT) in Div. 1D and 1E.

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Trawlers	16	14	29	42	20	7	1	4[1]	40[1]	73[1]	
Other vessels	38	39	27	21	13	8	6	12[1]	22[1]	30[1]	
Total (000 tons)	54[2]	53	56	58	33	15	7	16[1]	62[1]	103[1]	
TAC (000 tons)	20[1]	50	62	62	68	28.3	12.5	1.25	53	90	110
CPUE (tons/hr)	1.08	2.90	1.93	1.23	0.89	0.7	-	1.61[1]	2.87[1]	4.33[1]	

[1] Provisional data.
[2] Estimates used for assessments.

b) Commercial Fishery Data

i) Catch-per-unit-effort for Greenland trawlers

Catch and effort data for Greenland trawlers in 1975-89 have been carefully scrutinized and the earlier figures have been revised. In 1989, the trawlers operated only in Div. 1D, 1E and 1F. The distribution of effort showed that the fishery shifted southward. The overall catch-per-unit-effort increased from 2.9 t/hour in 1988 to 4.3 t/hour in 1989. The catch-per-unit-effort in the second quarter of the year was the highest on record for these trawlers.

Catch-rate data have been analyzed using a multiplicative model including effects of year, division and month (SCR Doc. 90/28). The data consist of logbook records from 6 sister trawlers owned by the Greenland Home Rule Government, which on average over the period analyzed account for about 90%

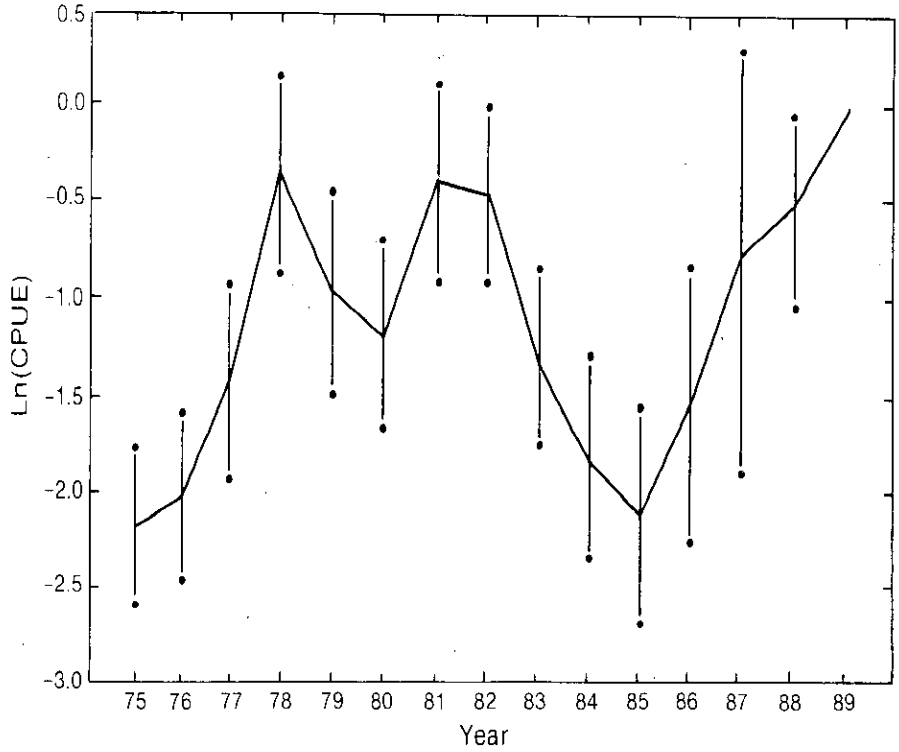


Fig. 1. Cod in Subarea 1: CPUE in natural log units from multiplicative model, with error bars (±2 x S.E.).

ii) Age composition

Catch statistics for the Greenlandic fishery are now collected on a gear-basis, but data are at present only available which allow catches to be split into trawl catches and catches by other gears (inshore catches mainly).

Greenland trawl catches were well sampled throughout the year. All samples from other gears were pooled, regardless of month and division, and used to convert the total inshore catch into numbers. For trawl catches of the Federal Republic of Germany (FRG) and the United Kingdom (UK), samples from the FRG commercial fishery were used as their length frequency distributions differed from those of the Greenland trawl catches.

Greenland trawl catches were dominated by age-group 5 (96% by numbers) throughout the year and in all areas. The dominance of age-group 5 was also evident in the FRG catches (80%) with age-group 4 as the next most abundant (18%). Some of this difference may be due to discarding of age-group 4 fish by Greenlandic trawlers, as a part of that age-group was still below the minimum landing size of 44 cm in Greenland.

In the inshore catches, age-groups 5 and 4 dominated with 77% and 21% by numbers, respectively.

Overall, the 1984 year-class accounted for 86% by numbers (88% by weight), whereas the 1985 year-class accounted for 12% by numbers (SCR Doc. 90/74, Table 5.2)

iii) Weight-at-age data.

During the 1979-85 period, mean weight-at-age decreased, but increased again in 1986 and 1987, only to decrease in 1988 and further in 1989. Overall mean weight in the landings increased from 1.14 kg in 1988 to 1.24 kg in 1989.

c) Research Data.

estimates for the total survey area off West Greenland are given in Table 3.

Table 3. Cod in Subarea 1: Estimate of total biomass and abundance (with 95% confidence intervals) and mean weights (W) from autumn surveys off West Greenland, 1982-89.

Year	Tons	Number ('000)	W (kg)
1982	189,934 ± 37.0%	109,039 ± 36.1%	1.65
1983	98,843 ± 28.5%	59,362 ± 26.5%	1.67
1984	24,945 ± 39.7%	16,104 ± 39.1%	1.55
1985	31,860 ± 60.1%	52,466 ± 33.3%	0.61
1986	76,220 ± 30.8%	134,716 ± 31.8%	0.57
1987	464,286 ± 47.0%	582,868 ± 42.6%	0.80
1988	547,566 ± 42.1%	563,601 ± 42.3%	0.97
1989	349,812 ±	342,452 ±	1.02

From 1982 to 1984, the survey results revealed a drastic decline in cod biomass and abundance which was observed not only for the whole survey area but for all Divisions. The total survey biomass and abundance, however, increased considerably after 1984 and particularly in 1987 due to increased recruitment, mainly of the outstanding 1984 year-class. In 1988, the survey biomass of age 4 and younger cod increased by 122,000 tons. The biomass of age 5 and older fish, however, decreased by 39,000 tons.

The survey results of 1989 revealed a pronounced decrease in abundance by 221 million fish (39%), together with an obvious southward displacement of the stock with 91% of the total survey abundance occurring in Div. 1E and 1F. This decrease was caused mainly by a reduction in the abundance of the 1984 year-class. The abundance estimate for NAFO Div. 1E has been revised since the ICES Working Group on Cod Stocks off East Greenland met in February 1990 (SCR Doc. 90/74).

Since 1987, Greenland has conducted annual inshore longline surveys at the same time as the trawl surveys were undertaken (SCR Doc. 90/29). Inshore abundance of cod above 35 cm has been calculated by converting longline catch-per-unit-effort to swept-area estimates.

The survey in 1989 was carried out in inshore areas of Div. 1B, 1C, 1D and 1E. The inshore component was estimated to be 21% of the total in 1989, consistent with the results of previous years' survey.

During June-July 1989, Greenland carried out a gillnet survey on young cod in inshore areas of Div. 1B, 1D and 1F (SCR Doc. 90/30).

In Div. 1B, catches were dominated by 2- and 3-year old cod with a substantial amount of older fish as well. In Div. 1D 2-year old cod dominated, and few older fish were caught, whereas catches of young age-groups in Div. 1F were very low.

Based on this survey, the 1987 year-class was estimated to be about 70% of the 1985 year-class, and the 1988 year-class seemed to be poor.

ii) Studies of migrations of cod by otolith types

Studies of otolith types, intended to quantify the migration rate of cod between West and East Greenland, were reported (SCR Doc. 90/34). The method was based on the assumption that the structure of annuli in any otolith was influenced by the growth rate and thereby by the environmental conditions under which each growth zone in the otolith was formed. Each growth zone in the otolith was classified using three structure types (called A, B and C). Almost all young cod (1-3 years old) off East Greenland showed type B and/or type C zones, whereas most young cod off West Greenland showed type A zones. Therefore, it seemed likely that older cod at East Greenland which showed type A in their inner growth zones were immigrants from West Greenland. The study showed that the proportion of cod with type A zones at East Greenland increased by age which indicated that cod occurring at East Greenland and of East Greenland origin were gradually being mixed with fish of West Greenland origin. However, the well known migration to Iceland of cod from West Greenland as well as from East Greenland may influence the proportions of otolith types at East Greenland.

instead of a constant coefficient of 0.15 for age groups 5 and older as was used in the VPA by the ICES Working Group this year, was presented. The emigration rates obtained for the 1984 and 1985 data may not be valid for the stock in 1989. Data of otolith types exist from recent years' trawl surveys and these data should be included in future analyses to reflect year-to-year variations of the coefficients of emigration.

iii) Origin and larvae drift of year-class 1984 and 1985

Results of satellite-tracking of four drifting buoys connected with drogue at 100 m depth, deployed in May 1988 off East Greenland, indicated the possibility of larvae drift from East Greenland to Southwest Greenland and the possible temporal and spatial distribution. However, those results were difficult to interpret in relation to larvae drift of the year-classes 1984 and 1985 because the drift was not measured in the year of the larvae stage of those year-classes, and because the drift of the buoys occurred over a period during which larvae would grow up to a size when they have active movements. Nevertheless, drift buoy experiments based on large number of drifters may be useful in future to evaluate the origin of new year-classes.

d) Distribution Pattern of the Stock

The important 1984 and 1985 year-classes started recruiting to the fisheries in 1987 and 1988, respectively. In the last two months of 1987, when offshore fishing was again allowed and in 1988, offshore fishing at West Greenland took place in the very southern part of Div. 1C, and in Div. 1D and 1E, with Div. 1D as the most important area. In 1989, Div. 1E was by far the most important Division, and it was furthermore noted that the catch and effort decreased in Div. 1D, thus indicating a southward displacement of the bulk of the fishable stock.

The survey results of the FRG showed the same trend. The survey biomass of Div. 1D decreased dramatically from 1988 to 1989, whereas there was a considerable increase for Div. 1E and 1F. Furthermore, the survey biomass at East Greenland increased by 98,000 tons from 1988 to 1989, and the major part was found south of 63°N.

From 1988 to 1989, length compositions and mean weights were rather stable in the survey stock at West Greenland whereas mean weight increased and length composition shifted toward larger fish in the survey stock at East Greenland. This indicated that the migration from West to East Greenland was mainly of larger fish of the 1984 year-class.

The reasons for the displacement which took place during 1989 are not known.

e) Estimation of Parameters

Natural mortality was assumed to be 0.2 for age 5 and older fish. For age-groups 3 and 4, the natural mortality was increased to 0.3 to account for discarding. An emigration coefficient of 0.15 was applied for age-groups 6 and older to account for emigration to East Greenland. This value was chosen because it produces the number of emigrants which on average over the years is necessary to account for the immigrants to East Greenland, as calculated by the ICES Working Group on cod stocks off East Greenland in its reports. Previously, a migration coefficient of 0.05 was applied for cod age 6+ based on interpretations of former tagging experiments. However, in some years higher values have been applied, e.g., 0.30 for 1986.

The stock distribution in 1989 indicated that the 5-year-old cod (1984 year-class) have shown a considerable migration from West Greenland to East Greenland. Therefore, it was decided to apply an emigration coefficient of 0.25 to age 5 fish in 1989.

Tuning a VPA using ADAPT with linear defined residuals revealed that the solution was strongly dependent on just two observations. Using ADAPT with logarithmic residuals was hampered by very large variations in observations for year-classes which were very poor.

The stock is dominated by the 1984 year-class and to a lesser extent by the 1985 year-class. Consequently any projection will be largely determined by the assumption of the total mortality in 1989 for the 1984 year-class. From the surveys, Z is estimated as being 0.85 which suggests that the terminal F for 1989 for that year-class should be 0.40 ($F = Z - M - E$). This value tallies with the accepted estimate of 500 million of the 1984 year-class at age 3, the VPA estimate being 570 million. Lower terminal Fs and hence lower Z values would suggest a very

page 51) multiplied by F = 0.40 as applicable to the fully recruited age-groups.

f) Assessments Results

In previous assessments (except in 1989) STACFIS used uncorrected survey abundance estimates in two consecutive years and catches between the times of the surveys to arrive at estimates of fishing mortality and emigration. Due to variability in the survey results this method resulted in high variation between years in the resultant estimates of emigration rate.

In 1989, STACFIS decided to correct the survey abundance by a factor taking a possible overestimation of abundance from surveys into account. Recent trends in spawning stock biomass and fishing mortalities were estimated by the ADAPT method. This year it was decided to assess the West Greenland stock by a VPA incorporating the period 1975-89 and age-groups 3 to 12+.

The fishable biomass of the 4+ group from the VPA (sum of each year-class biomass as multiplied by the relative F shown in Table 4) for the years 1975 to 1989 has been plotted against the annual indices derived from the multiplicative analysis of CPUE in Fig. 2 and a linear relation is apparent.

Table 4. The parameters used to project catch and biomass are as follows:

Age	Year-class	Stock size('000) 1 Jan 1990	M+E	Relative F	Mean Weight (kg)	Percent Mature
3	1987	20,000	0.3	0.039	0.52	1
4	1986	1,013	0.3	0.52	0.72	3
5	1985	41,294	0.45	1	1.27	6
6	1984	113,646	0.45	1	1.67	8
7	1983	1,099	0.35	1	2.31	65
8	1982	163	0.35	1	3.71	90
9	1981	321	0.35	1	4.21	98
10+	<1980	1,195	0.35	1	4.72	100

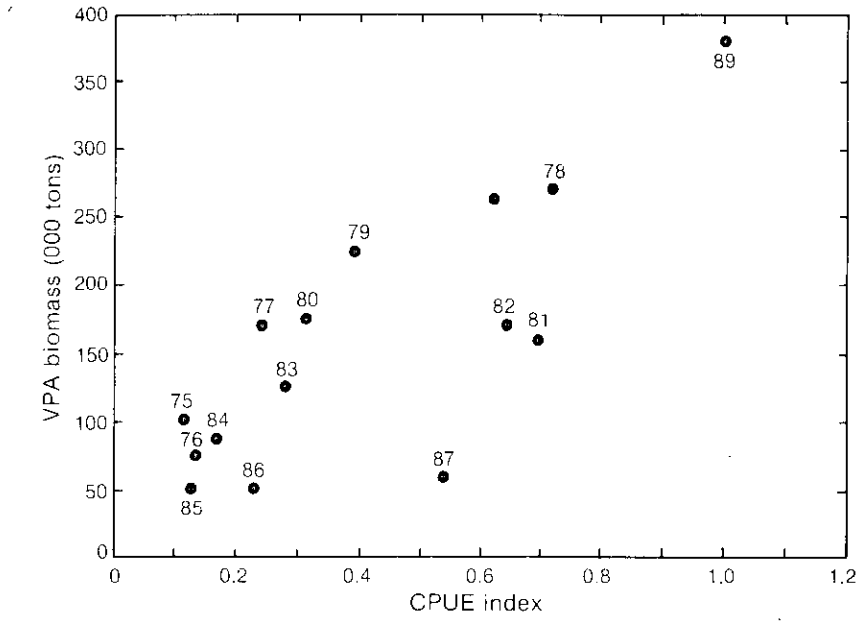


Fig. 2. Cod in Subarea 1: biomass ('000 tons) calculated from VPA *vs* annual CPUE index from Greenland Home Rule Government trawlers. West Greenland, 1975-89.

g) Recruitment Prospects

1986 year-class. Both in the trawl survey and in the young-cod survey this year-class shows a northerly distribution (Div. 1D and north thereof). The abundance is low in all surveys and the 1986 year-class is expected to be low. The conventional figure for poor year-classes of 20 million fish at age 3 has therefore been used for this year-class in the projections.

1987 year-class. This year-class shows a very low abundance in Div. 1F in both surveys, but higher abundance in the northern Divisions. The young-cod index shows a high value of 70% of the 1985 year-class, and according to this, the year-class might account for some 70 million fish at age 3. This is in contrast to the trawl survey results which projects only 7 million fish at age 3. It is the first time that the two surveys have shown disagreement. In both surveys last year, this year-class showed low densities. As a cautious approach, and because the offshore area might be given higher weight than the inshore area, the value of 20 million fish at age 3 for poor year-classes has been used in the projections.

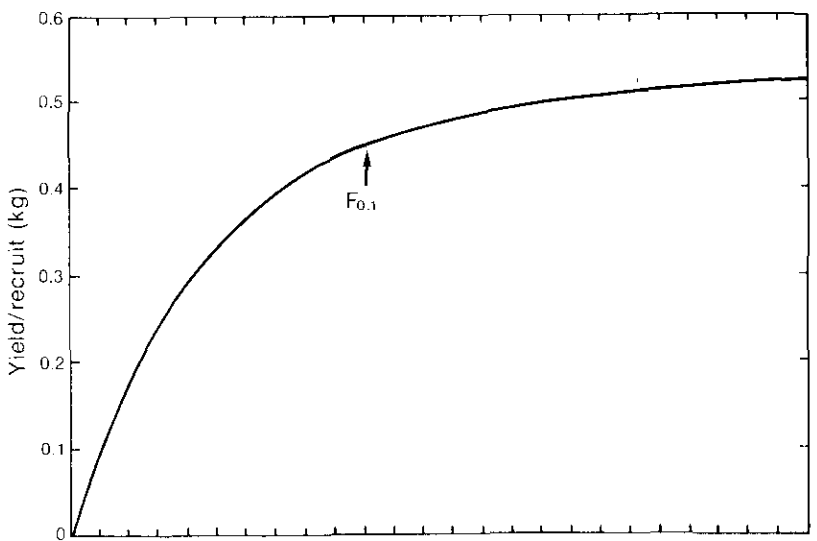
1988 year-class. Very few fish of the 1988 year-class were caught in the two surveys, and in Div. 1B only. This indicates that the year-class is poor. The conventional figure of 20 million fish at age 3 has been used in the projections.

1989 year-class. Few 0-group fish were caught in the trawl survey in Div. 1F, and little inflow of larvae from Iceland can be expected as the Icelandic 0-group survey gives an index value of almost zero for the East Greenland area. This year-class is, therefore, expected to be small. An initial value for poor year-classes of 20 million fish at age 3 has been used in the projections.

h) Projections of Catch and Stock Size for 1991-94

The parameters used to project catch and biomass are shown in Table 4. Stock size at 1 January 1990 is taken from the VPA. The natural mortality and the mean weights are the same as those used for the VPA. The fishing pattern, i.e. the relative Fs, is that used in 1989. For emigration (E) a value of 0.25 for the 1984 year-class is used for this year-class throughout the period projected. Furthermore, the same E value is applied to the 1985 year-class at age 5 and older as this year-class also has a very southern distribution. E value of 0.15 has been applied to the other year-classes as was done in the VPA. The fraction of mature fish in age-group 3 and 4 which are mature are as in last year's projections, while the values used for age-groups 5 and 6 (year-classes 1984 and 1985, respectively) are 8% and 6%, respectively, as observed in March 1990 in Div. 1F. Because of these low proportions of mature fish of these two year-classes, the percent of mature fish for age-group 7 is set to the mean between the value for age-groups 6 and 7 from last year's projections. The same procedure has been used with regard to both age groups 8 and 9 (i.e. mean of last year's values for age-groups 7 and 8, and 8 and 9, respectively).

The parameters in Table 4 were used to calculate a yield-per-recruit curve (Fig. 3) from which $F_{0.1}$ and F_{max} were estimated as 0.409 and 1.363. F_{max} was, however, not well defined.



All projections were carried out assuming the catch in 1990 to be 110,000 tons, the TAC set by Greenland. This catch, if taken, would correspond to a fishing mortality of F=0.729, which is more than double the value projected last year for a catch in 1990 of 112,000 tons. The reason for this change is mainly that the mean weight of the 1984 year-class has not increased in 1989 as much as expected in last year's projections. Furthermore, the migration to East Greenland in 1989 has been higher than expected, and the catch in 1989 was also higher than the one assumed in last year's projections.

The results of the projections of catches in 1991 for a range of fishing mortalities are given in Fig. 4.

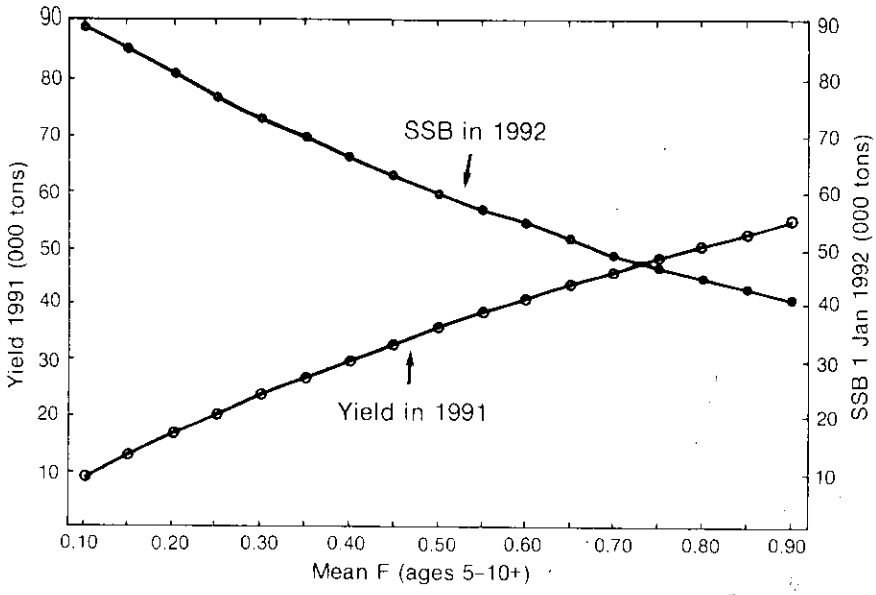


Fig. 4. Cod in Subarea 1: calculated yield in 1991 and spawning stock biomass (SSB) at beginning of 1992 for various levels of fishing mortality in 1991.

Various management options are illustrated, viz. constant F values of 0.729 (the F generated by the 1990 fishery by a catch of 110,000 tons), F = 0.409 ($F_{0.1}$) and F = 1.363 (F_{max}), and steady annual catches of 90,000 (TAC of 1989) and 110,000 tons (TAC of 1990). Furthermore, the two fixed-catch options mentioned subject to the constraint that F should not be allowed to exceed 0.60 in any year have also been shown. The projections are similar for the two last options mentioned, because the F values exceed 0.60 already in 1990.

All projections were carried forward to include catches in 1994 and spawning stock biomass (SSB) at the beginning of 1995 (Table 5).

The projections show that the catch will decrease rapidly in the coming years. Applying a fishing mortality in 1991 equal to F_{90} results in a decrease of the catch in 1991 to 49,000 tons and further decreases would occur in the following years if such a fishing level is maintained. However, exploitation at the lower level of $F_{0.1}$ in 1991 does not lead to any noticeable increase in catch level in 1993 and 1994. Although the SSB will increase in the nearest future for F-values below F_{90} it would stay at a rather low level. If the TAC of 110,000 tons is taken in 1990, catch levels of 90,000 or 110,000 tons do not seem possible in 1991 and would leave no prospect for a viable fishery thereafter.

Table 5. Cod in Subarea 1: projections of annual age 3+ biomass (B3+), spawning stock biomass at the beginning of the year, and catch and fishing mortality (F) during the year for different management strategies (weights in '000 tons).

Year	Parameter	Stable fishing mortality F(90)	F(0.1)	Fmax	Stable catch level TAC=90	TAC=110	Stable catch level - but F never above 0.6 TAC=90
1990	B3+	263					
	SSB	28					
	F(5-10)	0.729					
	Catch	110					
1991	B3+	127	127	127	127	127	127
	SSB	59	59	59	59	59	59
	F(5-10)	0.729	0.409	1.363	2.229	5.909	0.6
	Catch	49	32	73	90	110	43
1992	B3+	85	107	56	37	20	93
	SSB	48	66	26	11	1	54
	F(5-10)	0.729	0.409	1.363	B(3+)<TAC		0.6
	Catch	31	27	28			30
1993	B3+	56	81	35			65
	SSB	23	45	7			29
	F(5-10)	0.729	0.409	1.363			0.6
	Catch	19	19	14			19
1994	B3+	44	64	30			50
	SSB	11	26	2			15
	F(5-10)	0.729	0.409	1.363			0.6
	Catch	15	18	11			16
1995	SSB	6	17	1			9

i) Future Assessment

In the present situation, when both the West and the East Greenland stocks are concentrated in the southernmost areas the border line at Kap Farvel between, the NAFO and ICES management areas are of little biological relevance. Cod east of this line may be cod from West Greenland which have been displaced only temporarily, whereas spawning migration to Iceland is not considered to be so. In the present situation it is difficult to provide advice for two separate stocks, and management may best be achieved by setting TACs for East Greenland and West Greenland based on a combined assessment.

2. Cod in Division 3M (SCR Doc. 90/22, 40, 43, 53, 68; SCS Doc. 90/05, 12, 13)

a) Introduction

i) Description of fishery

The cod fishery of the Flemish Cap is traditionally a directed fishery for Portuguese trawlers and gill-netters, Spanish pair-trawlers and Faroese longliners. Cod is also caught as by-catch in redfish and flatfish fisheries. The fleet fishing at Flemish Cap is not substantially different from that fishing on the Grand Bank outside of the 200-mile Economic Zone. The fleet includes vessels from non-contracting parties.

A moratorium on the Flemish Cap cod fishery was agreed by the Fisheries Commission for 1988 and 1989 as a consequence of the low level of stock biomass. Despite the moratorium, cod catches increased in 1989 to an estimated level of around 40,000 tons. In 1988 the situation is less clear.

ii) Nominal catches

From 1974, when a TAC was established, to 1979, catches ranged from 22,000 to 33,000 tons when TACs were 25,000-40,000 tons. Catches had been at that level or higher for the ten previous years. The TAC was set at a level of 13,000 tons in the period 1980-87 and meanwhile the reported nominal catches were about 12,000 tons. Since 1988, when the moratorium was established, the reported catches were less than 1,000 tons. TACs and reported nominal catches for the last years are as follows ('000 tons):

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	40	13	12.7	12.4[1]	12.4[1]	13	13	13	13	0	0	0
Catch	30	10	14	13	10	13	14	15	8	1[2]	1[2]	

Catch and effort data from one non-member country's pair-trawler fishing for cod in Flemish Cap were available. Sightings of boats fishing on the Flemish Cap reported by the Canadian Department of Fisheries and Oceans (DFO) include single and pair-trawlers. Based on this information catches were thought to be around 40,000 tons in 1989 and a value of the same order of magnitude is likely to have been taken in 1988. It is also thought that the fishing effort in 1990 could be equal to the 1989 level or even higher.

b) Input Data

i) Commercial fishery data

Sampling data for 1989 were available for Portuguese (first to third *quarter)* and Spanish stern trawlers (fourth quarter).Catches are dominated by 4-year-old cod (1985 year-class). No sampling data were available from pair trawlers that fished the main portion of the catch.

ii) Research vessel data

Biomass and abundance estimates were available from research vessel trawl surveys conducted by USSR from 1977 to 1989. Both abundance and biomass have a minimum trawlable estimate in 1988 with 26.7 million fish, and 7,720 tons. In 1989 the abundance estimate was 170.9 million fish and 36,500 tons biomass, both of them somewhat above the long-term average for the 1977-89 period. Acoustic estimates of cod biomass indicate that about 50% of the total stock biomass was distributed pelagically, i.e., these fish were out of the reach of bottom survey gear. Total biomass estimates increased from 34,200 tons in 1988 to 78,300 tons in 1989.

A bottom trawl survey was conducted by the EEC in 1988 and 1989. As for the USSR survey, cod age 3 (1986 year-class) was the most abundant age group, but abundance of large size cod was somewhat higher. Bottom trawlable biomass estimates increased from 37,000 tons in 1988 to 103,600 tons in 1989. The increase in abundance of most year-classes also observed must be due to increased availability in 1989 compared to 1988.

Exploitable biomass (age 3+) was estimated to be between 78,000 and 101,700 tons in 1989. A target biomass of 85,000 tons was proposed in 1985 to increase TAC beyond 12,965 tons (FC Doc. 88/IX/4).

c) Estimation of Parameters

Analytical assessments of the stock have not been conducted since 1984 because of perceived inadequacies in the commercial fishery database (NAFO Sci.Coun. Rep., 1986, page 51). This situation remains unchanged for the current assessment.

Spawning stock biomass was assumed in the past to be equal to the biomass of fish six-years-old and older. According to USSR data, about 50% of fish became mature having reached the length of 54 cm (males) or 60 cm (females), with mean age of 4.8 years. Immature fish constitute the main portion of the stock. It was calculated that mature fish constitute between 3.9% (USSR survey) and 5.8% (EEC survey) of the total abundance in 1989.

d) Prognosis

The low level of biomass estimated in USSR survey in 1987, as well as in 1988 for both the USSR and EEC surveys, is due to several consecutive weak year-classes (1982, 1983 and 1984). The stock biomass increased in 1989 as a consequence of the recruitment of the relatively abundant 1986 year-class. The 1985 year-class also showed some strength in the 1989 EEC survey, but this was not evident in the USSR index. The 1987 year-class appears weak in both surveys. The spawning stock biomass remains at a low level, and STACFIS advises that there should be no fishing for cod in Div. 3M until the spawning component of this stock shows evidence of recovery from the present depressed level. The estimated catch of 40,000 tons in 1989 indicates that the cod fishing moratorium was never effective.

Although STACFIS continues to recommend a cessation of fishing cod in Div. 3M, it is realized that a substantial catch will continue to be taken. The absence of detailed catch and sampling data from these fisheries will continue to make the evaluation of the status of the cod stock in Div. 3M difficult.

3. Cod in Divisions 3N and 3O (SCR Doc. 90/05, 72, 73; SCS Doc. 90/12, 13)

a) Introduction

i) Description of fishery

Nominal catches from this stock declined from a peak of about 227,000 tons in 1967 to a low of about 15,000 tons in 1978. Catches subsequently

increased and, with the exception of the high catch in 1986 (51,000 tons), averaged about 41,000 tons from 1985 to 1988 (Fig. 5). Reported catches for 1989 were approximately 30,000 tons[1]. For the period since 1978, catches have been taken predominantly by Canada and EEC-Spain. The Canadian catch has been taken primarily by otter trawlers, mainly from within the Canadian 200-mile fishery zone while Spanish catches, mainly by pair trawlers, have been taken in the Regulatory area. Canadian catches were stable at about 19,000 tons from 1985 to 1988 but declined to 13,000 tons in 1989. Catches by EEC-Spain have been stable at approximately 16,000 tons since 1986 while those by EEC-Portugal have declined.

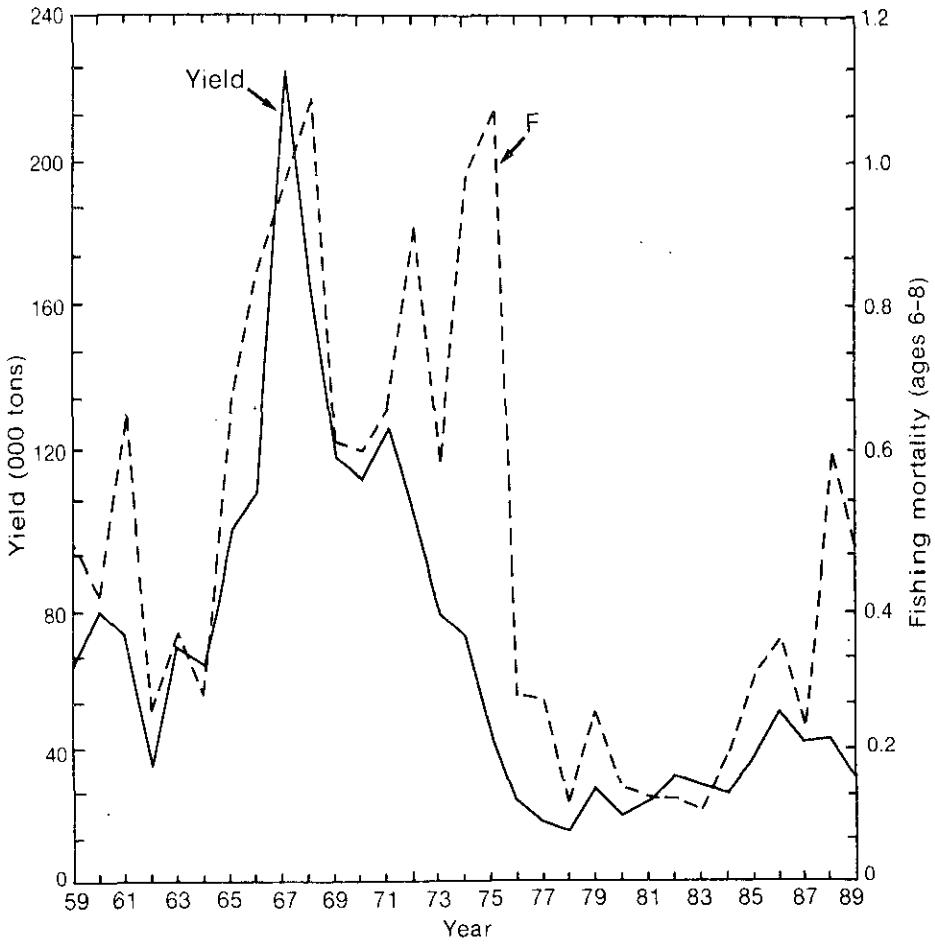


Fig. 5. Cod in Div. 3NO: trends in nominal catch and fishing mortality for 1959-89.

Estimates of the cod catch in Div. 3NO by non-member, non-reporting countries were not available for 1989. Catches by EEC-Portugal decreased from 6,900 tons in 1986 to about 900 tons in 1989 while those by the USSR, which ranged between 3,000 and 4,000 tons during the early-1980s, was only 5 tons in 1989. Catches by other member countries decreased from 2,300 tons in 1987 to 117 tons in 1989. These decreases in catch by countries mainly fishing outside the 200-mile zone are related to lower abundance and decreased availability of cod in that area. It is therefore expected that catches of cod in Div. 3NO by non-member, non-reporting countries would be

[1] The provisional nominal catch for Div. 3NO, as reported in NAFO SCS Doc. 90/21, was somewhat higher than that used in the current assessment. The difference of approximately 10% resulted from an update of Spanish pair trawl catches from 15,277 tons to 17,904 tons. This information was not provided in sufficient time for incorporation in the current assessment, however, this omission is likely to have only a marginal effect on the estimation of population size for 1989.

inconsequential during 1989. Furthermore, Korean vessels, which have reported substantial catches of flounders in 1988, have not reported any cod catch.

ii) Nominal catches

Recent TACs and catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	26	26	17[1]	17[1]	26	33	33	33	40	25	18.6
Catch	20	24	32	29	27	37	51	42	43[2]	30[2]	

[1] Excludes expected catches by EEC-Spain.
[2] Provisional data.

b) Input Data

i) Commercial fishery data

In the most recent assessment of this stock (NAFO Sci. Coun. Rep., 1989) catch-rate indices were not used in the calibration model (ADAPT) because they were not considered to be reflective of stock abundance. The two main concerns were the definition of directed effort for Canadian otter trawlers which take a large portion of their cod catch as by-catch in the American plaice fishery, and the fact that the variable Spanish catch-rate data only relate to a portion of the stock.

These issues have not been resolved and as such, catch-rate indices were not used for calibration in the current assessment. STACFIS considered that these issues may not be resolved in the near future and concluded that commercial catch rates have limited usefulness as calibration indices for this stock.

ii) Research survey data

Stratified-random research vessel surveys have been conducted by Canada in Div. 3N for the 1971-90 period, with the exception of 1983, and in Div. 3O for the years 1973-89 with the exception of 1974 and 1983. To account for incomplete coverage in certain years, estimates of abundance for non-sampled strata were obtained using a multiplicative analysis. In general, biomass and abundance increased from the late-1970s to the mid-1980s with a subsequent decline. Recent estimates of abundance (1989-90) are lower than any previously observed for this stock. The large declines in abundance are attributed to a succession of very weak year-classes. The 1983 and 1984 (age 5 and 6 in 1989) year-classes are considered to be weaker than any previously observed and in addition, the data indicate that the 1985 year-class (age 4 in 1989) is also at a low level. Biomass in both Divisions increased sharply from 1982 to 1984, was somewhat stable from 1984 to 1986 and increased sharply again in 1987, especially in Div. 3O. Estimates decreased substantially in 1988 for both Divisions with those for Div. 3O showing a further large biomass decrease in 1989. Preliminary results for 1990 indicate that both biomass and abundance are similar to 1989 levels. The decline in biomass has been relatively smaller than that for abundance due to growth in the older age-groups.

Canadian survey data were analyzed relative to biomass, abundance and age compositions occurring both inside and outside the 200-mile boundary. It was found that a higher percentage of the total 3NO biomass occurred outside the 200-mile line in the earlier years (6-29% from 1973 to 1982) than in the later period (3-10% from 1984-89). Comparisons of percent survey catch-at-age indicated similar age compositions both inside and outside the 200-mile line from 1973 to 1982 and a predominance of younger ages outside the 200 miles from 1984 to 1989. The relatively lower level of total biomass as well as the proportionately lower numbers of older fish outside the 200-mile boundary in years since 1982 are likely to be the result of higher rates of exploitation in that area compared to the area inside the boundary.

Surveys by the USSR were conducted on a stratified-random basis from 1983 to 1989. Surveys from the 1977-82 period used a different methodology but were reanalysed to make that series comparable with the recent period. The abundance and biomass estimates generally increased from 1979 to 1985 but have since decreased substantially. The abundance estimate for 1989 was the lowest in the time series. Cod of ages 3 to 4, 7 and 8 made up the bulk of the catches.

Acoustic estimates from the 1987-89 USSR surveys indicated that 11%, 71% and 27% respectively of cod numbers were distributed pelagically.

iii) Catch-at-age data

Biological sampling data from the Canadian otter trawl, seine and gillnet fisheries as well as Spanish pair trawl and Portuguese gillnet fisheries were used to estimate the age composition of the commercial catch in 1989. The 1981-83 year-classes (ages 6-8) were most numerous in the Canadian catch, the 1978-80 year-classes (ages 9-11) in the Portuguese fishery and the 1984-86 (ages 3-5) in the Spanish fishery.

Average weights-at-age were available from the Canadian, Portuguese and Spanish fisheries. With the exception of those for ages 3 and 4, average weights were higher in 1989 than in 1988. A sum of products check indicated that the calculated catch in 1989 was less than 1% different than the reported catch.

c) Estimation of Parameters

i) Sequential population analysis

As indicated in Section b(i) of this report, the catch-rate indices available were not used because, for the reasons stated, they were not considered to reflect stock abundance. Consequently, it was decided to use only survey results for calibration.

Canadian and USSR research vessel (RV) survey data were analyzed in a single formulation of the adaptive framework (ADAPT). In the 1989 assessment of this stock, data for some years for each series were excluded from an analysis using ADAPT because they had been considered anomalous. For the current assessment it was decided to include data for all years in both RV series and determine anomalies from the residual patterns. The ADAPT formulation used is described in Section f below.

Previously, it had been established that intercepts were not significant and hence were not included in this analysis. With the exception of age 3 abundance, all estimated parameters were significant, however, the coefficients of variation (CV) on most other abundance estimates were high, ranging between 44% and 48%. All of the research vessel slopes were estimated with CVs around 0.30. Residuals indicated a great deal of annual variation in the data for both the Canadian and USSR results. In some years all residuals were negative while in other years the opposite was true. These patterns were to be expected given that a number of surveys which were considered anomalous and were deleted in the 1989 assessment were reintroduced in this year's analysis. Although none of the correlations between estimated parameters were greater than 0.50, there was some relationship between catchabilities for the Canadian and USSR RV at the same age. Population numbers at January 1 indicated that 1983-86 year-classes at age 3 were the four lowest in the series (Fig. 6) while fishing mortalities on younger ages (4 and 5) were high.

Preliminary formulations of ADAPT indicated that flat-topped partial recruitment produced catchability estimates for RV that increased with age through the oldest age. The catchabilities for the USSR index showed a similar pattern. RV catchabilities should be at least stable if not declining, through older ages. It was demonstrated that a fishing mortality on the oldest age (12), set at about 40% of that on ages 7-10 produced stable catchabilities for older ages in the RV indices.

Data for both Canadian and USSR RV indices were also analyzed in separate formulations of the adaptive framework. The Canadian data on its own indicated that the 1989 population was considerably larger than that estimated in the combined analysis, however, none of the population estimates were significant, and the CVs on the estimated slopes were quite high (40%-50%).

For the analysis using only the USSR data, estimated abundance for ages 5-8 were significant and all CVs on estimated slopes were about 30%. In this analysis, however, the estimated population for 1989 numbered only 17 million fish. A population of this size in 1989 implied fishing mortalities on ages 5 and 6 in excess of 2. Fishing mortalities at those levels had never previously been observed for this stock. STACFIS concluded that neither the Canadian or USSR survey results on their own were appropriate to estimate the size of the stock in 1989, however, when both indices were included in a single analysis the results appeared reasonable, i.e. most parameter estimates were significant and estimated fishing mortalities were in the range of those previously observed.

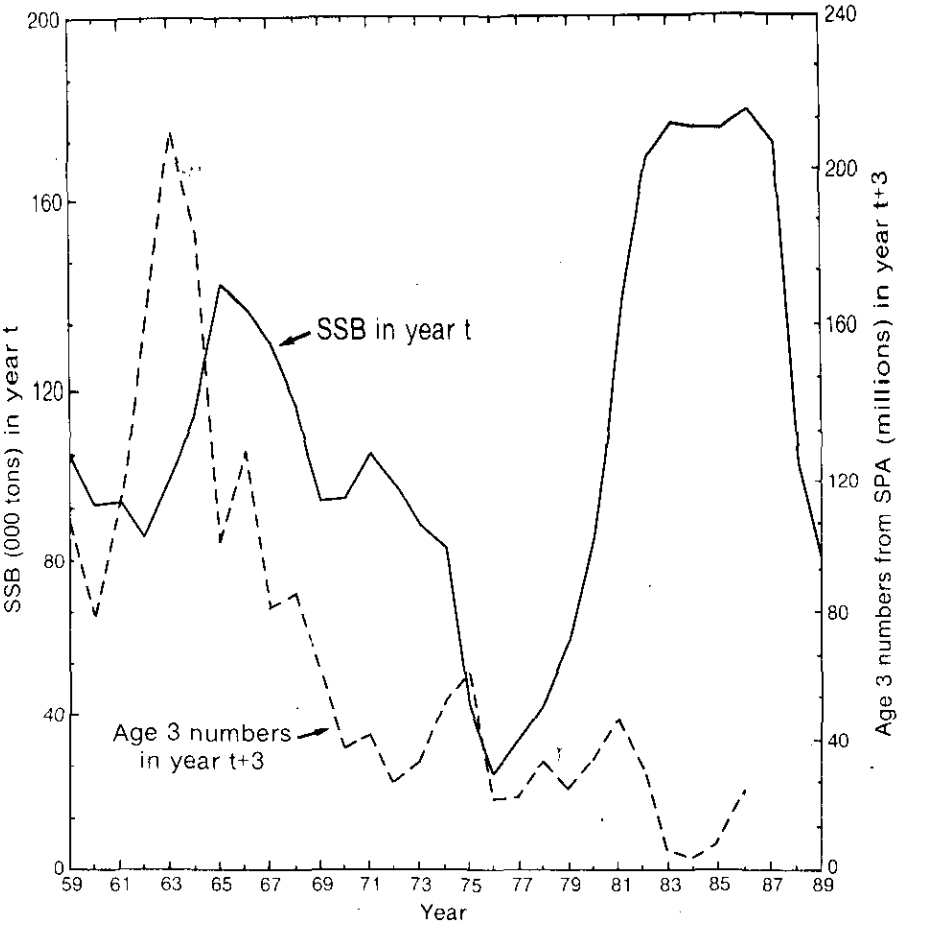


Fig. 6. Cod in Div. 3NO: trends in spawning stock biomass and abundance at age 3 from sequential population analysis for 1959-89.

Fishing mortality and population estimates for the period 1959-76 were obtained by setting fishing mortality on the oldest age (12) equal to the weighted (by population numbers) F for ages 7-10, while that for 1977-89 was set at 40% of the weighted F at those same ages.

ii) Yield-per-recruit

The most recent yield-per-recruit analysis for this stock was conducted during the 1988 assessment. Input data included average weights-at-age from the commercial fishery from 1977-87 and partial recruitment estimates for the period 1977-86. The latter were flat topped and the age range from 3 to 20 was considered appropriate.

In the current assessment a yield-per-recruit analysis was conducted based on a dome shaped partial recruitment. The exploitation pattern of the fishery appeared to have changed in that younger fish were being more heavily exploited. Partial recruitment and average weights-at-age estimates used were averages over the period 1982-88. The age 3 partial recruitment value for 1987 was not included in the average for that age because it was a higher than normal value on a very weak year-class. Some recent analysis of yield-per-recruit on cod stocks in Canadian waters indicated that ages to age 16 were appropriate and those were used in the present analysis. The reference fishing mortality levels estimated were $F_{0.1}$ = 0.25 and F_{max} = 0.40 (Fig. 7) with yield-per-recruits of 1.03 and 1.08 kg respectively.

d) Assessment Results

The age 3 abundance derived from ADAPT using RV data was not precisely estimated and consequently the size of this year-class was set at the 1977-88 geometric mean at age 3 of about 25 million fish. This would suggest that the 1989 age 3+ population numbers were about 53 million fish.

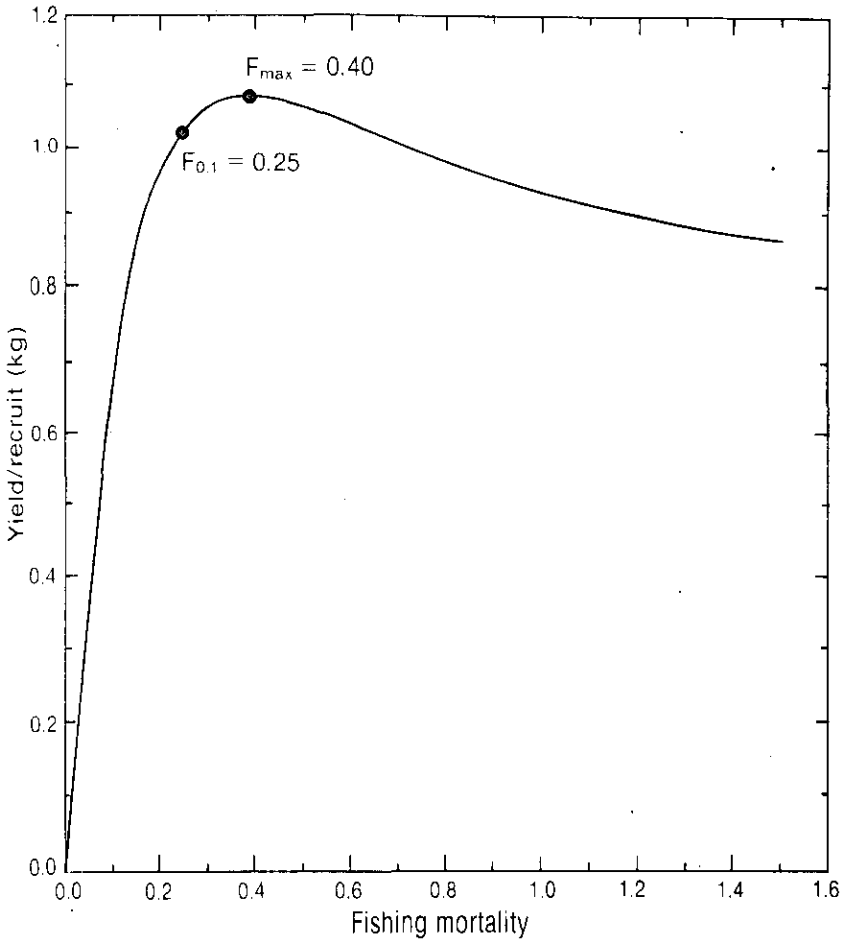


Fig. 7. Cod in Div. 3NO: yield-per-recruit for a range of fishing mortalities.

declined to approximately 100,000 tons in 1989. The major reasons for the decline is the size of the weak 1983-85 year-classes. These year-classes are each estimated to be less than one half the size of the lowest previously observed year-class. Fishing mortalities on the fully recruited ages (6-8) (Fig. 5) have been high and were above F_{max} in 1988 (0.59) and 1989 (0.47), F on ages 3 and 4 in 1989 were the highest since the mid-1970s.

e) Catch Projections

The parameters which were used to project stock size are given in Table 6. The partial recruitment used was the average for 1982 to 1988. The value for age 3 in 1987 was not included in the average for that age because the value obtained was higher than normal for a weak year-class. Average weights-at-age were an average of values from 1987 to 1989. The 1987 and 1988 year-classes at age 3 in 1990 and 1991 were set at the 1977-88 geometric mean of approximately 25 million fish. The 1990 catch was assumed to be the 1990 TAC of 18,600 tons.

Table 6. Cod in Div. 3NO: parameters used in projections of stock biomass and catch.

Age (yr)	Stock size 1 Jan 90 ('000)	Mean weight (kg) Mean Annual	Mean weight (kg) Start of Year	Percent Mature	Partial Recruitment
3	25,000	0.58	0.46	0	0.10
4	19,022	0.93	0.73	4	0.36
5	4,178	1.43	1.15	22	0.83
6	467	1.95	1.67	64	1.00
7	521	2.80	2.34	94	1.00
8	2,293	4.38	3.50	99	0.71
9	3,827	6.49	5.33	100	0.69
10	1,524	8.05	7.23	100	0.68
11	1,276	9.56	8.77	100	0.57
12	1,301	11.97	10.70	100	0.33

Projections of catch for 1990 and spawning stock biomass for January 1, 1992 are given in Table 7 and Fig. 8. The projected 1991 catches for $F_{0.1}$ = 0.25 and F_{max} = 0.40 are 13,600 tons and 20,800 tons respectively. The TAC of 18,600 tons for 1990 now implies a fully recruited fishing mortality in that year of 0.37.

Table 7. Cod in Div. 3NO: projections of catch and spawning stock biomass (SSB) at various reference levels of fishing mortality assuming catch in 1990 of 18,600 tons.

SSB (1.1.1991) (tons)	Reference fishing mortality levels	Catch (1991) (tons)	SSB (1.1.1992) (tons)
69,200	$F_{0.1}$ = 0.25	13,600	65,800
	F_{max} = 0.40	20,800	60,200
	F_{89} = 0.47	24,000	57,800

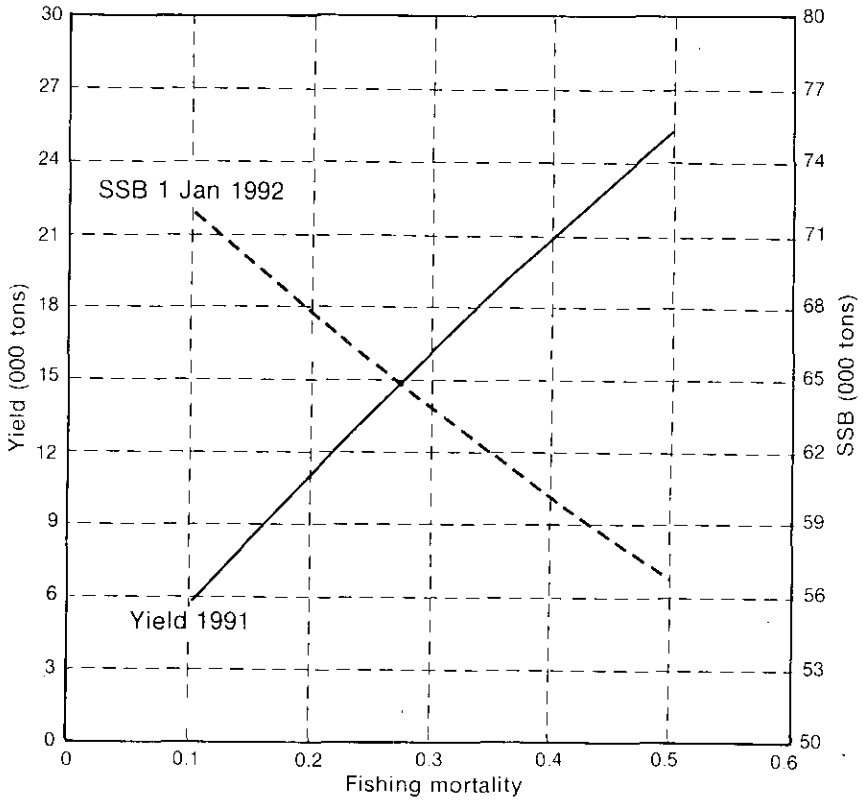


Fig. 8. Cod in Div. 3NO: projection of catch for 1991 and spawning biomass (SSB) at 1 January 1992.

During the last assessment of this stock, the 1983 and 1984 year-classes at age 3 were estimated to be about one half the strength of the lowest previously observed age 3 estimate. The current assessment suggests again that these year-classes are very weak and even smaller than that previously estimated. As well, the size of the 1985 year-class was estimated to be similarly weak. The size of these year-classes was about one third the next lowest year-class (22 million) and similarly of the 1977-88 geometric mean recruitment (25 million fish). During the 1977-88 period age groups 6-8 contributed approximately 50% of the catch biomass. It is projected that the 1983-85 year-classes at ages 6-8 in 1991 will only contribute about 10% of the total catch biomass for that year.

f) The Accepted Formulation of ADAPT

Parameters:

- year-class estimates

$N_{i,\ 1989}$ $\quad i = 3\text{-}11$

- calibration coefficients for RV numbers

$K(Can)_i \quad i = 3\text{-}11$
$K(USSR)_i \quad i = 3\text{-}11$

Structure:

- Natural mortality was assumed = 0.20
- Error in catch-at-age assumed negligible
- F on oldest age (12) was calculated as 40% of the weighted (by population numbers) F for age-groups 7-10
- Intercepts were not fitted

Input:

- $C_{i,t}$ $\quad i = 3\text{-}12 \quad t = 1977\text{-}89$
- $RV(Can)_{i,t}$ $\quad i = 3\text{-}12 \quad t = 1977\text{-}82,\ 1984\text{-}89$
- $RV(USSR)_{i,t}$ $\quad i = 3\text{-}12 \quad t = 1977\text{-}89$

Objective Function:

- Minimize

$$\sum_{it}\sum [\text{obs } (\ln RV(Can)_{i,t}) - \text{pred } (\ln RV(Can)_{i,t})]^2 +$$

$$\sum_{it}\sum [\text{obs } (\ln RV(USSR)_{i,t}) - \text{pred } (\ln RV(USSR)_{i,t})]^2$$

Summary:

- Number of observations = 225
- Number of parameters = 27

4. Redfish in Subarea 1 (SCR Docs. 90/39, 46, 65, 88; SCS Doc. 90/14)

a) Introduction

Redfish are taken mainly as by-catch in the trawl fishery for cod. Landings were considered almost exclusively golden redfish (*Sebastes marinus*). Total nominal catches were stable between 1978 and 1983 averaging 8,000 tons. From 1984 to 1986, catches declined to an average level of 5,000 tons due to an effort reduction of the cod fishery by trawlers of the EEC-FRG. This reduction was only partly compensated by a directed redfish fishery of Japanese trawlers. With the closure of the offshore cod fishery in 1987 catches decreased further to only 1,200 tons and remained at this low level in the following years in spite of increasing effort in the cod fishery by trawlers from Greenland and the EEC-FRG. Recent catches ('000 tons) were as follows:

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Catch	8	9	8	6	8	7	6	4	5	1	1[1]	1[1]

[1] Provisional data.

Small juvenile redfish (*S. marinus* and *S. mentella*) are quite abundant in the northern Div. 1ABC where large numbers were taken and discarded as by-catch in the shrimp fishery.

b) Input Data

i) Commercial fishery data

No data available.

ii) Research vessel survey data

Adult *Sebastes marinus* (golden redfish). Biomass and abundance estimates for *Sebastes marinus* are derived from the stratified-random bottom trawl surveys conducted by the EEC-FRG since 1982. These results indicate a continuous decline of the adult stock component inhabiting Div. 1D-F from a level of 74,000 tons and 129 million fish to only 6,000 tons and 13 million fish in 1989.

Adult *Sebastes mentella* (beaked redfish). Stratified-random bottom trawl surveys, conducted jointly by Japan and Greenland and covering depths of 400-1500 m in Div. 1 A-D in 1988 and 1989, gave biomass estimates for *Sebastes mentella* of 5,700 and 3,100 tons respectively.Adult *Sebastes mentella* occur in depths exceeding 400 m. These depths were insufficiently covered by the survey which was primarily designed for cod. Hence, survey estimates were downward biased. The estimates remained fairly stable until 1988, averaging about 3,000 tons and 7 million fish. In 1989 almost no adults were caught but small juvenile specimens were obtained in the survey catches throughout the survey area and total biomass and abundance estimates were only 1,000 tons and 19 million fish (mean weight 55 g). The Japan-Greenland surveys estimated 200 tons for *S. marinus* in both 1988 and 1989.

Juveniles. In the northern part of the survey area (Div. 1 B+C), covered by the EEC-FRG, predominantly small juvenile redfish (both species) below 20 cm were distributed. Maximum biomass and abundance estimates have been obtained since 1982, and estimates of 10,000 and 9,000 tons and 159 and 130 million fish were obtained in 1986 and 1987, respectively. In 1989 the area of distribution of small redfish was extended further south, however, the total biomass and abundance estimates for both redfish species combined were only 2,000 tons and 43 million fish.

Stratified-random shrimp surveys conducted by Greenland in 1988 and 1989 covered a far larger area, also including part of Div. 1A. Biomass and abundance estimates for small juvenile redfish amounted to 23,000 tons and 250 million fish in 1988. No estimates were available for 1989. The redfish by-catch in the commercial offshore shrimp fishery in 1989 was estimated at about 6,000 tons (9-16% of the total shrimp catch).

c) Catch Projections

In view of comparatively low catch levels in recent years the considerable decline of the fishable stock biomass and abundance as observed from survey estimates can obviously not be attributed to the cod fishery. Large amounts of juvenile redfish in the northern part of Subarea 1 were caught by the shrimp fishery and this adversely affects recruitment. Whether small year-classes are a result of a small spawning stock is not known at present.

By-catch regulations for the shrimp fishery could become advisable if considerable proportions of the biomass of juvenile redfish continue to be caught. As long as catches of the adult stock component remain limited to by-catches of fisheries directed to other species, no TAC is advised by STACFIS.

5. Redfish in Division 3M (SCR Doc. 90/08, 68; SCS Doc. 90/05, 12, 13, 17)

a) Introduction

From 1979 to 1985, catches were at or below the TAC Level (20,000 tons). Catches began to increase in 1986, and more than doubled the TAC in 1987. Provisional data for 1989 indicate a catch of about 27,000 tons, up from about 23,000 tons in 1988 but down from about 44,500 tons in 1987. For the past number of years, this fishery has been prosecuted mainly by EEC-Portugal and the USSR. Cuba has taken about 1700 tons annually. In 1989, the majority of the catch was taken by EEC-Portugal (48 %) and USSR (51 %). There has been an increase in the presence of vessels from non-member non-reporting countries in recent years, but their catches cannot be quantified. Reported catches and TACs ('000 tons) for the recent period are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	20	20	20	20	20	20	20	20	20	20	50
Catch	16	14	15	20	20	20	29	44	23[1]	27[1]	

[1] Provisional data.

b) Input Data

i) Commercial fishery data

Catch and effort data were available from ICNAF and NAFO Statistical Bulletins for the period 1967-87. These data and preliminary data for 1988 were analyzed using a multiplicative model to derive an estimate of standardized catch rate and effort. Figure 9 shows that catch rates increased from 1959 to 1961, then declined until about 1967 after which they again increased. After peaking in 1970, they declined until about 1973 and have remained fairly stable since then. STACFIS reiterated that while the catch rates may not be indicative of stock abundance, the lack of any changes since 1973 may indicate a general stock stability (NAFO Sci. Coun. Rep. 1989, page 64).

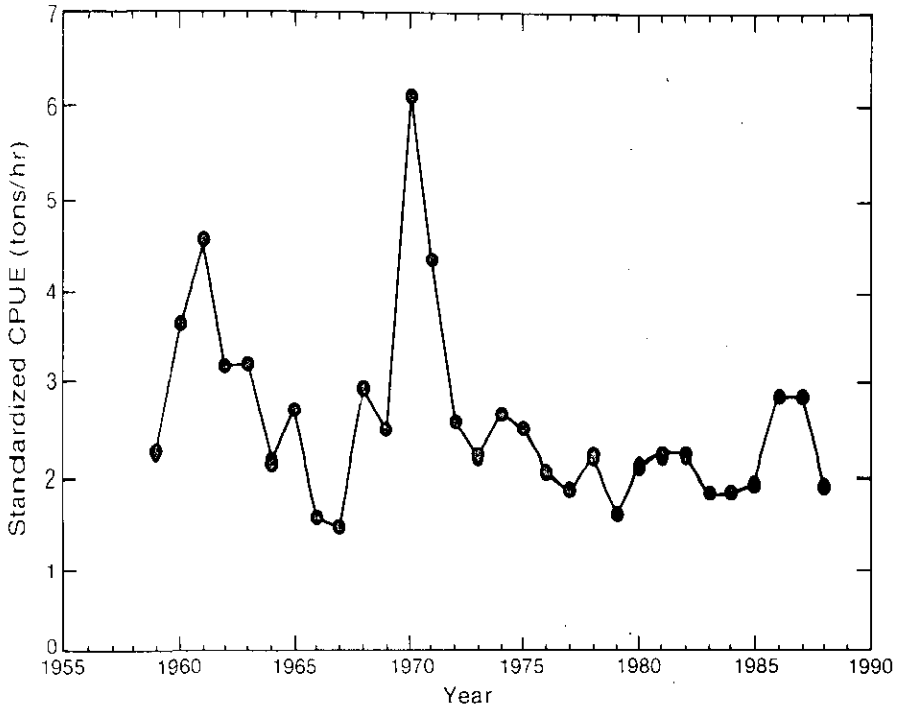


Fig. 9. Redfish in Div. 3M: standardized catch rates from ICNAF and NAFO data.

Catch-rate information from two Portuguese stern trawlers in 1989 indicated an increasing trend from January to May (0.383 to 1.485 tons/hr) followed by a decline through August (0.524 tons/hr) (SCS Doc. 90/12).

ii) Catch-at-age data

A single commercial length frequency available from the 1989 Spanish fishery (SCS Doc. 90/13) was bi-modal, with peaks at 17 and 26-27 cm. The estimated catch-at-length from the Portuguese fishery was also bi-modal, but with modes at 25 and about 32 cm (SCS Doc. 90/12).

Catch-at-age estimated from the USSR fisheries were available for 1978-89 (SCR Doc. 90/08). In 1989, the modal age was 8. STACFIS noted that data were available from 1968 to 1978 but were not presented. Also, the fish weight-at-age matrix was not available. STACFIS recommends that *catch-at-age and weight-at-age data from 1968 onward be provided for future assessments.*

iii) Research data

The results of research survey by EEC in 1989 were presented (SCR Doc. 90/68). The total biomass was estimated to be about 137,000 tons, only slightly less than the estimate of about 158,000 tons in 1988. The results of the USSR combined trawling and acoustic survey (SCS Doc. 90/05) also suggested stability between the revised estimate for 1988, and that of 1989 (379,000 and 366,000 tons respectively). The results of USSR trawling

over the time period. It was noted previously (NAFO Sci. Coun. Rep. 1989, page 64) that the proportion of the redfish biomass up in the water column above the swept area of the trawl may vary from year to year. In 1987, the percentage above the trawl was estimated to be about 70 %. This was determined to be 90% in 1988, and 87 % in 1989. Biomass estimates from the various surveys ('000 tons) are as follows:

		1983	1984	1985	1986	1987	1988	1989
USSR	Trawl	155	132	52	310	106	47	83
	Acoustic	-	-	-	-	322	322	283
	Total	-	-	-	-	428	379	366
EEC	Trawl	-	-	-	-	-	158	137

Both the EEC and USSR survey results in 1989 indicated the presence of a relatively strong year-class, probably that of 1985. These fish were about 14-17 cm in 1989. STACFIS noted that this year-class did not appear to be as strong as that of 1980.

c) Estimation of Parameters

i) Sequential population analysis

Separate SPA analyses incorporating a fixed estimate of natural mortality of 0.1, and variable M over all ages were available. The relationship between fishing mortality and effort was used to calibrate the SPA, and correlation coefficients ranged from 0.44 to 0.76 for ages 6-19. The results suggested a relatively stable stock biomass.

As was the case in 1989 (NAFO Sci. Coun. Rep. 1989, page 65) however, STACFIS was unable to evaluate these analyses because details of the effort series used for calibration were not available, nor were sufficient details of the calibration process (e.g. regression plots) or partial recruitment. This is a recurring problem, and STACFIS recommends that *details of the calibration process in tuning SPA be provided in the future*. In addition, it was noted that the lack of data concerning the fishing activities of non-member non-reporting countries hampers the usefulness of SPA.

d) Prognosis

In 1989, STACFIS noted that the results of the 1988 USSR combined trawling-acoustic survey suggested a population size well above the long term average and noted that this may suggest that yields of 50,000-85,000 tons at $F_{0.1}$ and F_{max} respectively could be taken (NAFO Sci. Coun. Rep. 1989, page 66). However, because of reservations concerning the survey results, STACFIS advised establishing the TAC below these reference levels. The results from both the EEC and USSR surveys in 1989 suggested stability in the stock, and catch-rate data since 1973 tend to support this. The average biomass determined from revised combined trawling and acoustics estimates from USSR surveys for 1987-1989 is 391,000 tons. Applying the same rational as was used last year, catches at reference fishing mortalities of $F_{0.1}$ and F_{max} would be 43,000 and 78,000 tons respectively. As such catch levels are much higher than the long-term productivity of the stock at $F_{0.1}$ and F_{max}, STACFIS advises that the 1991 TAC should be set at 43,000 tons.

6. Redfish in Divisions 3L and 3N (SCR Doc. 90/09, 87; SCS Doc. 90/05, 08, 12, 15, 16, 17, 21)

a) Introduction

The average nominal catch from this stock for the period 1959-89 was about 24,000 tons. In the early- to mid-1980s, landings averaged about 19,000 tons and between 60-80% of the total was taken in Div. 3N. In 1986, reported landings doubled to 43,000 tons with 65% taken in Div. 3L. The increase in catch in 1986 was due to the greater participation of EEC-Portugal in both Div. 3L (13,000 tons) and Div. 3N (8,000 tons). The USSR also took most of their landings from Div. 3L in 1986. Catches increased again in 1987 to the highest reported historically at 71,000 tons. This can be attributed to further increased catches by EEC-Portugal in Div. 3L (7,000 tons more than 1986), increases by USSR (8,000 tons) and substantial catches by South Korea (16,000 tons). In 1988 landings declined to about 45,000 tons. Preliminary landings for 1989 indicate a further reduction to about 24,000 tons.

Canadian surveillance estimates for non-member countries fishing in the Regulatory

Country	1987	1988
Cayman Islands	4,500	3,000
Panama	3,000	3,900
St. Vincent		1,000

No estimates were available for 1989 but catches should be less than in 1988 (about 8,000 tons) due to a shift of effort to Div. 3M according to surveillance observations. Recent nominal catches and TACs ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	25	25	25	25	25	25	25	25	25	25	25
Nominal Catch	16	24	22	20	15	21	43	71	45[1]	24[1]	

[1] Provisional data.

b) Input Data

i) Commercial fishery data

Catch and effort data were obtained from ICNAF and NAFO Statistical Bulletins for the 1959-87 period. These were combined with preliminary NAFO data for 1988 and preliminary Canadian data for 1988 and 1989. These were utilized in multiplicative analyses to derive standardized catch-rate series for each Division separately because it has been shown previously that there were somewhat different patterns in each of the Divisions in recent years (NAFO Sci. Coun. Rep., 1987, page 51). Effort data from EEC-Portugal in hours were not available in the NAFO database for 1986 to 1988, the period coinciding to the increase in catches, particularly by that country. STACFIS considers the availability of these data to be important and notes that EEC-Portugal scientists are planning to compile these data in the future.

Although there was considerable interannual variability in both series, no overall trends with time were apparent. The lack of trends in either Division may indicate a general stability of the stock over the 1959-89 period.

Commercial length frequencies suggest the main proportion of fish caught in Div. 3L were in the 27-37 cm range while in Div. 3N the majority represented the 21-27 cm range.

Commercial catch-at-age data were available for the fishery from 1978 to 1989 (SCR Doc. 90/09). Age 7 dominated in the catch in 1989. It was noted that these data are actually available as far back as 1968. STACFIS recommends that *the entire time series of catch-at-age and weight-at-age be made available.*

ii) Research survey data

A survey conducted by Canada in Div. 3L in January of 1990 estimated the total biomass to be only about 13,000 tons (SCR Doc. 90/87). This was below the 1986 estimate of 30,000 tons based on a survey in the same area and at the same time. Estimates of stock size from USSR trawl surveys from 1983 to 1989 in Div. 3LN (SCS Doc. 90/05) showed much interannual variability but indicated a decline in both abundance and biomass (Fig. 10) since 1983, from about 125,000 tons to about 11,000 tons in 1989. Trawl-acoustic survey results for Div. 3LNO combined for 1988 and 1989 indicated a dramatic decline in both numbers and biomass (Fig. 10) from 1988 to 1989, decreasing from about 362,000 tons to 104,000 tons (SCS Doc. 90/05). Such a change in redfish population size could not be explained by neither the biology of the species nor the magnitude of the fishery. The acoustic data indicate a considerable portion of the biomass to be above the trawl swept area in 1988 and 1989, although these proportions are variable from 79% in 1988 to 63% in 1989. In last year's assessment the USSR trawl-acoustic survey results were available for Div. 3LN and STACFIS recommends that *trawl-acoustic information be presented by Division, if possible, or at least by stock area as was done in 1989.*

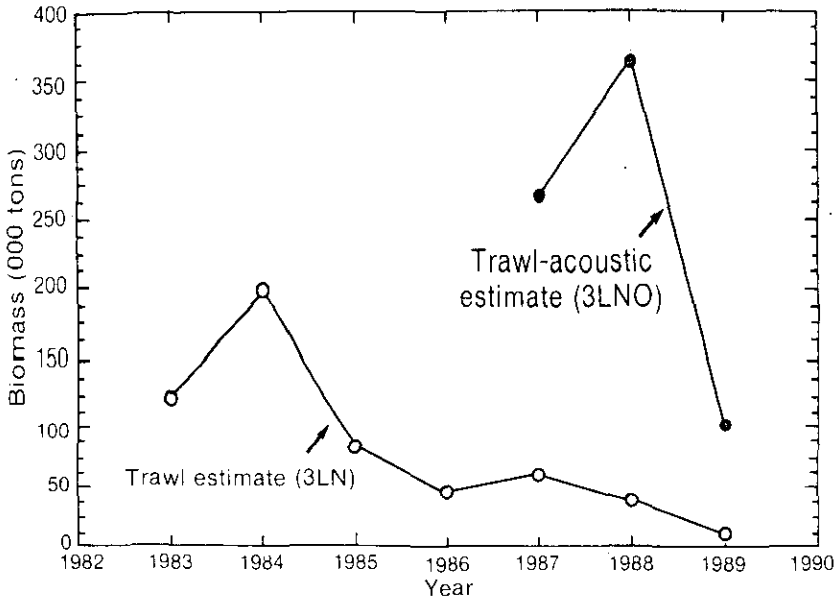


Fig. 10. Redfish in Div. 3L and 3N: total biomass estimates from USSR bottom-trawl surveys from 1983 to 1989 and from trawl-acoustic surveys in Div. 3LNO from 1987 to 1989.

Length compositions from the USSR bottom trawl surveys from 1983 to 1989 indicated quite different population structures for each Division (SCR Doc. 90/09). The data from Div. 3N suggested relatively good recruitment in this portion of the stock with fish of 14-16 cm present in 1989. However, STACFIS could not evaluate the strength of this recruitment, as these frequencies were presented in terms of relative percentages at length for each year. There is no indication of recent good recruitment in Div. 3L.

c) Estimation of Parameters

i) Sequential population analysis

SPA of the Div. 3LN redfish was available (SCR Doc. 90/08) but STACFIS was unable to evaluate the results. It was noted however that the results of the analyses suggested a steady increase in biomass from 1978 to 1989, contrary to the trends from available indices (no change in CPUE; decline from research vessels).

ii) General production model

General production analysis has not been considered appropriate for this stock because there was not significant contrast in the catch and effort data for Div. 3L and Div. 3N (NAFO Sci. Coun. Rep., 1989, page 68). The update in the database for this year has not changed this view.

d) Prognosis

Catch rates are not considered reflective of stock status because of the patchy distribution of this species in this area.

Estimates of Div. 3LN stock size from USSR trawl surveys indicated a substantial decline in trawlable biomass from 1983 to 1989. STACFIS has noted that this decline was evident even before the very high reported catches were taken from 1986 to 1988.

Estimates of stock size in Div. 3L based on Canadian bottom trawl surveys in January 1986 and 1990 also suggested a decline and suggested a low population biomass (13,000 tons) similar to USSR bottom surveys for the whole stock (11,000 tons). Total biomass estimates for Div. 3LNO combined (bottom and pelagic) from the 1987-89 USSR trawl-acoustic surveys, although they were only for three years, may indicate a general decline (Fig. 10). These results were available as separate estimates for Div. 3LN and Div. 3O only in 1988 (SCS Doc. 89/08) and indicated equal proportions of biomass in each area. Trawlable biomass estimates from the USSR surveys from 1983 to 1989 indicated, on average, there were equal

proportions in Div. 3LN and 3O. Therefore, STACFIS considers that 50% of the combined Div. 3LNO trawl-acoustic total biomass estimates likely resides in Div. 3LN. Given the rather large fluctuations in the three USSR trawl-acoustic survey estimates, STACFIS considers that an average of these three estimates may be closer to the real situation. Based on last year's yield-per-recruit calculations (NAFO Sci. Coun. Rep., 1989, page 69), applying $F_{0.1}$ and F_{max} exploitation (11% and 20% respectively) to the average biomass considered to be in Div. 3LN (at 50% about 123,000 tons) gives yields of about 14,000 and 25,000 tons. It was quite evident that from 1987 to 1989, the proportion of the catch-at-age representing 11+ ages had systematically decreased following increased catches in the 1986 to 1988 period. There is a strong signal from the survey results indicating a stock decline. Therefore, the present TAC (25,000 tons) appears to be too optimistic and STACFIS advises that the TAC for 1991 should be lowered to 14,000 tons.

7. Silver Hake in Divisions 4V, 4W and 4X (SCR Doc. 90/01, 02, 04, 14, 15, 18, 19, 20, 21, 48, 49, 50; SCS Doc. 90/02)

a) Introduction

The fishery is conducted primarily by large otter trawlers using small-meshed bottom trawls. Recently, Canadian 45 and 65 foot otter trawlers have fished for silver hake. Nominal catches since 1970 ranged from a maximum of 300,000 tons in 1973 to a minimum of 36,000 tons in 1983. Since 1977 catches have generally increased from 37,000 tons in 1977 to 92,000 tons in 1989. Prior to 1977 the fishery was not restricted by season or area, however since 1977 the fishery has been restricted to the months of April through November and to the area seaward of the small mesh gear line (SMGL). Recent catches and agreed TACs are ('000 tons):

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	90	80	80	80	100	100	100	100	120	135	135
Catch	45	45	60	36	74	75	83	62	74[1]	91[1]	

[1] Preliminary data.

The 1989 commercial fishery was conducted primarily to the seaward side of the SMGL. The total catch of silver hake was the highest seen since 1977. The catch was primarily silver hake, but as the season progressed the by-catch levels for cod, haddock, and pollock increased.

The fishery opened on March 15 (for an exploratory fishery) and was over early in August with most of the allocations taken. The catches fell short of the TAC in recent years because of Canadian allocations to countries or fleets which did not fish for silver hake. However, since 1986 both the USSR and Cuba have usually caught more than 90% of their respective allocations.

The pattern of the 1989 commercial fishery closely resembled that of previous years. As in 1988, the fishery had an early start, with a small number of vessels fishing in mid-March. Cuba and the USSR were the principal participants, taking 77,000 tons and 14,000 tons, respectively. A small Canadian domestic fishery was pursued, with a catch of approximately 300 metric tons (SCR Doc. 90/19, 20, 21).

The by-catches of pollock, cod, haddock, hakes (*Urophycis* spp.) and mackerel were low relative to earlier years and were within the allowable rate (SCR Doc. 90/19). In 1989, as in the previous year, extremely dense and stable aggregations of silver hake were observed on the Scotian Shelf slope (see Annex 3 below).

It was suggested that silver hake moved out of the fishing area due to hydrological conditions and food availability rather than due to reaching maturity (SCR Doc. 90/14).

b) Input Data

i) Commercial fishery data

As advised by the STACFIS workshop on the silver hake database in January, 1990, catch rate standardization used an agreed upon series of catch and effort data (see Annex 3 below).

The results of a multiplicative model showed that catch rates have increased irregularly from 1980 to 1989. The catch rate in 1982 was much higher than in adjacent years and is the fourth highest in the series. It was considered unlikely that the drastic change in catch rate seen in 1982 was representative solely of a change in biomass. The 1986 and 1987 catch rates are similar and are slightly higher than those in 1982. The 1988

highest in the series. The catch rate since 1982 was at a higher level than was calculated prior to that year.

Observed catch rates for 1989 peaked in mid-March, at 17 tons/hr for the USSR, and 12 tons/hr for Cuba. These catch rates declined steadily as the fishery progressed, falling below 0.5 tons/hr at the end of the fishery in August.

For 1990, preliminary data show observed catch rates in March and April to be substantially lower than those of 1989. In addition, comparisons of length frequency data for 1990 with data for 1989 indicate that a higher proportion of the catch in 1990 is composed of 25-27 cm fish which are approximately age 2 and 3 silver hake.

At the January workshop ageing differences between Canadian and USSR age readers were again noted (Annex 3). Following that meeting, Canadian and USSR age readers met in March, 1990 at PINRO in Murmansk, USSR, to review their respective ageing techniques. The results suggested that current techniques are comparable. The Soviet age readers re-aged their 1989 otoliths and presented an age length key which, for ages up to and including age 3, was similar to that presented by Canada. Some differences in otolith interpretations at age group 4 still exists. The old fish will, however, make a negligible contribution to the catch in the forecast year. STACFIS decided to use the catch-at-age for 1977-89 and abundance estimates from Canadian adult surveys, based on Canadian age-length keys, for the assessment of the silver hake stock. The USSR re-aged key for 1989 was not used as it was not separated by sex.

As in the previous assessment, the catch-at-age matrix used separate male and female ages and lengths adjusted to catch. Segregation of sexed samples was supported by SCR Doc. 90/04, which describes the difference in growth between the sexes as significant after age 3.

For this assessment, the age composition of the catches in 1977 to 1989 were constructed from Canadian observer sampling. The 1989 age composition by numbers in the catch was dominated by the 1985 and 1986 year-classes at ages 3 (36%) and 4 (32%).

In size distribution, a modal length of 30 cm was seen through the fishery for silver hake. In June and July of 1989 a second peak of smaller fish appeared, indicating the appearance of age 1 fish in the fishery.

ii) Research vessel indices

The Canadian July survey results were used to estimate numbers and biomass of silver hake from 1977 to 1989. Biomass has declined since 1984 and abundance in numbers since 1986. The abundance in numbers for 1986 was the highest in the series, while the abundance in 1989 is 76% of the average estimated from 1977 to 1989. The 1989 survey gave an abundance estimate of the 1985 year-class (age 4) below what had been seen in earlier surveys. This was also found in the 1988 survey. The 1986 and 1987 year-classes appear to be average in the 1989 survey. On average, the indices for 1982 to 1989 have been higher than in the period prior to 1982.

The joint USSR-Canada juvenile silver hake survey has been conducted in a consistent manner since 1981. A standardized method of calculating the index was agreed upon in 1986 (NAFO Sci. Coun. Rep., 1986, page 121) and was used to calculate the following series.

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Number/tow	579	9	232	43	285	198	102	205	132
Std. Error	0.11	0.14	0.11	0.16	0.22	0.19	0.11	0.17	0.09

The juvenile survey indicates that the 1989 year-class is similar in size to the 1987 year-class and is below the strong 1985 year-class. The 1988 and 1986 year-classes are of comparable size.

The 1988 juvenile survey showed high concentrations along the shelf slope (SCR Doc. 90/01). It was noted that this is a slightly different distribution than observed in previous years, however these data were within the core strata (60-78). No comparable distribution maps were presented for the 1989 survey.

iii) Growth

Growth studies of silver hake juveniles from surveys in 1977-88 were reviewed. Daily growth increments were related to length and provided a method to estimate the tentative dates of the main spawning which was determined to be early July. STACFIS noted that for the weight relationships, the fit was strongly dependent upon the 1985 point. In both the length and weight relationships, the cluster of 1977 and 1978 data were highly influential in determining the shape of the curves.

c) Estimation of Parameters

i) Sequential population analysis

Several formulations of the adaptive framework (ADAPT) were explored to determine the stock size in 1989. Data from age disaggregated CPUE and surveys were analyzed separately and in combination. These results suggested fishing mortalities in excess of 1.0 for ages 3-9 and some parameter estimates were not significant. Combining Canadian standardized catch rates-at-age and research vessel survey data in a single formulation of the ADAPT gave the best results for all diagnostic tests.

The initial formulations included a flat-topped partial recruitment pattern as was used in previous assessments. Using survey and commercial CPUE data, these produced survey catchability estimates that increased with age through to the oldest age. Such catchabilities should be at least stable if not declining through to the oldest ages. Exploration of the appropriate partial recruitment pattern suggested a dome. Stable catchabilities were achieved by setting F at age 9 to 10% of that on ages 3-5. The need for a dome could also reflect age dependent natural mortality (senescence).

During the model formulation, intercepts were found not to be significant and were not included in this analysis. The accepted formulation includes both survey and commercial CPUE indices in a single analysis and is summarized in Section f below.

With the exception of the age 1 abundance, all estimated parameters were significant. All the research vessel slopes were significant but the residual pattern indicated annual variation in the data. In some years all the residuals were negative (1977 and 1989) while in 1982 they were all positive. This is to be expected due to the fluctuations in yearly survey population estimates. To a lesser extent this was true for the catch rate-at-age series. Parameter correlation were low.

ii) Yield-per-recruit

Previous yield-per-recruit assessments used a partial recruitment that was flat topped at age 3+. $F_{0.1}$ was 0.464 with a corresponding yield-per-recruit of 0.063 kg. The current assessment indicates an exploitation pattern that is dome shaped with full recruitment occurring at ages 3 to 5 with F on the oldest age (9) about 10% of this value. The partial recruitment is the average of 1984-88 and weight-at-age data is the average over 1984-89.

Age	Average Weight	Partial Recruitment
1	.057	.035
2	.137	.235
3	.182	1.000
4	.224	1.000
5	.259	1.000
6	.308	.761
7	.411	.381
8	.525	.141
9	.665	.078

The current analysis estimates $F_{0.1}$ to be 0.72 with a corresponding yield-per-recruit of 0.060 kg. F_{max}, like in previous yield-per-recruit analyses for this stock is not well determined.

iii) Size structured analysis

SCR Doc. 90/49 presented a model which was fitted with a non-linear least squares algorithm. Because the author did not have the requisite size-structured catch data available, aged data were converted into length

into weight-classes. The method also used recruitment estimates from surveys and CPUE data. Two illustrative runs were performed, one without and one with survey data in the objective function. An advantage of this method is that it does not require aged data. It may also be used in "hybrid" manner when age data are available for the earlier period but not for the most recent year(s).

An illustrative length-based SPA using ADAPT with data from Scotian Shelf silver hake was reviewed. The model was used to perform two illustrative runs: one with a Canadian age-length pattern and one with a Soviet based pattern. The model was fitted to length aggregated survey data. Irrespective of the age-length pattern chosen, the runs suggested that there is little survivorship above age 4, or equivalently to sizes greater than 40 cm.

iv) Historical productivity at F0.1

A method was presented to explore $F_{0.1}$ productivity in relation to historical recruitment. The method was based on earlier work by Rikhter (ICNAF Res. Doc. 74/64 and NAFO SCR Doc. 88/04). These papers outline a method for distributing the productivity of year-classes into relative catches. The method converts a recruitment series into yield by multiplying by the yield-per-recruit (0.063 kg/recruit). The resultant series is the potential yield from these recruits if they had been harvested at $F_{0.1}$. The potential yield is distributed over ages by applying an average (by weight) catch distribution. This distribution takes the place of partial recruitment, growth and natural mortality used in traditional catch projections. The results of the analyses have been in terms of relative potential yield because the recruitment series comes from surveys that have not been corrected for catchability.

This approach was modified by taking the relative recruitment series and converting these values to absolute estimates by applying the calibration coefficient from an ADAPT SPA. These calibration coefficients have been seen to be relatively stable compared to other parameters estimated by ADAPT. For example, the coefficient from the asymptotic partial recruitment run was .099 and one from the domed partial recruitment was .091. The latter value was used for conversions.

When the research survey data age 1 estimates were corrected for gear efficiency, the $F_{0.1}$ yields ranged from 40,000 to 200,000 tons over the period 1983-91. The results were quite variable and the 1983 point was considerably lower than any other point in the series. The mean $F_{0.1}$ productivity was just over 110,000 tons. The same procedure was applied to the recruitment series from the domed SPA run. This series was about half as variable as the estimates based on the survey series alone. The mean $F_{0.1}$ productivity estimate as calculated from the modified approach was about 83,000 tons.

STACFIS noted that the calculation of historical productivity was based on the assumption that the year-classes had been fished at exactly $F_{0.1}$. On the other hand, the results of the SPA imply that higher fishing mortalities had occurred during that time. In addition, the average productivity estimates were based on average growth conditions while the catch projections were generally based on recent trends in mean weight-at-age. Finally, the historical productivity estimates are very sensitive to year-to-year variability in survey estimates and, in this particular case, are greatly influenced by the large estimate of the 1985 year-class.

In short, in both methods, $F_{0.1}$ productivity and catch projections are consistent when the same assumptions are made with respect to growth and recruitment.

d) Assessment Results

The surveys indicated that the 1988 year-class is in the range of 1.22 and 1.5 billion fish. The age 1+ population at the beginning of the year increased from about 1.6 billion fish in 1977 to about 3.7 billion in 1986 and is currently about 3.0 billion fish. The average fishing mortality (weighted by population numbers) for ages 3-5 has ranged between 0.25 to 0.81 during the 1977-89 period with no apparent trend. The weighted age 3-5 fishing mortality for 1989 was estimated to be 0.56.

e) Prognosis

i) General information

However, the fishing mortalities for 1989 are within the range of mortalities during the 1977-88 period. The yield-per-recruit analysis suggests that $F_{0.1}$ is 0.72 which indicates that fishing mortalities for 1989 are in the range of $F_{0.1}$. Calculated population size (2+) for 1989 is 280,000 tons. This is 80,000 tons less than that estimated for 1988 when the large 1985 year-class dominated the fishery.

ii) Catch projections

The population sizes from the ADAPT formulation described previously were used to project catches for 1991. The magnitude of the 1988 year-class at age 1 in 1989 was not well estimated. Both the juvenile and research vessel survey suggests that the size of this year-class is the fourth highest in the respective time series. The fourth highest in the estimated population structure from ADAPT would be the 1983 year-class at age 1 in 1989 (1.47 billion). This value was used as an estimate of the size of the 1988 year-class in 1989. The juvenile survey estimates the size of the 1989 year-class as average. Recruitment has been at a high level since 1982 and that for projection, average recruitment would be most appropriately set using the geometric average of the 1982-88 age 1 estimates from ADAPT (1.2 billion). STACFIS also noted that the average weights in the most recent years have been increasing and decided that for the purposes of projection, the mean weights for 1989 would be more representative of mean weights in 1991. The catch in 1990 is expected to be 60,000 tons (F = 0.5) and this value was used in the catch projections.

Projection of the 1991 population numbers and catch biomass using the above as input indicates that the $F_{0.1}$ (F = 0.72) catch in 1991 would be 93,000 tons. Given the uncertainties of the estimates of the sizes for the 1988 and 1989 year-classes, STACFIS advises that the TAC for 1991 be set at 100,000 tons.

f) Adapt Formulation

The parameters used in this model were;

Parameters:

- Year-class estimates

  $N_{i,1989}$ i = 1-8

- Calibration coefficients for R/V numbers

  K_i i = 1-8

- Calibration coefficients for CPUE-at-age numbers/hour

  K_i i = 1-8

Structure:

- Natural mortality = 0.4
- Error in catch-at-age assumed negligible
- F on oldest age (age 9) set equal to 10% of weighted (by population) F on age 3-5
- Intercepts not fitted

Input:

- Catch-at-age

  $C_{i,t}$ i = 1-9 t = 1977-89

- Otter trawl (TC 7) CPUE-at-age

  $CPUE_{i,t}$ i = 1-8 t = 1977-89

- Research Vessels

  $RV_{i,t}$ i = 1-8 t = 1977-89

- Log of Survey and CPUE

Objective function:

- Minimize

$$\sum_i \sum_j [(\text{obs.ln } RV_{j,t} - \text{pred.ln } RV_{j,t})^2] +$$

$$[(\text{obs.ln } CPUE_{j,t} - \text{pred.ln } CPUE_{j,t})^2]$$

Summary:

- Number of observations = 208
- Number of parameters = 36

g) Future Studies

The continuation of the joint Canada-USSR juvenile research vessel surveys is encouraged.

8. American Plaice in Division 3M (SCR Doc. 90/68, 71, 81; SCS Doc. 90/5, 12, 13)

a) Introduction

This stock has been regulated since 1974, when a TAC of 2,000 tons was agreed. That TAC has been maintained since then with the exception of 1978, when the TAC was set to 4,000 tons. Until 1985 landings were between 600 and 1,900 tons, with an increase since then due mainly to the EEC catches (Spain and Portugal) resulting in landings between 2,861 and 5,600 tons. The catch in 1989 was 3,895 tons, 3,397 tons of which was taken by EEC-Spain and EEC-Portugal.

The exploitation level of this stock is not accurately known because of the lack of information of by-catches from vessel fishing cod in this area or catches directed to this species by non-member vessels. Recent TACs and nominal catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	2	2	2	2	2	2	2	2	2	2	2
Catch	1.2	0.6	1.1	1.9	1.3	1.7	3.8	5.6	2.8[1]	3.9[1]	

[1] Provisional data.

b) Input Data

i) Commercial fishery

Length compositions for the Spanish catches were available for four months in 1988, as well as age compositions for two months in 1989. Age 6 and older dominated the Spanish commercial catches in 1989.

ii) Research vessel surveys

The USSR surveys showed a relatively stable biomass (7,500-9,300 tons) from 1983 to 1987, without taking into account the high value obtained in 1986 that was considered an anomaly. Total biomass estimations from the EEC surveys for 1988 and 1989 remained at a stable level, with values of 11,868 and 10,533 recorded along with the presence of a strong year-class from 1986, this year-class will not recruit until 1992.

c) Prognosis

STACFIS noted that both surveys indicated a slight decrease in the biomass from 1988 to 1989. Nevertheless those figures may not reflect a real decline in the total biomass of this stock, due to the observed high variability in the American plaice biomass indices, and STACFIS interpreted those indices as the biomass being stable at around 10,000 tons. Therefore STACFIS advises that the TAC for 1991 be set at 2,000 tons corresponding to an exploitation rate of 20% of the present biomass level. Previous yield-per-recruit studies have indicated that this exploitation level could correspond to the $F_{0.1}$ level.

d) Future Studies

STACFIS noted that there are now substantial survey data available on this stock at some national laboratories. STACFIS recommends that *survey data, particularly*

9. American Plaice in Divisions 3L, 3N and 3O (SCR Doc. 90/71, 76, 80; SCS Doc. 90/07, 08, 12, 13)

a) Introduction

This stock has been exploited consistently since the early-1950s, with the peak catch of 94,000 tons in 1967. Vessels from the USSR took substantial catches during 1965-76, while Canadian vessels accounted for over 90% of the catch during 1976-82. Starting in 1982, other nations increased their involvement in the fishery, taking catches in the NAFO Regulatory Area on the Nose and Tail of the Grand Bank. These catches escalated rapidly from about 1,200 tons in 1982 to 27,000 tons in 1986, then declined to about 12,000 tons in 1988-89. Overall, catches have declined from about 65,000 tons in 1986 to about 44,000 tons in 1989. Catches by EEC-Spain (10,895 tons) and Canada (27,892 tons) accounted for almost 90% of the total in 1989, which was similar to 1988. The Canadian catch in 1989 was up by 1,000 tons over 1988, but these 2 years had the lowest Canadian catches since 1963. The Spanish catch declined from over 14,000 tons in 1987 to 9,000 tons in 1988, before increasing in 1989. Catches by USA vessels have been relatively stable around 1,200 tons during 1985-89.

The catch in Div. 3L in 1989 was 21,700 tons, an increase of about 3,300 tons from 1988. This was similar to the catches in Div. 3L during 1983-85, but substantially less than the 33,000 tons removed in 1987. The catch in Div. 3N was between 16,000-18,000 tons during 1987-89, and was about half the 1986 level, which was close to the highest observed in Div. 3N. The catches in Div. 3O have been relatively stable around 5,000 tons in the last 5 years.

The 1986 and 1987 catch statistics are now final, and in addition, there were revised estimates of catches by non-reporting, non-member countries from Canadian surveillance authorities. This caused minor revisions to be made to the catches for 1984-85, with increases of about 3,700 tons, 2,300 tons, and 3,400 tons to the catches for 1986, 1987 and 1988 respectively. These changes were mainly in the South Korean catches, based on a revised estimate of the amount of American plaice in the catches reported as "unspecified flounder". No surveillance estimates were available for 1989, and South Korea had not yet reported its catch to NAFO for that year. Therefore, a figure of 3,100 tons was assumed for South Korea and the non-reporting countries in 1989, based on the levels of catch estimated for these nations in 1987-88. The catches by countries such as Panama and Cayman Islands, which accounted for an estimated total of over 4,000 tons in 1985 and 1986, have been estimated as zero during 1987-89, as effort shifted into deeper water for redfish.

Recent TACs and nominal catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	47	55	55	55	55	49	55	48	40[1]	30.3	24.9
Catch	49	50	51[2]	39[2]	39[2,3]	54[2,3]	65[2,3]	55[2]	42[2,3,4]	44[3,4]	

[1] Although the TAC was set at 40,000 tons, Canada reduced its domestic quota to 33,000 tons, therefore the effective TAC was 33,585 tons.
[2] Includes a percentage of the "flounder non-specified" catch reported to NAFO by South Korea.
[3] Includes estimates of catch based on surveillance reports.
[4] Provisional data.

b) Input Data

i) Commercial fishery data

Catch and effort. Data from the Canadian commercial fishery in Div. 3LNO from 1956 to 1989 were analyzed using a multiplicative model to obtain a catch-rate series. The data were from Canada (N) trawlers, tonnage classes 4 and 5, and the same procedure was followed as in the recent assessments of this stock. As has been noted previously, these were the only catch and effort data available for some years (e.g. late-1970s and early-1980s) from which a CPUE series could be calculated. The results showed a continuous decline for the first 20 years of the series to a low level in 1975-77. There was a gradual increase to 1980, and catch rates remained stable at that level until 1985. In 1986, the CPUE declined by about 25%, and has remained at this lower level over 1987-89. The current CPUE is at the same level as the previous low observed in the mid-1970s.

Catch-at-age and mean weights-at-age. Catch-at-age was calculated from the length frequencies of the Canadian, Spanish and USA catches in 1989. The major age groups in these 3 fisheries were 9-11, 4-6, and 8-10 respectively. The proportion of the catch at each age for Canada and USA was similar to that observed in 1988, but the Spanish catch in 1989 contained proportionally more fish at younger ages than in 1988. Approximately 71% of the Spanish catch in numbers in 1989 was at ages 2-6, compared to less than 1% at these ages in the Canadian catch. In 1988, the peak ages in the Spanish catch were 6-8, with about 37% of the catch numbers coming from ages 6 and younger.

To derive the total catch-at-age for 1989, the catch-at-age for EEC-Spain and USA in Div. 3NO was combined and adjusted to reflect a total catch of 12,255 tons, which included the unsampled catches in the Regulatory Area (Tail of the Bank). This was then added to the catch-at-age calculated for EEC-Spain in Div. 3L and Canada in Div. 3LNO. The resulting catch-at-age was bimodal, with peaks at ages 4-5 (total of 25.6 million fish) and ages 9-10 (total of 26.4 million fish). Overall, there was about 40% more fish in the 1989 catch compared to 1988, even though the nominal catch was only about 5% higher in 1989. The Spanish fishery caught about 10,600 tons, comprised of about 38 million fish, compared to a catch of 27,900 tons and 40 million fish in the Canadian fishery. The number of older fish (age 11+) in the catch declined in 1989, and was at a level similar to the lowest observed for this stock since 1974.

Some corrections to the 1986-88 catch-at-age were necessitated by the revisions to the catches in these years. In addition, it was decided to adjust the non-sampled catches in Div. 3N to the total non-Canadian catch-at-age, rather than to the total available catch-at-age. This was viewed to be a more reasonable approach in estimating the catch-at-age for the non-reported and non-sampled catches in the Regulatory Area in Div. 3NO. These changes produced more fish at all ages in 1986-87, and proportionally more fish at younger ages in all 3 years, because the available sampling of catches in the Regulatory Area was more skewed toward younger fish than was the overall catch-at-age.

The mean weights at ages 9+ were relatively stable in recent years, but the weights at ages 5-8 showed a decline from 1987 to 1989. This was likely to be caused by the change in selectivity brought on by the shift in the catch to younger ages over this time period.

The size of American plaice in the Spanish catches, along with information presented on selectivity of mesh sizes for American plaice, indicated that the effective mesh size being used in some fisheries in the Regulatory Area was well below the minimum size, and may be as low as 60 mm. Information from the Canadian fishery in 1988 showed that the discard rates of American plaice were less than 4% (by number) in almost all areas of the Grand Bank.

Catch-rate-at-age. An index of CPUE-at-age was calculated from the Canadian commercial fishery in Div. 3LNO. This was derived from the Canadian catch-at-age divided by the effort from the Canadian fishery. This effort was calculated from the multiplicative model described earlier, by dividing the estimated annual catch rate by the total Canadian catch. This index shows a lower stock size in 1986-89, particularly at ages 11+ compared to the estimates of the early to mid-1980s.

Fishing effort used to derive the index at age should relate only to offshore catches. The total Canadian catch used, includes about 10% from inshore areas. It was concluded that the inclusion of this relatively small amount of inshore catch would not be likely to bias the current results, but should be adjusted for the next assessment of this stock.

ii) Research vessel surveys

Canadian stratified-random groundfish surveys. Data from spring surveys in Div. 3L, 3N and 3O were available from 1971 to 1990, excluding 1983. In Div. 3L, the biomass remained relatively stable from 1985 to 1988, ranging from 174,000 tons to 193,000 tons. However, the estimate for 1989 was lower at 153,000 tons and the 1990 value is much lower at about 83,000 tons. In Div. 3N, the estimate of biomass declined from about 60,000 tons in 1984-85 to about 30,000 tons in 1990. In Div. 3O, the biomass fluctuated between 44,000 tons and 77,000 tons in the 1984-90 surveys, with the 1990 estimate being about 53,000 tons.

To examine the biomass in the NAFO Regulatory Area in Div. 3N (Fig. 11), all the 200 fathom (368 m) strata which have all or almost all their area in that zone were selected. These strata showed a decline from a mean

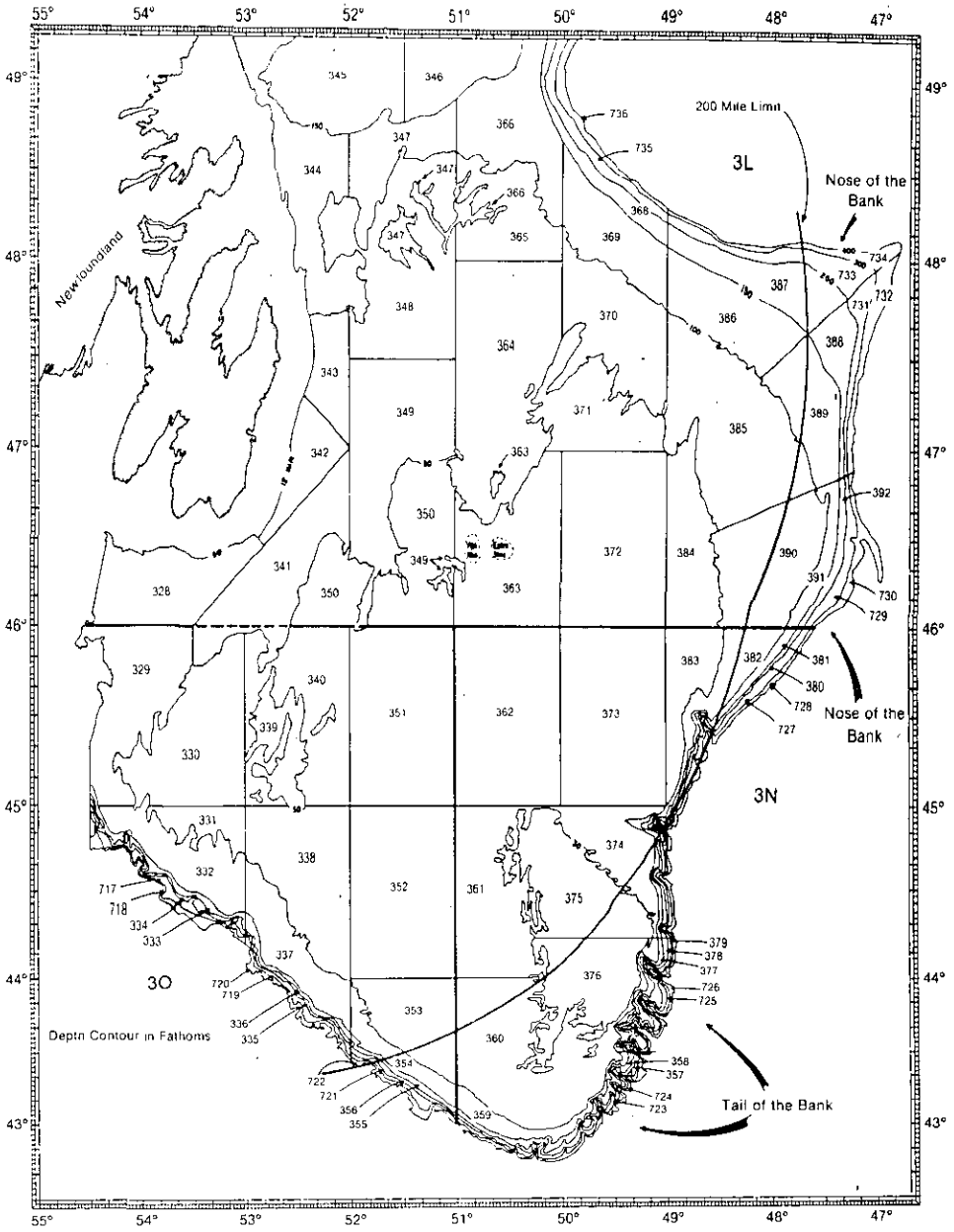


Fig. 11. American plaice in Div. 3LNO: strata in the Regulatory Area.

about 26% of the total biomass in Div. 3N. This figure declined to about 12% in 1987-88 and rose to about 20% in 1989-90.

Age-by-age abundance estimates for Div. 3L, 3N and 3O for the 1971-89 period were derived using multiplicative models to fill in values for strata not fished in a given year. This procedure was the same as that used in the 1989 assessment. Data for 1990 could not be used at this time because the survey was just recently completed and ages were not yet available for the American plaice catches.

In Div. 3L, the abundance in recent years was considerably lower than that observed from 1976 to 1982, when a number of strong year-classes were present in the population. Although the surveys during 1986-88 indicated that the 1979-1981 year-classes were somewhat higher than the preceding few, the estimates of these year-classes in the 1987 and 1988 surveys were still below the estimates observed for strong year-classes at the same ages in earlier surveys. These year-classes did not appear to be strong in the 1989 survey in Div. 3L and it should be noted that the biomass estimate in Div. 3L from the 1990 survey was about 45% lower than the 1989 survey.

In Div. 3N, the abundance estimates have shown more fluctuation over the series, but it was again clear that the abundance during 1986-89 was

recruitment in the 1987 and 1988 surveys in Div. 3N, although the 1989 survey indicated that the 1985 year-class was the largest in the series and that the 1984 year-class was above average. The 1990 biomass was down from 1989 to about the 1988 level.

In Div. 3O, the estimates of abundance showed even more variability than in Div. 3N; however, 1986, 1988 and 1989 were the lowest three estimates in the 14-year series. In 1990 the biomass in Div. 3O was close to the mean from 1986-89.

Overall, the abundance in Div. 3LNO combined has declined in recent years to about the level observed around 1973. There was a decline in abundance from about 1 billion fish at ages 6+ in 1981-82 to about 500 million fish in 1985-86, after which time the abundance remained at the lower level. In addition, the number of older fish (age 12+) in the surveys has declined in 1987-89 to the lowest level observed.

From fall surveys in Div. 3L, population estimates in 1986-88 were lower than those from 1981 to 1984. In 1989, the population declined by about a third from the mean 1986-88 level. These surveys also indicated that the biomass in Div. 3L had declined from about 300,000 tons in 1983-84, to about 150,000 tons in 1986-88, and to about 100,000 tons in 1989.

Canadian juvenile flatfish surveys. Stratified-random surveys of Div. 3LNO have been conducted inside the 50 fathom depth contour from 1985 to 1988 and expanded out to 100 fathoms in the 1989 survey. In the 1989 survey the largest catches of juveniles aged 1-4 years were taken in the Regulatory Area in Div. 3NO, consistent with previous surveys. Two other sites were identified as areas of major concentrations of juveniles: stratum 339 in Div. 3O in the area known as Whale Deep, and the strata located on the north and northeast slope of Div. 3L in depths up to 90 fathoms. The area of concentration of adult plaice corresponded to the juvenile concentrations.

Abundance-at-age estimates in stratum 360 doubled in 1989 and was the highest in the time series. These estimates were dominated by the 1985 and the 1986 year-classes (age 3 and 4 years) which made up 56% of the total abundance. These two year-classes were also dominant in the other areas of the Bank. The 1985 year-class was also indicated to be strong at ages 1, 2, and 3 in the 1986 to 1988 surveys respectively. The total biomass in Div. 3N increased by 33% from 1988 to 1989 and about 84% of the biomass in Div. 3N was found in stratum 360 in the Regulatory Area.

USSR stratified-random surveys. Results from USSR surveys in Div. 3LNO were available for the period 1983-89. After a decline in 1988, the abundance increased in 1989 to the same level as the mean in 1985-87. This value was about half of the mean abundance in 1983-84. The biomass also increased in 1989 to about the level of 1987. This was about 70% of the mean biomass in 1985-86, and about 40% of the mean in 1983-84.

c) Estimation of Parameters

i) Sequential population analysis (ADAPT)

The catch-at-age from 1975 to 1989, the abundance-at-age from the Canadian groundfish surveys, and the CPUE-at-age from the Canadian commercial fishery were used in the Adaptive framework. In the first formulation attempted, the RV survey data were used to estimate population numbers at ages 6-15. All parameter estimates were significant and the catchabilities (slopes) were relatively stable over ages 9-14. However, the population numbers estimated at ages 9-12 implied fishing mortalities on these ages which were outside the range of any previously observed, and were therefore not considered to be reasonable. The CPUE data were then used in a separate formulation, also to estimate population numbers at ages 6-15. Again, all parameters estimates were significant, although the coefficients of variation on the abundance estimates were higher than in the formulation with the RV data alone. For the younger ages (6-8), the fits of ln CPUE *vs* ln SPA numbers were poor and took the form of 2-point regressions, with the 1989 point being separate from the other points. Examination of the population numbers showed the sizes of the 1981-83 year-classes to be substantially lower than historic values and were thus not considered to be realistic.

It was decided to combine the 2 indices into a single formulation of ADAPT (see Section f below). For the RV surveys, ages 6-14 were chosen, and for the C/E, ages 9-14 were chosen. Ages 15-18 were excluded from the calibration because there were few fish at these ages in either of the indices, and ages 6-8 were excluded from the CPUE calibration series for the reasons outlined above. All parameters estimates were significant,

with coefficient of variation on the abundance estimates at ages 8-13 of 20% or less. However, the fits generated patterns of residuals as was seen in the 1989 assessment. There are no high correlations between parameters.

STACFIS concluded that this formulation of ADAPT was the most reasonable. This approach was considered to be better than the one used in 1989, when catch-rate-at-age data were not available and the CPUE calibration used aggregate biomass at ages 12+. In addition, the approach used this year estimated the population sizes within a single ADAPT formulation, as opposed to selecting appropriate population sizes from 2 separate calibrations, as was done in 1989.

ii) Yield-per-recruit

STACFIS noted that the shift in the exploitation pattern to younger ages would have an effect on the reference F levels for this stock and advised that a new Y/R analysis be conducted. It was noted that the most dramatic change in the catch-at-age occurred from 1988 to 1989. However, it was not considered reasonable to use the parameters from just one year (1989) in a Y/R analysis, as this year may have been anomalous, with the possibility that the fishery in subsequent years would not produce the same exploitation pattern. Therefore, it was more reasonable to average the mean weights-at-age and partial recruitment values over a recent period (1987-89), acknowledging that this reflected neither the long term values for the stock nor the situation in 1989, but was likely to be closer to the present situation. Figure 12 shows the new Y/R analysis, using the mean weights-at-age and partial recruitment values in Table 8 and an age range of 5-16. A similar analysis in the 1989 assessment used the long-term average weights and partial recruitment is also shown in Fig. 12 for comparison. The $F_{0.1}$ reference point is similar in both analyses, but the F_{max} is 0.51 in the new analysis, compared to 3.1 in last year's. The sensitivity of F_{max} to changes in the Y/R parameters has been noted previously for this stock.

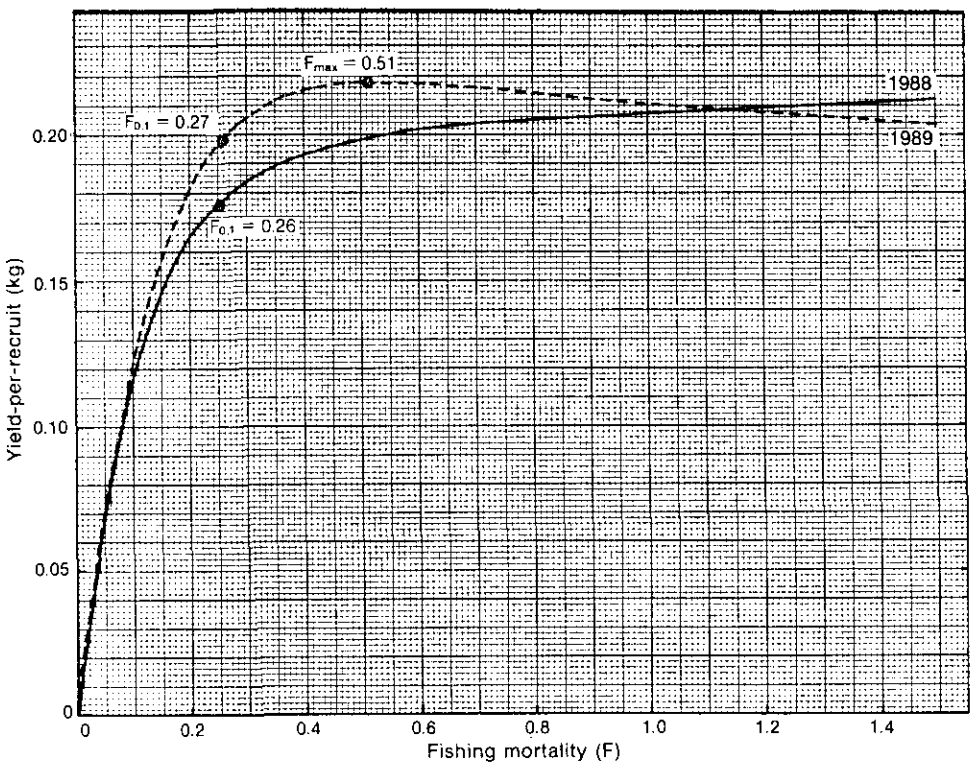


Fig. 12. American plaice in Div. 3LNO: yield-per-recruit for a range of fishing mortalities from 1988 and 1989 assessments.

Table 8. American plaice in Div. 3LNO: parameters used in projections of biomass and yield.

Age	Jan 1, 1990 population numbers (000)	Average weight (kg)	Partial Recruitment
5	213,000	0.167	0.048
6	162,890	0.244	0.070
7	134,120	0.334	0.115
8	93,048	0.424	0.180
9	77,181	0.491	0.408
10	46,371	0.621	0.675
11	24,256	0.807	1.000
12	9,345	1.068	1.000
13	4,505	1.403	1.000
14	2,515	1.762	1.000
15	1,336	2.235	1.000
16	569	2.923	1.000
17	150	3.625	1.000
18	15	4.319	1.000
19	5	4.500	1.000
20	0	4.600	1.000

d) Assessment Results

This assessment indicated that fishing mortality (F) increased from a relatively low level in 1983 to a peak in 1987, then declined subsequently (Fig. 13). The Fs in 1988 and 1989 were about 0.38 for ages 9+ and about 0.6 for ages 11+ (fully recruited), with both estimates being weighted by population numbers-at-age. The estimates for F in 1988 were about 20% higher than those calculated for 1988 in last year's assessment. STACFIS noted the increase in F on the younger ages (5-7) in 1989 and that these values were at or around the highest levels in the series from 1974-89. Population size at older ages (11+) continued to decline, although there was a slight increase in the estimated population sizes at ages 6-10 in 1989 over 1988. The estimated spawning stock biomass (Age 9+, knife-edge) was about the same in 1988 and 1989, at the lowest level since 1974 (Fig. 14). The assessment indicated that there has been a slight increase in recruitment in recent years (Fig. 14) with the 1980 and 1981 year-classes being about 15-20% larger than those from 1976 to 1978. However, the 1980 and 1981 year-classes were still estimated to be about 25-30% smaller than those from 1969 to 1971.

e) Prognosis

i) General information

Although the catch was lower in 1988-89 than the preceding 3 years, the TAC was exceeded by about 25% in 1988 and 30% in 1989. This is of concern, given that some fisheries in the Regulatory Area were catching large quantities of juvenile American plaice. STACFIS again cautions that this fishery will be all but impossible to manage if catches by non-member countries increase beyond the levels observed in 1988-89.

ii) Catch projections

The population sizes from the ADAPT formulation described previously were used to project catches for 1990. The population at age 5 in 1989 and 1990 was taken as the geometric mean from 1974 to 1988. The average weight-at-age and the partial recruitment were averages from 1987 to 1989 (Table 8).

The partial recruitment values were generally higher at ages 5-11, reflecting the shift in the catch in 1989 to younger ages. However, it was noted that these partial recruitment values were likely to be underestimates of the partial recruitment in 1989 at the youngest ages (5-6).

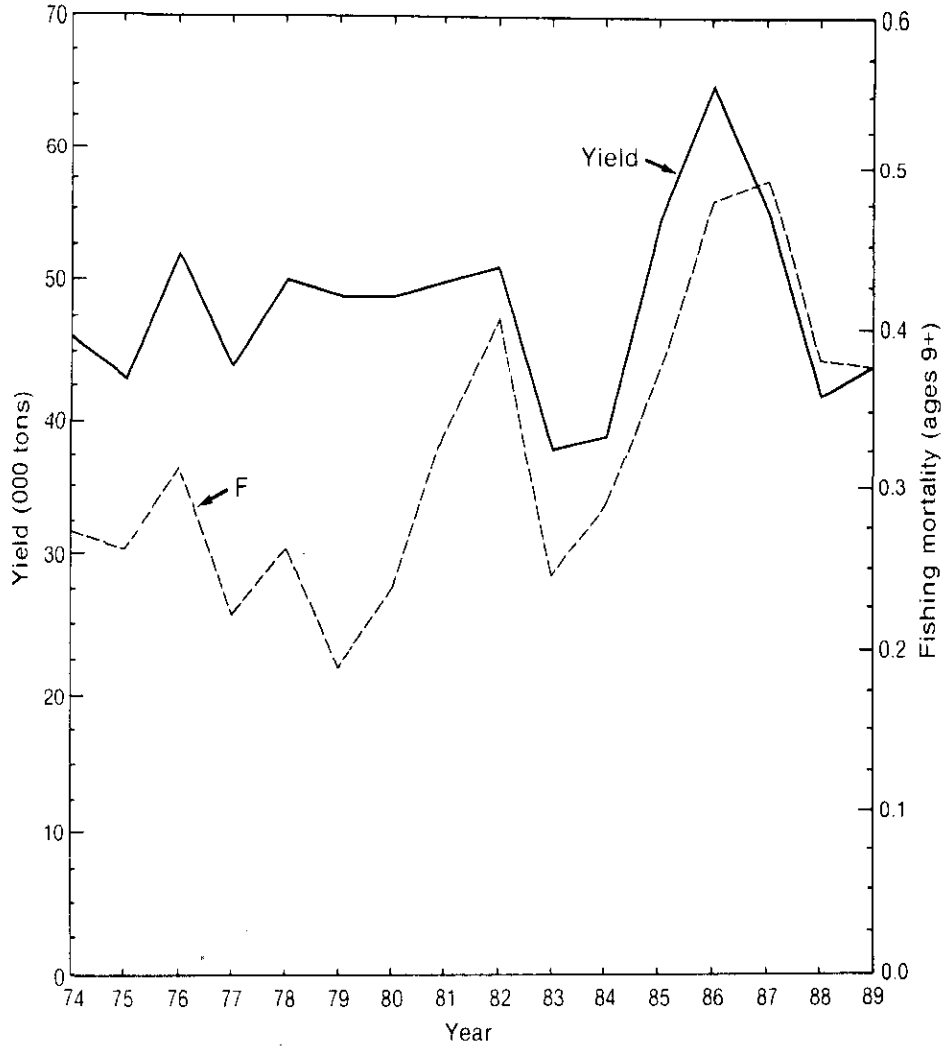


Fig. 13. American plaice in Div. 3LNO: trends in yield and 9+ F (weighted by population numbers).

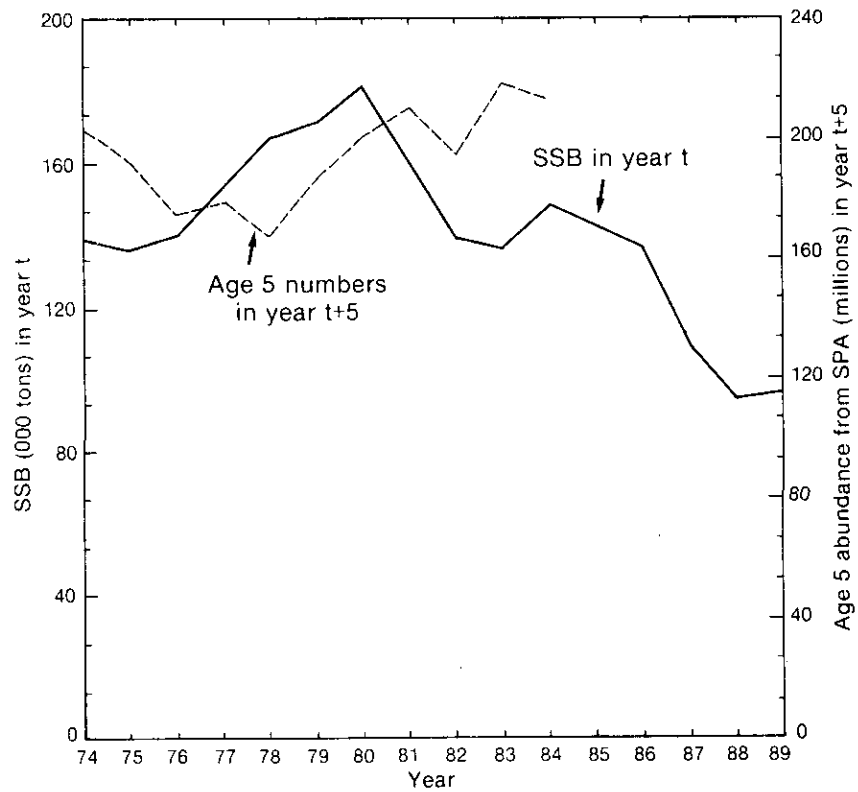


Fig. 14. American plaice in Div. 3LNO: trends in SSB and SPA abundance at

Tables 9 and 10 show the results of catch projections to 1991, assuming catches in 1990 of 24,900 tons and 40,000 tons respectively. The first option represents the catch in 1990 equal to the TAC while the second option assumes the catch in 1990 will be similar to the level observed in 1988-89.

Table 9. American plaice in Div. 3LNO: projected catch in 1991 and spawning stock biomass (SSB) on Jan 1, 1992 at various F levels, assuming 1990 catch = 24,900 tons (Fig. 15).

SSB, Jan 1, 1990 (tons)	SSB, Jan 1, 1991 (tons)	1990 Catch (tons)	1990 F (Age 11+)	F in 1991	Catch in 1991 (tons)	SSB, Jan 1, 1992 (tons)
100,800	116,400	24,900	0.31	$F_{0.1}$ = 0.27	25,800	136,700
				F_{max} = 0.51	45,200	119,200
				F_{89} = 0.60	51,700	113,400

Table 10. American plaice in Div. 3LNO: projected catch in 1991 and SSB on Jan 1, 1992 at various F levels, assuming 1990 catch = 40,000 tons (Fig. 16).

SSB, Jan 1, 1990 (tons)	SSB, Jan 1, 1991 (tons)	1990 Catch (tons)	1990 F (Age 11+)	F in 1991	Catch in 1991 (tons)	SSB, Jan 1, 1992 (tons)
100,800	103,100	40,000	0.54	$F_{0.1}$ = 0.27	22,900	124,600
				F_{max} = 0.51	40,100	109,200
				F_{89} = 0.60	45,900	104,100

STACFIS concluded that the second option was more realistic and advised that Table 10 be used in providing advice for this stock, pointing out that these 2 options were provided last year, but that the TAC for 1990 had been based on option 1.

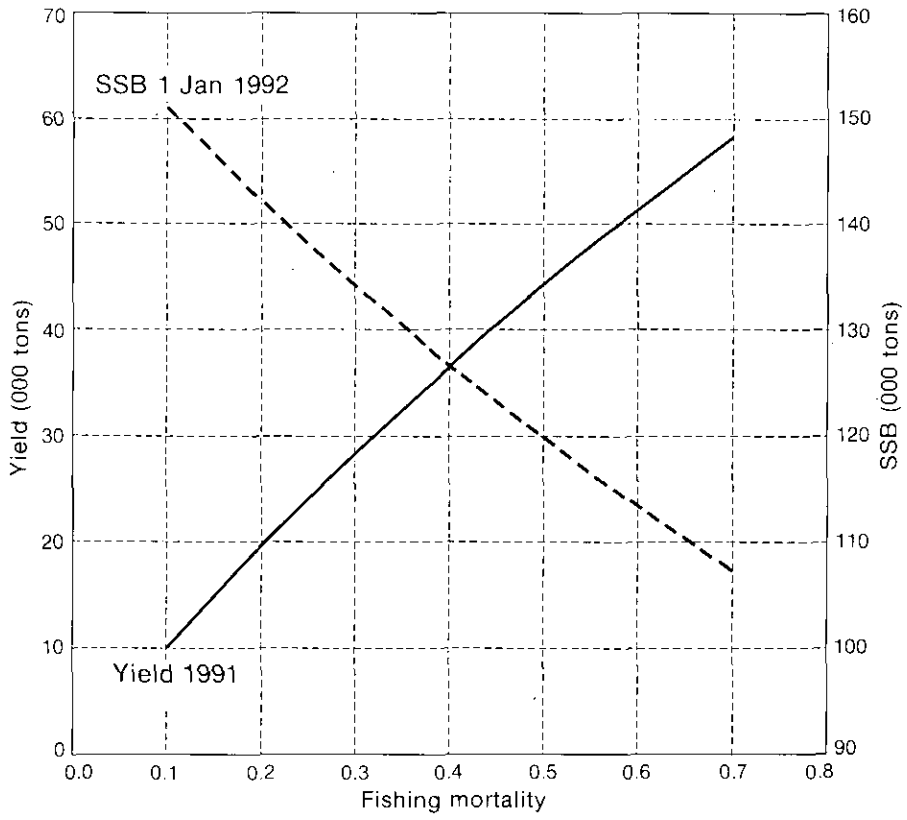


Fig. 15. American plaice in Div. 3LNO: projection of catch for 1991 and SSB at 1 January 1992 (assumed catch for 1990 = 24,900 tons).

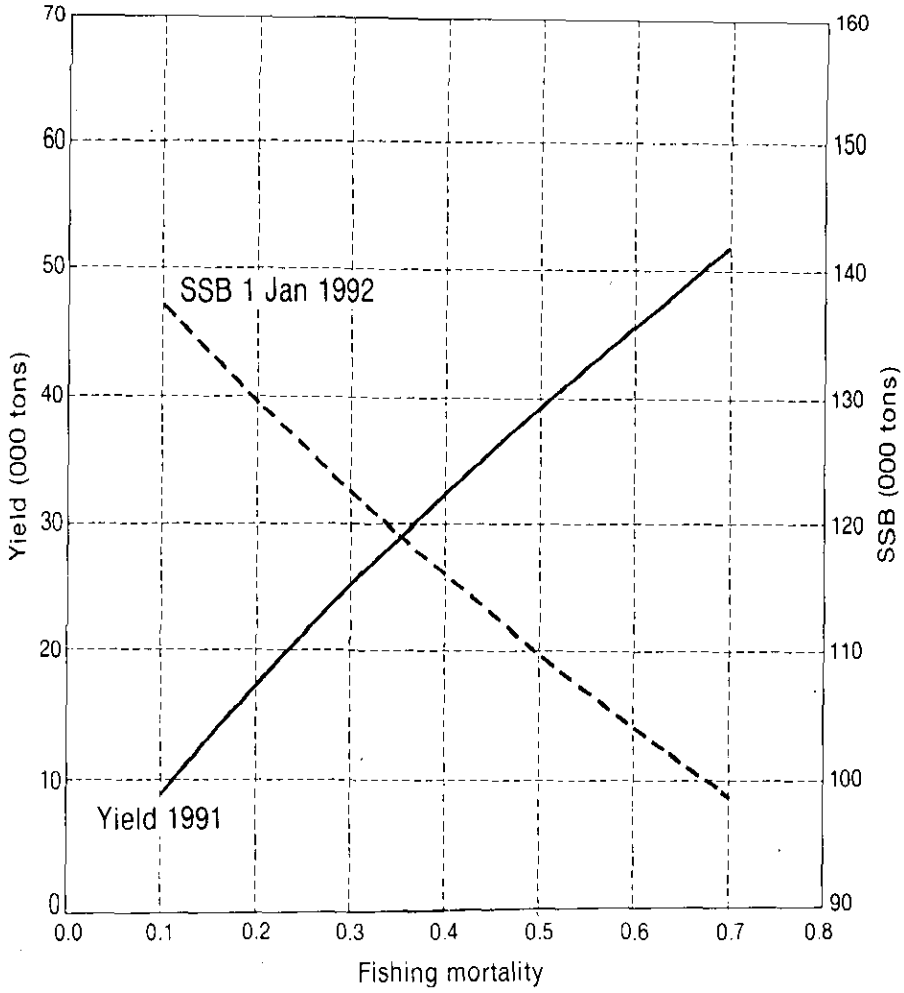


Fig. 16. American plaice in Div. 3LNO: projection of catch for 1991 and SSB at 1 January 1992 (assumed catch for 1990 = 40,000 tons).

STACFIS notes that these projections do not reflect the exploitation pattern of 1989, although they do reflect a shift toward younger fish. It was also noted that there was a catch of about 1,200 tons at ages 3 and 4 in 1989 and that no estimate of catch at these ages is accounted for in the catch projections.

f) Formulation of the Adaptive Framework

Parameters:

- Year-class estimates

  N_i 1989 i = 6, 14

- Calibration coefficients for R/V numbers

  $q1_i$ i = 6, 14

- Calibration coefficients for C/E numbers

  $q2_i$ i = 9, 14

Structure:

- M = 0.2
- Error in catch-at-age assumed negligible
- F on ages 16-18 set to mean F weighted by population numbers on ages 12-15
- Age 5 estimated by partial recruitment
- Intercepts not fitted

Input:

-	$C_{i,t}$	i = 5, 18	t = 1975-89	Catch-at-age
-	$RV_{i,t}$	i = 6, 14	t = 1975-82, 1984-89	R/V numbers-at-age
-	$C/E_{i,t}$	i = 9, 14	t = 1975-89	C/E-at-age

Objective function:

- Minimize

$$\sum_{it}\sum [\text{obs } (\ln RV_{it}) - \text{pred } (\ln RV_{it})^2] + \sum [\text{obs } (\ln C/E_{it}) - \text{pred } (\ln C/E_{it})^2]$$

Summary:

- Number of observations = 216
- Number of parameters = 24

10. Witch Flounder in Divisions 3N and 3O (SCR Doc. 90/54, 57; SCS Doc. 90/05, 12, 13)

a) Introduction

Reported catches of witch flounder from 1970-84, ranged from about 2,400 tons in 1980 and 1981 to 9,200 tons in 1972. With increased effort mainly by EEC countries in 1985 and 1986, particularly EEC-Spain and EEC-Portugal, catches rose rapidly to 8,800 and 8,500 tons respectively. This increased effort was concentrated mainly in the Regulatory Area of Div. 3N. Non-member countries such as the USA, Korea, Cayman Islands and Panama also contributed to increased catches. In 1987 and 1988, the catch was 7,600 and 6,100 tons respectively, and was taken mainly by Canada, EEC (Spain and Portugal) and USSR. With reduced catch rates for flatfish generally outside the Canadian 200-mile limit, some countries diverted effort towards other species such as redfish, and this may explain some of the reduction in catch in 1987 and 1988 compared to very high levels during 1985 and 1986. The preliminary catch for 1989 was 3,612 tons which is near the lowest in 10 years, however, this would not include any catch from non-reporting countries. For catches reported, the largest portion was taken by EEC followed by Canada. Only 81 tons was reported by USSR in 1989 although historically USSR has been a major prosecutor of this fishery, particularly in Div. 3N. Recent catches and TACs ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	7	5	5	5	5	5	5	5	5	5	5
Catch	2	2	4	4	3	9	9	8	6[1]	4[1]	

[1] Provisional data.

b) Input Data

i) Commercial fishery data

Catch and effort statistics for Canada (N) from 1972 to 1988 were available from the fishery conducted in Div. 3O. Canadian catch rates declined from 0.72 tons/hr in 1972 to a low of 0.19 tons/hr in 1979. Between 1979 and 1984 catch rates fluctuated from 0.19 tons/hr and 0.67 tons/hr. The catch rates declined somewhat over the 1985-87 period, but, were still considerably above those levels experienced during the late-1970s. For 1988, on the other hand, the catch rate fell to 0.27 tons/hr near the lowest level for the period with a slight increase in 1989 to 0.31 tons/hr. It is recognized, of course, that for some years the proportion of main species catch on which the figures are based is very low and the precision of such data as indices of stock size is questionable.

ii) Research vessel surveys

Annual estimates of biomass from Canadian surveys in Div. 3N were most often less than 1,000 tons since 1971 which is generally below the reported catch levels and it was noted that since the surveys did not cover depths beyond 366 m, much of the biomass was not estimated. On the other hand, USSR surveys during 1987-89 indicated that, while biomass estimates were

somewhat higher than those of the Canadian surveys, they were still below reported catch levels although the surveys were conducted to depths of 731 m. It was clear therefore that the surveys in Div. 3N were not adequate for witch flounder. Survey biomass estimates were much higher for Div. 3O but showed a higher degree of variability. It was observed that high variations in biomass were generally related to differences in stratified estimates for those strata near the southwestern slope of the Grand Bank. It was therefore considered that the fluctuations in biomass in Div. 3O may be largely a result of distributional changes as fish move in and out of the survey area near the continental slope.

c) Catch Projections

Considering the commercial fishery data, STACFIS concluded that the stock component in Div. 3O may have declined since 1985, however, the information was based upon small proportions of the total removals. With the high variability in estimates of biomass from surveys in Div. 3O and concerns expressed regarding the reliability of surveys in Div. 3N, STACFIS was unable to draw firm conclusions regarding stock size. With the information available, STACFIS advises that the TAC for 1991 should not be changed from the 5,000 ton level presently in effect.

STACFIS reiterates its concern about the high catch levels in the mid-1980s, particularly in Div. 3N, and considered that the recent declining trend in catch levels may be a reflection of a reduced stock size.

d) Future Research

STACFIS reiterates its recommendation that *countries fishing the witch flounder stock in Div. 3NO should collect catch and effort information as well as length and age data and present them to NAFO to allow for a better evaluation of the status of this resource.* Of particular importance is information on precise locations of commercial activity in order to better interpret survey results.

11. Yellowtail Flounder in Divisions 3L, 3N and 3O (SCR Doc. 90/85, 86; SCS Doc. 90/05, 13)

a) Introduction

Nominal catches increased rapidly from a few hundred tons in 1963-64 to a high of about 39,000 tons in 1972. Vessels from Canada and USSR took almost all of the catch, up to and including 1975, with only Canada taking significant catches during 1976-81. After 1981 several other countries entered the fishery, notably South Korea, EEC (Spain and Portugal), Panama, USA and the Cayman Islands and catches by these fleets increased up to 1986. Catches in the Regulatory Area declined in 1987-89 as effort was directed primarily at redfish. In 1989, the catch was about 7,600 tons, compared to 16,000 tons in the previous 2 years. With the TAC of 5,000 tons restricting catches, the catch by Canada in 1989 was the lowest since 1968. Except for 248 tons taken by Scottish seines, the remainder of the catch by Canada was taken by otter trawls.

The catch by EEC-Spain declined from about 3,200 tons in 1988 to about 1,100 tons in 1989. USA catches continued to decline and totalled 319 tons in 1989, down from 861 tons in 1988 and almost 3,800 tons in 1985.

Catch statistics for this stock are not adequate, with as much as 8,000 tons of catch (in 1986) being estimated from surveillance reports. Although it is felt that the catch by non-member, non-reporting nations had declined in 1989, it was pointed out that there were no surveillance estimates of catch in 1989 and that an estimate of 100 tons was used for this part of the catch, in addition to an estimate of 1,000 tons for the South Korean catch. Recent TACs and nominal catches ('000 tons) are as follows:

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	18	21	23	19	17	15	15	15	15	5	5
Catch	12	15	13[1]	10[1]	17[1,2]	29[1,2]	30[1,2]	16[1]	16[1,2,3]	8[2,3]	

[1] Includes a percentage of the "flounder non-specified" catch reported to NAFO by South Korea.
[2] Includes estimates of catch based on surveillance reports.
[3] Provisional data.

b) Input Data

i) Commercial fishery data

CPUE data. A multiplicative model was used to analyze the catch and effort data for this stock as in the 1989 assessment. It should be noted that for some years, particularly the late-1970s, the Canadian fleet provided the only source of CPUE data for this stock. The CPUE declined steadily from 1965 to 1975, increased slightly in the 1983-85 period, then declined to a low but stable level in 1986-89. The CPUE observed in these recent years is similar to the previous low values in 1974-76.

Although this CPUE index did cover the majority of the stock, it was likely to underestimate the recent decline in the stock as a whole, as the Canadian fleet rarely fished for yellowtail flounder in the Regulatory Area, where catches have declined sharply since the high values in 1985 and 1986.

Catch-at-age and mean weights-at-age. Catch-at-age was calculated from the length frequencies of the Canadian, USA and Spanish fisheries in 1989. Age-length keys from the Canadian commercial fishery were used to calculate the USA catch-at-age, while keys from the Canadian RV surveys were required for the Spanish data, as the length frequencies of these catches contained fish smaller than those found in the Canadian fishery.

In the Canadian catch, ages 7 and 8 comprised about 40 and 42% respectively of the catch numbers, which was similar to the proportion at these ages in recent years. In the USA catch, ages 6 and 7 predominated, which was similar to the pattern observed in 1988. For EEC-Spain, age 4 yellowtail flounder comprised 53% of the catch in numbers, with 26% taken at age 5. These percentages were similar to those observed in the 1988 fishery at these ages (45% and 28%). Overall, there were about 12 million fish in the Spanish catch of 1,126 tons, compared to about 10 million fish in the Canadian catch of 5,007 tons. Information from the Canadian fleet for 1988 indicated that the discard rate of yellowtail flounder by this fleet did not exceed 3% anywhere on the Grand Bank.

The mean weights-at-age were derived from the Canadian, USA and Spanish catches in 1989. For the Canadian weights, there was very little difference between years at ages 5-9 over the period examined (1986-89). The weights-at-age in the Spanish catch were lower in 1989 than 1988 at ages 3-4 and slightly higher at ages 5-6. Compared to the Canadian and USA weights-at-age, the Spanish weights were lower at ages 5-6, similar at age 7, and higher at ages 8-9.

STACFIS reviewed some recalculations of catch-at-age for 1988 and noted that substantial changes in the numbers of fish caught at age were obtained, based on the re-application of sampling data to estimated and unsampled catches. There are large portions of unsampled catch in some years (e.g. about 13,400 tons in 1986), and even the catch levels themselves contained a high proportion of estimates in some years.

In addition, it was noted that all the catch-at-age calculations applied to length frequencies collected in the Regulatory Area were done using age-length keys from the Canadian RV surveys, and that this would likely introduce biases in the estimated sizes-at-age. For these reasons, STACFIS concluded that the overall catch-at-age in recent years for this stock was not suitable for use in sequential population models. For these same reasons, the overall mean weights-at-age for the stock for recent years should also be treated cautiously.

ii) Research vessel surveys

Canadian stratified-random groundfish surveys. Surveys have been carried out by Canadian research vessels in Div. 3LNO each year from 1971 to 1982 and 1984 to 1990. The surveys from 1984 to 1990 are comparable in terms of coverage and vessel/gear used. Most of the biomass of this stock is found in Div. 3N. In this Division, the biomass has declined from about 60,000 tons in 1985-86 to about 35,000 tons in 1988-89 with an increase in 1990 to 42,000 tons. Overall, the stock biomass (Div. 3LNO) decreased steadily from 94,000 tons in 1985-86 to 49,000 tons in 1989 with the 1990 survey being about 16% higher at 59,000 tons.

In strata 360 and 376 (Fig. 17) which encompasses virtually all the yellowtail flounder habitat in the Regulatory Area, the biomass declined from 32,000 tons in 1984 to 1,000 tons in 1988 (97% decrease). In 1989 the estimate increased to 15,000 tons (40% of total biomass of Div. 3N) but in 1990 the estimate has decreased to 6,000 tons (14% of the total biomass) in the Regulatory area.

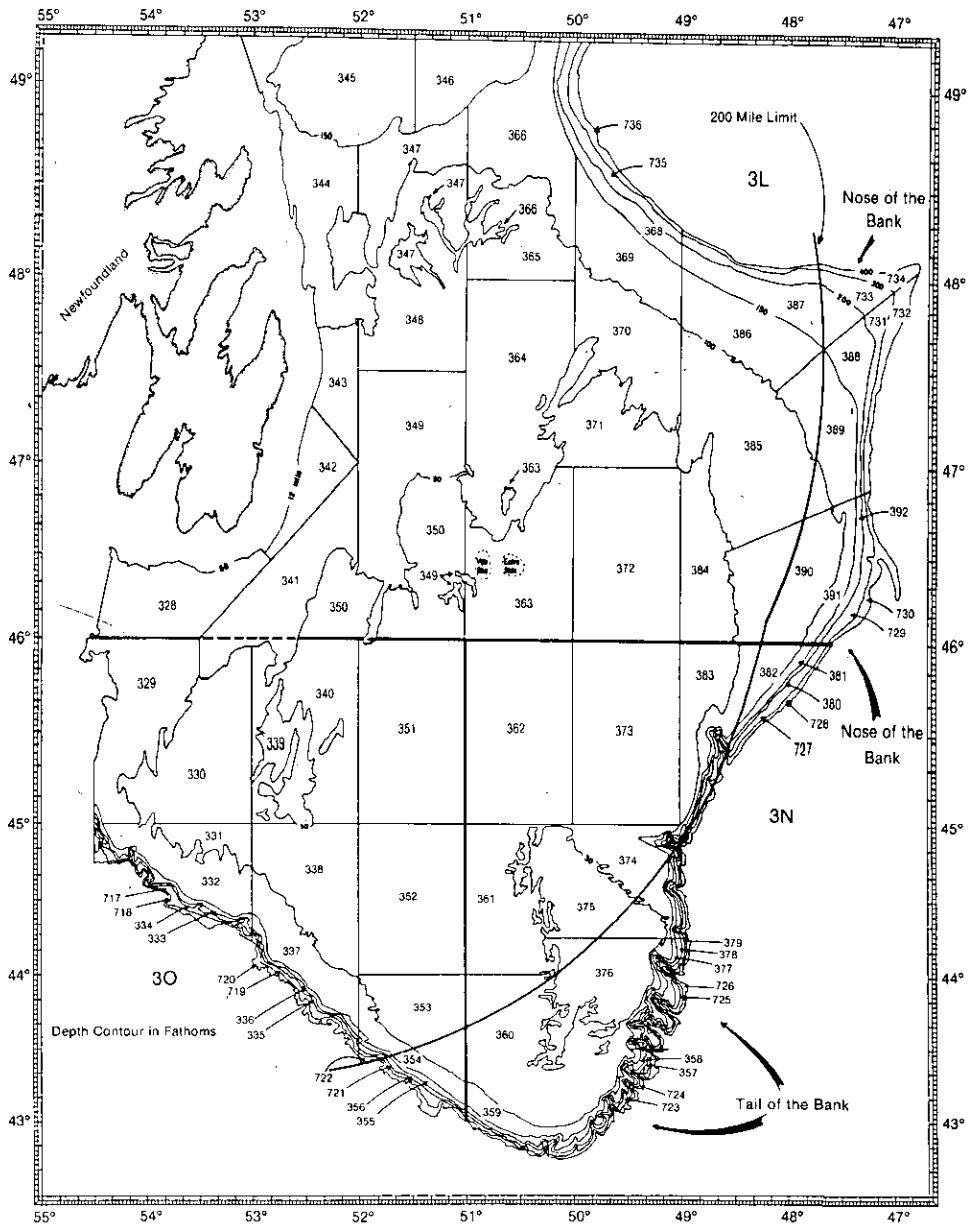


Fig. 17. Yellowtail flounder in Div. 3LNO: strata in the Regulatory Area.

As was done in the 1989 assessment, a multiplicative model was employed to obtain estimates of abundance which accounted for strata not surveyed in some years and included the 1990 values. As in previous years, the estimates from 1971 to 1982 were multiplied by 1.4 to make them comparable to those from 1984 to 1990. The total abundance of this stock remained relatively stable between 240 and 340 million from 1975 to 1984, after which time it declined steadily to about 100 million in 1988. In 1989, the estimate increased by 30% to 132 million and the recent survey showed a further 12% increase in numbers, but was still the third lowest value in the 19 year series. The decline from the mid- to late-1980s was also present in the groundfish surveys conducted by USSR, as was the increase in abundance from 1988 to 1989.

In the 1989 Canadian survey 90% of the total population abundance at ages 5 and 4 years (the 1984 and 1985 year-classes) in this stock was largely outside the 200-mile limit and comprised 80% of the catch-at-age in the Spanish fishery on the "Tail of the Bank". In the 1990 survey only 50% of the population of these year-classes was found in the two strata (360 and 376) outside the 200-mile limit.

The estimate of age 7+ abundance increased from 52.5 million in 1989 to 89.5 million in 1990 and comparable to the 1988 estimate. However it is still the fourth lowest estimate in the time series of 1971-90 and represents about 60% of the total abundance in 1990.

The following table summarizes the relative strengths of the 1981-85 year-classes as measured by the Canadian groundfish surveys of 1986-90. The numbers expressed in decimal units indicate the proportion that each estimate was of the mean estimate at that age from 1973-90, while the numbers in parenthesis represent the rank of that estimate in the 17 years of the survey from 1973 onward (1973-82, 1984-90):

Age	1986	1987	1988	1989	1990
5	.39(14)	.21(16)	.05(17)	.86(09)	.73(10)
6		.35(16)	.17(17)	.48(14)	.51(13)
7			.37(17)	.39(16)	.53(14)
8				.36(15)	.81(11)

The estimates in 1988 were the lowest in the series at ages 5, 6 and 7. Although there appeared to be some improvement in the relative strengths of the 1982 and 1983 year-classes in the 1989 and 1990 surveys, it was noted that all estimates were still below the mean values, as were the estimates of the 1984 and 1985 year-classes.

Canadian juvenile flounder surveys. From 1985 to 1989, annual fall stratified random surveys have been conducted in Div. 3LNO, directed at juvenile flounder, particularly those aged 1-4 years. Most of the juvenile population for this stock is located in the Regulatory Area, in Strata 360 and 376 (Fig. 17). The index of yellowtail flounder biomass declined from 1986 to 1988, but increased in 1989. In 1989, average numbers-per-tow were twice those calculated for the 1988 survey, and were comparable to the 1987 values. The catch from the 1985 year-class was the highest at age 4 in the time series and contributed to the high mean numbers in the 1989 survey. About 33% of the total abundance was attributed to this year-class. The 1986 year-class at ages 1 and 3 was approximately the same size as the 1985 year-class at ages 1 and 3, but was much lower at age 2 compared to the 1985 year-class at age 2.

The results of the juvenile surveys, which showed strong 1985 and 1986 year-classes were confirmed by comparing them with the age compositions in the Spanish fishery in the Regulatory Area in Div. 3N. The percentage of the 1986 year-class in the 1989 Spanish fishery was about the same as the percentage of the 1985 year-class in the 1988 Spanish catch.

USSR stratified-random groundfish surveys (1983-89). After declining steadily over the period 1983-88, the USSR survey in 1989 showed an increase of almost triple in abundance and about double in biomass from the very low levels of 1988. The biomass in 1989 was 10% higher than the 1986 estimate but was still only about 45% of the mean biomass in 1983-85. The abundance was about 40% higher than the 1986 value, but was still only half of the mean abundance from 1983-85.

c) Estimation of Parameters

STACFIS noted that the catch-at-age could not be used in an sequential population analysis based model for this stock. In addition, the lack of partial recruitment values (no fishing mortality estimates from SPA) and reliable weights-at-age for the stock as a whole precluded the use of a yield-per-recruit model. Therefore, it was again decided that the information contained in the indices of abundance (RV surveys and CPUE) would have to be evaluated to determine stock status.

d) Assessment Results

All 3 surveys in 1989 showed an increase in abundance from 1988, with the 1990 Canadian groundfish survey showing a further slight increase. However, the USSR and Canadian groundfish surveys still show the population size to be at a

1989, at a level similar to the lowest observed previously. The fact that the 1989 CPUE did not decline was viewed as a positive indication, given that in 1988 STACFIS noted that "the prospects for the 1989 and 1990 fisheries, which should be comprised mainly of the 1981-83 year-classes, are very poor." (NAFO Sci. Coun. Rep. 1988, page 65). This is consistent with the data in the Canadian surveys, which showed the relative strengths of the 1982-83 year-classes to be greater in both 1989 and 1990 than had been estimated in 1987-88.

The 1984 and 1985 year-classes still appeared to be stronger than the 3 preceding poor ones, but did not appear to be as strong in 1990 compared to 1989. However, substantial numbers of yellowtail flounder from these year-classes were taken in fisheries in the Regulatory Area in 1988 and 1989.

The information from 1989-90 in the RV survey and CPUE indices pointed to a slightly more optimistic view of this stock in 1990 compared to the previous two assessments. Although the stock is still at a relatively low level, there is improved recruitment from the 1984-85 year-classes, and the size of the 1982-83 year-classes appeared to be larger in 1989-90 compared to 1987-88.

In 1988, STACFIS advised a decrease in the TAC from 15,000 tons to 5,000 tons, based mainly on the mean estimate of abundance of age 5-7 yellowtail flounder in the Canadian spring surveys in 1987-88, which were estimated to be about 30% of the mean at these ages from the historic data. Although the mean estimate of abundance at these ages had increased by about 50% in the 1989-90 surveys, STACFIS concluded that this was not sufficient on its own to recommend a change in the current TAC.

In retrospect, the rationale used in 1988 to derive the 5,000 ton TAC may have lead to a somewhat pessimistic view of the resource, given that CPUE data were not considered directly in the calculation and that the 1988 survey produced the lowest estimates of the 1981-83 year-classes. Therefore, it was decided to use a modified approach in analyzing the indices of abundance, in which the current levels of the indices of abundance were compared with the levels during a period of relative stability in the stock.

From 1977 to 1984, the Canadian surveys showed a relatively stable index of abundance at ages 5-7, averaging about 200 million fish. The CPUE index during these years also showed little trend, and had a mean value of about 0.64. Catches were also relatively stable with a mean of about 14,100 tons. In the 1987 to 1990 surveys, the mean abundance at ages 5-7 was only 78 million, or 38% of the mean in the earlier period. However, the CPUE, which was stable from 1986 to 1989, had a mean value of about 0.51, which was about 80% of the mean from 1977-84. It was considered that the CPUE, which was calculated only from the Canadian fleet, was likely to represent an overestimate of biomass in recent years because the portion of the stock outside 200 miles was not covered by this fishery. However, this alone does not account for the difference in the ratios of the indices between the earlier and later periods (38% in the surveys, 80% in the CPUE) and that the reduction in stock abundance was more likely to be about 50%.

e) Catch Projections and Prognosis

STACFIS concluded that the abundance of the stock was currently about 50% of the abundance in 1977-84 period, when an exploitation rate which produced an average catch of 14,100 tons did not result in trends in the indices of abundance. Applying this level of exploitation to the current stock size implies that a catch of about 7,000 tons for 1991 would not be harmful to the stock in its present condition. This corresponds to an exploitation rate of less than 15% of the mean biomass from the Canadian RV surveys in 1988-90. STACFIS advises that the TAC for 1991 be set at 7,000 tons.

The reduction of the TAC to 5,000 tons in 1989 had succeeded in restricting the catch, which was less than half the value in 1987-88. If the current TAC of 5,000 tons for 1990 has a similar effect, there will have been a substantial reduction in catch from the level of about 30,000 tons in 1985-86.

STACFIS concluded that this stock was no longer declining, although it was still at a relatively low level compared to earlier years. The 1984-85 year-class sizes appeared to be larger than those of the preceding 3 year-classes, and these 2 stronger year-classes will contribute to the spawning stock in 1990-91. The estimated increase in population size at ages 5-7 in 1989-90 over 1987-88 will not translate into any long-term increases in population size or catch beyond 1991, as yellowtail flounder at ages 9+ usually comprise less than 5% on average of the commercial and RV survey catches, i.e. have essentially disappeared from the fishery and possibly the population.

The rationale for increasing the TAC to 7,000 tons assumes an exploitation pattern

at age similar to that observed in the earlier period (1977-84) when ages 5-8 dominated the catch. It was concluded that the population size at these ages is now higher than previously estimated, and the fishery could sustain an increase in catch from these ages before they disappeared from the population after age 8. This does not account for the recent shift in exploitation toward younger yellowtail flounder in the Regulatory Area.

The size of the yellowtail flounder in the Spanish catches, along with information presented on selectivity of mesh sizes for the American plaice fishery in Div. 3LNO, indicated that the effective mesh size being used in some fisheries in the Regulatory Area was well below the legal minimum size, and may be as low as 60 mm. Although impossible to quantify, it was noted that continuation of the current exploitation pattern in these fisheries could result in a loss in yield-per-recruit.

STACFIS once again emphasized that this fishery will be impossible to manage if unregulated catches by non-member countries increase from the low levels of 1988-89 to the levels estimated in 1985-86.

12. Greenland Halibut in Subareas 0 and 1 (SCR Doc. 90/35, 36, 37, 38, 39, 52; SCS Doc. 90/03, 04, 05, 15, 16)

a) Introduction

Description of the fishery and nominal catches. Catches have been rather stable in the period 1980-89 with an average annual catch of 9,000 tons. Most of the catch has been taken by Greenland (86% in 1989) in the fjords of West Greenland. The Greenland fishery is an inshore gillnet and long-line fishery, with 93% of the total Greenland catch in 1989 taken in Div. 1A. The newly expanded fishery in the northern part of Div. 1A (north of 72°N), has reached a level of about 1,500 tons, which is about one fifth of the total catch in that Division in 1989. A joint-venture (Greenland-Japan) offshore fishery carried out in Div. 1C-1D by a Japanese vessel amounted to 1,300 tons. Recent TACs and catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	25	25	25	25	25	25	25	25	25	25	25
Catch	8	10	9	9	7	10	9	8	9[1]	9[1]	

[1] Provisional data.

b) Input Data

i) Biological information

Greenland halibut is considered a unit stock throughout the Northwest Atlantic with the exception of separate stocks in Gulf of St. Lawrence, and Fortune Bay, Newfoundland. Spawning supposedly takes place in the deeper waters of the Davis Strait south of 67°N. The larvae are dispersed by the north going currents off West Greenland as well as by the south going currents off Labrador and Newfoundland. Studies on meristic characters of adults at Newfoundland, in the Davis Strait, at West Greenland and in the Denmark Strait leads to the suggestion that Greenland halibut in the West Greenland fjords have been under different temperature conditions during their egg and larval stages, than have specimens from the other populations.

Observations of young fish have been made mainly at depths of 200-300 m on the banks off West Greenland north of 65°N and at coastal waters off Labrador and Newfoundland. Size frequencies in catches from Subareas 1, 2 and Div. 3KL indicates a migration of fish from the banks towards deeper areas in the Davis Strait as well as towards deeper parts of the fjords in Subarea 1. Tagging experiments and studies on genetics and parasites conducted in Subareas 1, 2 and Div. 3KL and Div. 4RST indicate some isolation of the fjord components in Subarea 1 and in the population in Div. 4RST, while populations in the other areas seem to be somewhat connected and hence assumed to belong to the same spawning stock. The fjord populations in Subarea 1 and in Div. 4RST are probably also recruited from this spawning stock complex in the Davis Strait. Although Greenland halibut in the fjords of West Greenland show signs of maturation they are rarely found in ripe condition.

These data were not considered conclusive and Greenland halibut in fjords at West Greenland are assessed as part of the stock in Davis Strait.

ii) Research data

Offshore trawl surveys. Bottom-trawl surveys have been conducted jointly by Japan and Greenland in Subarea 1 since 1987 . In 1989 the survey covered the depth range between 400 m and 1,500 m during April and May. The biomass was estimated to 63,300 tons for Div. 1CD. Although the surveys differed from year to year in areas and depths surveyed, the biomass estimates seemed consistent in the period 1987-89. Within the period the surveys have showed differences in distribution of the biomass which may be due to within-year migrations, as the surveys were carried out at different times of the year. Biological samples from the survey and samples from commercial catches in the area surveyed showed that sexual maturation increased from April/May to October/November.

A bottom-trawl survey was conducted jointly by USSR and GDR in Div. 0B in the autumn of 1989, covering the range 200-1,500 m . The biomass estimate was 84,000 tons, which was considerably higher (36%) than in 1988. This increase was considered to be somewhat related to the strong 1984-85 year-classes previously observed in Canadian shrimp surveys in Div. 2J+3KL.

iii) Other research results (SCR Doc. 90/36, 37)

A stock identification study using parasite infestation as natural tags from 5 areas in the western North Atlantic (offshore in Div. 1C and ICES Subarea XIVb, inshore in Div. 1A, 1D, 1F) showed that the southernmost fjords of West Greenland may not mix as adults with those from the other areas, although there were some similarities between these samples and those from the Denmark Strait (ICES Subarea XIVb). An additional sample from Div. 3K was different, but somewhat related to the Davis Strait sample as a cline in parasite infestation appeared towards this area and further on to the other areas investigated.

Preliminary results of tagging experiments in West Greenland fjords, showed some relationship between populations in southern West Greenland fjords and populations off West Iceland.

c) Estimation of Parameters

Virtual population analysis. A VPA covering Subareas 0, 1 and Div. 2GH was presented. Catch-at-age figures for the total area were created using age-length keys from USSR-GDR surveys carried out in the period 1975-89. However, STACFIS noted that the surveys did not cover the commercially exploited areas, and that the age composition in the surveys which were applied to the catches were therefore not considered representative for the commercial fishery, hence the VPA could not be accepted as an account of the status of the stock.

d) Prognosis

As the USSR and Japanese offshore surveys do not cover the whole area of distribution of Greenland halibut in Subareas 0+1, and as the biomass in Div. 0A as well as in the inshore areas of Subarea 1 is not known, STACFIS had no basis for an analytical assessment on which to advise a precise level of catch for 1991. However, based upon the available information, STACFIS advises that the present TAC level of 25,000 tons be maintained. STACFIS further advises that expansion of the fishery should be directed primarily towards areas outside the areas that are at present exploited by the fishery.

e) Considerations on a Combined Assessment for Subareas 0, 1, and 2 and Divisions 3KL

Last year STACFIS recommended that consideration should be given to the biological and practical implications of combined stock assessments for Subareas 0, 1, and 2 and Div. 3KL. Biological information was summarized, and STACFIS agreed that from a biological point of view there was no reason to maintain two separate assessments for the area as discussed in the section on biological information and other research above.

At present practical limitations impede such a combined assessment. The surveys are conducted in offshore areas whereas most of the fishery is conducted mainly in inshore areas of Subarea 1, and coastal areas of Subarea 2 and Div. 3KL. Therefore, the components of the stock exploited by the fishery can be considerably different from the portion of the stock surveyed. Furthermore, the age composition of the catch is quite different from that found in the trawl surveys.

13. Greenland Halibut in Subarea 2 and Divisions 3KL (SCR Doc. 90/51, 52, 57; SCS Doc. 90/05, 12, 13, 16)

a) Introduction

Greenland halibut catches in Subarea 2 and Div. 3KL have averaged between 25,000-30,000 tons annually from 1970 to 1976 with the 1978 catch at 38,500 tons being the highest since the beginning of the fishery in the early-1960s. Catches declined rather steadily since 1978 to reach an all time low of about 16,000 tons in 1986. The fishery improved to the extent that the 1987 catch of 30,900 tons was nearly double the 1986 catch and above the average over the last 18 years. The 1988 and 1989 catches, however, were again near the lowest in the time series at 18,900 tons and 20,100 tons respectively. Most of the 1989 catch was accounted for by Canada with 11,800 tons followed by EEC with 3,200 tons, the GDR with 1,700 tons and Faroe Islands, Japan, Poland and USSR accounting for most of the remainder. The Canadian trawler catches were 900 tons, compared to 600 tons in 1988, and were taken mainly in Div. 3K during April, May and August. The inshore gillnet catches were mainly in the southern Divisions of 3K (5,800 tons) and 3L (2,500 tons) with 2,200 tons taken in Div. 2J. The gillnet fishery occurred primarily during the months between July and October. Catches by other countries varied throughout the year, quite often in conjunction with catching other species. However, while Div. 3L had been rarely directly fished for Greenland halibut by countries other than the coastal state, catches of 4,100 and 3,300 tons were reported by the EEC in 1988 and 1989 respectively. Recent TACs and catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC[1]	35	55	55	55	55	75	100	100	100	100	50
Catch	33	31	26	28	25	19	16	31	19[2]	19[2]	

[1] TAC for Div. 2J+3KL only for 1977-84.
[2] Provisional data.

b) Input Data

i) Commercial fishery data

Considering the nature of this fishery, the migratory behaviour of this species as well as the low levels of directed catch, it was difficult to obtain catch rate data which were accurately representative of total stock size. Data that are available [mainly Canada (N)], however, could be helpful as indicators of distribution and abundance in localized areas. The only time series of catch rate directed data available for recent years was from Div. 2J during the summer. The catch rate declined steadily from 1.51 tons/hr in 1984 to 0.56 tons/hr in 1986 then increased to 0.82 tons/hr in 1987. This level was higher than that observed for 1982 (0.61 tons/hr) but still below the levels of 1983-84. It subsequently declined in 1988 (0.38 tons/hr) to the lowest observed during the period examined. During 1989 the level of directed catch by this fleet for Greenland halibut was insignificant and was therefore not reported here. However, data from the Portuguese trawler fleet for the same time period in 1989 for Div. 3L suggested catch rates equivalent to those of 1982 above.

Age compositions from only the Canadian fishery were available for 1989. These indicated that more than 53% of the Canadian catch was comprised of age 7 with 94% of the catch in the age range of 6-8. This age composition was virtually identical to that reported for the Canadian catch in 1988. Considering that the highest proportion of the commercial catch is taken by gillnet fishermen in the southern range of the stock, the exploitation of these few relatively young age-groups would likely be maintained. Furthermore, it can be expected that this fishery, which exploits such few age-groups, would be highly sensitive to fluctuations in individual year-class strengths. On the other hand, length frequency distributions available from the newly developed fishery for Greenland halibut in the NAFO Regulatory Area of Div. 3L by EEC-Portugal in 1989 indicate that the catches are comprised mainly of older fish with the modes of the length frequencies likely to be largely representative of 8 year old fish. This fishery is being prosecuted in depths greater than 800 m and appears to have intensified in the early months of 1990 according to Canadian surveillance observations.

ii) Research vessel surveys

Estimates of biomass from Canadian autumn groundfish surveys in Div. 2J (1977-89 down to 1,000 m), 3K (1978-89 down to 1,000 m) and 3L (1981-89 down to 366 m) were reviewed with values for most missing strata estimated using a multiplicative analysis model. For the area estimated in Div. 2J in 1989 the biomass estimate was 43,000 tons, which was the second lowest in the time series. The previous low was in 1988 at 35,000 tons. The average biomass estimate over the time series is 69,000 tons.

In Div. 3K, the 1989 biomass estimate was 73,000 tons which was near the lowest in the time series, although very similar to estimates provided for 1987 and 1988. The average biomass over the time period for this Division is 85,000 tons.

In Div. 3L, the 1989 biomass estimate was 13,000 tons similar to the 1986, 1987 and 1988 estimates. These estimates were within 20% of the average biomass for Div. 3L of 16,000 tons since 1981. For Div. 2J, 3K and 3L combined, the estimated biomass for 1989 was 129,000 tons compared to 122,000 tons in 1988.

Trends in biomass by Division indicated that for Div. 2J there has been an overall decline from about 108,000 tons in 1982 to an average of about 39,000 tons in 1988-89, a decrease of nearly 3 times. In Div. 3K, on the other hand, with the exception of highpoint estimates in 1983, 1984 and 1986, the estimated biomass has been relatively stable at about 75,000-80,000 tons since 1978. The estimated biomass in Div. 3L accounted for a much smaller portion of the stock although very little deep water was surveyed. Biomass estimates from this Division have been stable since fall surveys began in 1981, at a level of about 13,000 tons. The overall combined trend, however, shows a considerable decline in biomass since 1984 largely because of historic high levels in Div. 2J. Recent levels are about half of earlier estimates although they appear to be relatively stable during 1988 and 1989.

No Canadian surveys were conducted in Div. 2GH in 1989, however, a joint USSR-GDR survey estimated biomass to be about 43,000 tons which was similar to estimates previously reported from Canadian surveys in Div. 2GH in 1987 and 1988. For USSR surveys in 1987-89 in Div. 3K and 3L the results also indicated relative stability.

From the Canadian groundfish surveys in Div. 2J, 3K and 3L the dominant age-class in the 1987 survey was age 3 which represents the 1984 year-class and was more abundant than any other year-classes at age 3 in the Div. 2J+3KL series. Up to 1988, this year-class was also the most abundant year-class at age 4 than any other in the series, and again at age 5 in the 1989 survey. The 1989 survey indicates that the 1985 year-class may also be quite strong, an observation also supported from the results of USSR surveys. In the previous assessment an examination of data from shrimp surveys showed that the 1985 year-class dominated the catches at ages 1, 2 and 3 also suggesting a particularly strong year-class. Unfortunately, similar data from shrimp surveys are unavailable from 1989.

A comparison of relative year-class strengths at age 5 from Canadian autumn surveys in Div. 2J, 3K and 3L suggested that the 1976, 1977, 1981 and 1982 year-classes were average, with the 1978 and 1980 year-classes possibly average to just above average. The 1983 year-class was estimated to be relatively strong from Div. 3K and 3L data, however, it was weak according to Div. 2J data. The 1984 year-class, on the other hand, was estimated to be strong throughout the area and was similar in strength to that of the 1979 year-class.

c) Estimation of Parameters

STACFIS recommended in June 1989 that an attempt be made at an analytical assessment of that portion of the Greenland halibut stock covered by the fishery and the surveys in Subarea 2 and Div. 3K and 3L for consideration at the June 1990 meeting. An SPA was performed which was calibrated with ADAPT using the commercial catch-at-age from 1978-88 and the Canadian research vessel surveys index of abundance developed from data collected in Div. 2J, 3K and 3L.

The estimates of abundance from the model were significant at ages 6-12. The estimates of catchability (RV slopes) were extremely high (over 2.0 for most ages) and considered to be unrealistic for this species, for which previous values of catchability had been estimated to be as low as 0.20. The model also showed unacceptable patterns in the residual matrix and suffered from lack of fit in many

of the age-by-age analyses.

Given the estimates in the SPA of stock size obtained from RV surveys along with the recent catch levels from this stock, it was obvious that the estimates of population numbers and fishing mortality from the SPA were not realistic. Although the SPA may be useful in indicating a decline in stock size from the late-1970s to the present, it is known that both immigration and emigration, by age and by year, occur in this stock and are likely to be highly variable. It is clear that such movements have affected both the estimates from surveys and the age composition of the commercial catch and may explain the variable and high values of F at some ages in certain years. The analysis appears to serve little more than emphasize the significance of these factors. Thus, little faith can be placed in the SPA as a true measure of stock composition and size until these migration factors can be quantified.

d) Prognosis

The TAC of 100,000 tons, set in 1985, was put in place for 1986 based largely upon high survey biomass estimates, potentially good recruitment, and what was considered to be low fishing mortality. The biomass was estimated in excess of 400,000 tons of which 200,000 tons was estimated for Div. 2GH alone. The 1987-88 results for Div. 2GH based upon more appropriate survey design and data analysis suggested that these two Divisions contained about 38,000 tons. In Div. 2J, 3K and 3L, the estimated biomass had declined from about 225,000 tons in 1984 to nearly half that level in 1988. Estimates of biomass from 1989 surveys indicate that the stock had remained relatively stable, however, there was some potentially good recruitment for the future. Since the existing fishery prosecutes relatively young age-groups, the success of the fishery will remain contingent upon the strength of the recruiting year-classes mainly in age groups 6-8. These age groups in 1991 represent the 1983, 1984 and 1985 year-classes.

e) Catch Projections

Considering the evaluation of the SPA, STACFIS concluded that an acceptable analytical assessment of this stock will likely remain unattainable until at least the migration factors can be quantified. Therefore, advice on this stock will continue to be dependent largely upon an evaluation of research vessel survey results. Given that the estimated stock size has remained stable in the 1989 surveys compared to those of 1988 STACFIS advises that the TAC of 50,000 tons in effect for 1990 remain in effect for 1991.

14. Roundnose Grenadier in Subareas 0 and 1 (SCR Doc. 90/06, 39, 75; SCS Doc. 90/05)

a) Introduction

A total catch of only 49 tons have been reported to NAFO to date for 1989, compared with 540 tons reported for 1988. Catches since 1978 continue to be restricted to by-catches in the Greenland halibut fishery. Recent catches and TACs ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Catch	1.7	0.5	0.1	0.1	0.1	0.1	0.1	0.4	0.5[1]	+[1]	

[1] Provisional data.

b) Input Data

i) Commercial fishery data

There has been no directed fishery for roundnose grenadier in these Subareas since 1978. No update was possible of the catch/effort analysis which was presented previously (NAFO Sci. Coun. Rep., 1985, page 72).

ii) Research data

The results of a research survey in Subarea 1 by Japan and Greenland in 1989 were presented. The total estimated trawlable biomass was determined to be only about 5,900 tons. This compares with an estimated 45,700 and

the bottom temperature where most of the biomass was found (3.4°C) was the same as that in 1988. It is believed that the lower estimate was due to a feeding migration of the fish out of the survey area, since catch rates increased later in the year.

USSR research data also suggested that grenadier were distributed outside the survey area, being deeper than the depths surveyed in 1989. None were found in depths <800 m, and catches increased to 200-300 kg/tow deeper than 1100 m. The percentage roundnose grenadier increased with increasing depth, as did the size of the fish.

c) Prognosis

STACFIS noted the continuing lack of commercial data for this stock due to continued low catches. It was observed previously (NAFO Sci. Coun. Rep., 1987, page 71) that the present TAC of 8,000 tons represented an exploitation level of <10% of the biomass estimated from a 1986 Canadian survey, but is almost 20% based on the biomass estimates from the 1987 and 1988 Japanese surveys (NAFO Sci. Coun. Rep., 1989, page 96). Although the 1989 biomass estimate is about 10 fold less than those of 1987 and 1988, this is not considered to be realistic. STACFIS advises that the 1991 TAC should remain at the 1990 level of 8,000 tons.

15. Roundnose Grenadier in Subareas 2 and 3 (SCR Doc. 90/06, 75; SCS Doc. 90/05, 16)

a) Introduction

The provisional 1989 catch of 5,240 tons was down by about 1,000 tons from the reported catch in 1988 (6,291 tons). The catch by EEC-Portugal totalled only about 300 tons, about 600 tons less than 1988. Landings by USSR were up by about 600 tons, but those of the GDR were down by about 1,000 tons. Nominal catches remained low compared to those prior to 1979. Recent catches and TACs ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	30	27	27	11	11	11	11	11	11	11	11
Catch	2	7	4	4	4	5	7	8	6[1]	5[1]	

[1] Provisional data.

b) Input Data

i) Commercial fishery data

Catch and effort data were available from ICNAF and NAFO for the period 1967-88, and from the Canadian Observer Program for period 1978-89. The two data sets were analyzed separately using a multiplicative model to derive two estimates of standardized catch rate and effort. The ICNAF/NAFO data series indicated that catch rates were highest in the early-1970s, but had gradually declined since then. Catch rates remained fairly constant from 1981 to 1986, but appeared to have declined somewhat since then (Fig. 18). The series derived from the Observer Program also appeared stable from 1978 to 1986 although there was considerable inter-annual variability. Catch rates from this series have also declined somewhat since then.

STACFIS noted that it was unclear whether the observed decline in catch rates in recent years was an indicator of stock status, or availability to the fishery. Some evidence was presented which suggested that the fish may have been distributed deeper in recent years, and were therefore less available to the fishery. Therefore, some questions exist concerning the use of these as indicators of stock status.

ii) Catch-at-age data

Length frequency data for 1989 were available from the Canadian Observer Program. The anal fin length of commercial catches decreased as the year progressed in both USSR and GDR fisheries.

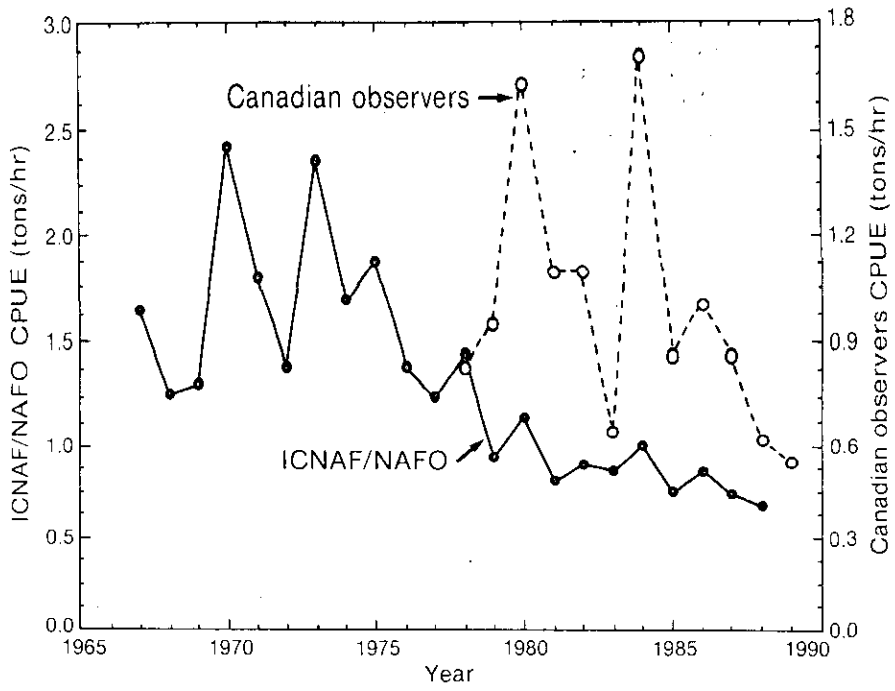


Fig. 18. Roundnose grenadier in Subareas 2 and 3: catch-rate data series from the commercial fishery.

Catch-at-age and weight-at-age estimated from USSR and GDR fisheries were available for 1979-89 period. Ages 2 to 19 were caught, with ages of about 6-13 dominating in most years. STACFIS noted that a single age-length key was used to construct the catch-at-age.

iii) Research data

The results of a research survey in Subarea 2 and Div. 3K by USSR in 1989 were presented. Fishing was carried out at depths of 400-1500 m, with grenadier being caught at depths >500 m in bottom temperatures of 3.4-3.5°C. Larger fish were caught in deeper waters, mean length being about 43 cm in 700-800 m, and about 61 cm in 1300-1400 m. As has been noted previously, fish caught in Div. 3K were smaller than those in the more northern areas. Males predominated with a ratio of 60:40.

An examination of research catch-at-age data for Subareas 0 to 3 combined indicated a modal age of 8 to 10 from 1983 through 1989. This was similar to the modal age of the commercial catches in Subareas 2 and 3.

c) Estimation of Parameters

i) Sequential population analysis

Two independent SPA analyses were carried out. Both utilized age-by-age calibrations and commercial catch-rate data. For both, natural mortality was assumed to be 0.15. The first analysis used catch-rate data from the USSR fleet, and each age was calibrated independently.

The second analysis utilized the Canadian Observer Program catch-rate data in an ADAPT formulation, calibrating over all ages (2-19).

d) Assessment Results

Results of the SPA using USSR vessel catch rates indicated a biomass of 48,100 tons in 1989 with an abundance of 236.9 x 10^6 fish. Except for age 2 population numbers, all estimated parameters were significant using the ADAPT formulation. The analysis resulted in an estimated 1989 abundance of 306.8 x 10^6 fish with a biomass of 57,700 tons.

e) Prognosis

Although the 1989 population estimates from the two analyses were reasonably close, STACFIS concluded that they are not representative of the true stock size. It is known that roundnose grenadier are distributed in depths down to at least 3000 m. At present, the fishery is not prosecuted below about 1600 m, and an unknown portion of the stock exists in depths greater than those currently fished. It has been postulated that in recent years grenadier have distributed deeper relative to the fishery. This is perhaps supported by the observation that the exploitable biomass, as determined from the ADAPT analysis, has been close to, or less than the reported catch in recent years.

STACFIS concluded that in its present form, SPA is not an appropriate tool for the assessment of roundnose grenadier in Subareas 2 and 3. Also, current survey data available do not provide reasonable estimates of population size because all inhabited depths are not surveyed, and the proportion of grenadier in deeper waters is unknown. It is also possible that this proportion changes between years. If there is a trend in recent years for grenadier to be distributed deeper, then the recent decline in catch rates may be reflecting this re-distribution rather than stock status. Last year, STACFIS concluded that the recent low catch rates were not the result of by-catch restrictions (NAFO Sci. Coun. Rep., 1989, page 98).

Given the above, STACFIS concluded that there are insufficient data upon which to base an assessment. STACFIS advises that the precautionary TAC level of 11,000 tons should remain in place until further information becomes available. It was noted that catches in recent years have been below this precautionary level, but STACFIS noted that most of the recent catches have been taken in Div. 3K whereas the TAC applies to all of Subareas 2 and 3.

16. Wolffish in Subarea 1 (SCS Doc. 90/14)

a) Introduction

The nominal catch reported for West Greenland waters includes two species: Atlantic wolffish (*Anarhichas lupus*) and spotted wolffish (*A. minor*). Since 1957, the combined nominal catch of both species has been in the range of 1,000-6,000 tons.

The fishery is partly a small-scale directed fishery and partly a by-catch in the trawl fishery for cod. Recent catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Catch	5	4	4	3	2	2	2	2	2[1]	1[1]	

[1] Provisional data.

b) Catch Projections

Until more biological data and separate catch statistics for the two species become available, it is not be possible to carry out any assessment. The previous advice of 5,000-6,000 tons corresponding to the average catch in the 1970s could be a sustained yield. Therefore, STACFIS finds no reason to change the previous advice of 5,000-6,000 tons.

17. Capelin in Division 3L

Discussion on this stock was deferred until the September 1990 meeting.

18. Capelin in Divisions 3N and 3O (SCR Doc. 90/07, 61; SCS Doc. 90/05)

a) Introduction

Nominal catches in these Divisions increased from about 750 tons in 1971 to 132,000 tons in 1975 and declined to 5,000 tons in 1978. During that period, most of the catch was taken by USSR trawlers and Norwegian purse seiners. The fishery was closed during 1979-86. The provisional catch in 1989 was 9,776 tons reported by Japan, Norway and USSR. The USSR fishery occurred on prespawning capelin while the Japanese and Norwegian fisheries occurred on the capelin spawning grounds in the Regulatory area. Recent TACs and catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Advised TAC	0	0	-[1]	0	0	0	0	10	10	28	30
TAC	0	0	0	0	0	0	0	10	15	28	30
Catch	0	0	0	0	0	+	0	1	7[2]	10[2]	

[1] No STACFIS advice.

[2] Provisional data.

b) Input Data

i) Commercial fishery data

The catch rates in the USSR midwater trawl fishery during May 1989, as reported by Canadian observers, was 3.5 tons/hr and 36.5 tons/day, an increase over the 1988 catch rates of 2.8 tons/hr and 33.0 tons/day. A preliminary estimate of the 1989 catch rate of BMRT trawlers from Soviet data was 42.8 tons/day.

The 1986 (77%) and 1985 (19%) year-classes predominated in the 1988 USSR fishery. Over 90% of the fish in these year-classes are expected to spawn in 1989.

ii) Research data

An acoustic survey by Canada in Div. 3N during 24 June-3 July 1989 provided a biomass estimate of 29,000 tons. This estimate was the lowest on record and well below the average (1981-88) of 303,000 tons. Some commercial fishing had concluded prior to the survey suggesting that the survey may have been too late to cover the peak spawning concentration of capelin. Thus, this estimate may have been biased downwards although it was not possible to quantify this. The 1986 and 1985 year-classes dominated, accounting for 80% and 10% of the estimate by numbers, respectively.

The USSR surveyed a portion of Div. 3NO as part of a Div. 3LNO acoustic survey during 18 May-5 June 1989. An estimate for the Div. 3NO stock could not be extracted from the total biomass estimate. STACFIS noted that separate estimates for Div. 3L and 3NO will be available in the future.

Results of a Soviet 0-group survey during 21 November-9 December 1988 indicated that the 1988 year-class was slightly stronger than the 1983 year-class which had been the strongest in the series. Results from a similar survey conducted during 19 November-9 December 1989 showed the 1989 year-class to be about 70% of the strength of the 1983 year-class. This 0-group survey has been ongoing since 1983 and STACFIS recommends that *the USSR 0-group survey be continued to provide a database that can be evaluated as an indicator of recruitment.*

c) Catch Projections

No stock projections were made for capelin in Div. 3NO because estimates of the 1987 and 1988 year-classes were not available for this stock. STACFIS considers an exploitation rate of 10% of the mature biomass to be appropriate for the Div. 3NO capelin stock. The average spawning biomass (1981-88) is 303,000 tons. STACFIS has no basis on which to change its previous advice and STACFIS advises that the 10% target removals be based on the average spawning biomass, 1981-88, indicating a catch of 30,000 tons in 1991.

d) Recommendations

Catches in this stock are increasing with the entry of new fleets and STACFIS recommends that *sampling data for all components of the capelin fishery in Div. 3NO, including details on timing and location of the fishery, be collected.*

19. Squid in Subareas 3 and 4

a) Introduction

Nominal catches of short-finned squid (*Illex illecebrosus*) in Subareas 3 and 4 peaked at 162,000 tons in 1979, and then declined to less than 2,000 tons during 1983-88. The provisional catch in 1989 was 6,537 tons. Recent catches and TACs ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
TAC	150	150	150	150	150	150	150	150	150	150	150
Catch	70	33	13	+	1	1	+	2	1[1]	7[1]	

[1] Provisional data.

b) Catch Projections

Because of the short life span of squid and unpredictable variability in availability, no catch projections can be made for 1991.

20. Shrimp in Subareas 0 and 1 (SCR. Doc. 90/44, 46, 63, 65 and 90).

a) Introduction

The nominal catch of shrimp in the offshore areas of Subarea 1 south of 71°N and the adjacent part of Subarea 0 increased from less than 1,000 tons before 1972 to almost 43,000 tons in 1976, fluctuated thereafter, but has been at a level about 45,000 tons during 1985-88. Preliminary statistics for 1989 indicate total catches of about 51,000 tons. This offshore fishery has been regulated by TAC since 1977 (Table 11A, B).

In both 1988 and 1989, there was a southward shift in this offshore fishery with more effort being expended in Div. 1C and 1D than in preceding years.

An offshore fishery began north of 71°N in 1985 and yielded about 4,300 tons that year. The catches increased to about 11,000 tons in 1986 and 1987, and decreased thereafter to 2,500 tons in 1989. In 1989 the fishery occurred from May to December. This fishery occurred outside the fishing areas in Subareas 0 and 1 for which TACs have been advised.

The West Greenland inshore shrimp fishery has been relatively stable with estimated catches of 7,000-8,000 tons annually from 1972 to 1987 (except for 10,000 tons in 1974). Preliminary catch statistics indicate an increase to 9,900 tons in 1988 and 14,400 tons in 1989.

Recent catches and TACs (tons) are shown in Table 11A, B.

b) Input Data

i) Commercial fishery

Catch rates. Catch and effort data for the shrimp fishery in 1989 were available from Canadian vessel logs from Subarea 0 and from French, Greenland and Norwegian logbooks from Subarea 1. Mean catch-rate indices for the Canadian fishery in the July-September period in Div. 0A (standardized to 1980) and for seven Greenland trawlers (721-1,000 GRT) in Div. 1B are given in Table 12. The Greenland index was standardized for vessel, year, month and area using a multiplicative analysis.

Table 11A. Shrimp in Div. 0A and Subarea 1: nominal catches and TAC (tons) included in TAC advice.

	1980	1981	1982	1983	1984	1985	1986	1987[1]	1988[1]	1989[1]	1990[1]
Div. 0A Canada	59	1,590	858	2,030	448	233	126	3,252	6,087	7,235	
Denmark	-	1,923	946	2,627	526	916	1,208	529	-	-	
France	-	-	-	-	436	-	-	-	-	-	
Faroe Islands	-	1,686	-	756	730	142	530	2,359	-	-	
Greenland	815	85	8	-	2	1,349	1,131	-	-	-	
Total	874	5,284	1,812	5,413	2,142	2,640	2,995	6,140	6,087	7,235	
SA 1 Offshore, South of 71°N											
Canada	590	-	-	-	-	-	-	-	-	-	
Denmark	872	995	959	451	397	417	572	502	312	391	
France	247	535	672	408	404	416	535	596	423	420	
Faroe Islands	3,554	1,234	530	1,583	360	471	481	474	421	476	
Greenland	27,501	28,197	32,016	30,929	32,129	37,788	39,537	37,998	35,947	42,164	
Norway	3,014	1,055	838	483	451	455	464	450	459	448	
Total	35,778	32,016	35,015	33,854	33,741	39,547	41,589	40,020	37,562	43,899	
0+1 offshore catch[2]	36,652	37,300	36,827	39,267	35,883	42,187	44,584	46,160	43,649	51,134	
0+1 advised TAC[2]	29,500	29,500	29,500	29,500	29,500	36,000	36,000	36,000	36,000	44,000	50,000
0+1 effective TAC[2]	29,500	35,000[3]	34,800[3]	34,625[3]	34,925[3]	42,120[4]	42,120[4]	40,120[4]	40,120[4]	40,120[5]	44,975[5]

[1] Preliminary data.
[2] South of 71°N.
[3] Including TAC of 5,000 tons in SA 0.
[4] Including TAC of 6,120 tons in SA 0.
[5] Including TAC of 7,520 tons in Div. 0A.

Table 11B. Shrimp in Div. 0A and Subarea 1: total nominal catches.

	1980	1981	1982	1983	1984	1985	1986	1987	1988[1]	1989[1]	1990[1]
SA 1 offshore (south of 71°N)	35,778	32,016	35,015	33,854	33,741	39,547	41,589	40,020	37,562	43,899	
Greenland (N of 71°N)	-	-	-	-	-	4,349	11,045	10,700	6,660	2,522	
Greenland (Inshore[2])	7,500	7,500	7,500	7,500	7,500	7,500	7,500	6,921	10,233	14,428	
SA1 Total	43,278	39,516	42,515	41,354	41,241	51,396	60,134	57,641	54,455	60,849	

[1] Preliminary.
[2] Inside 3-mile limit. Inshore component of total catch 1980-86 was estimated.

Table 12. Shrimp in Div. 0A and 1B: CPUE indices from the Canadian fishery (July-September) in Div. 0A and Greenland fishery (standardized, all year) in Div. 1B, 1976-89.

		1976	1977	1978	1979	1980	1981	1982	1983
Canada	0A	-	-	-	-	0.60[1]	0.66	0.78	0.63
Greenland	1B	1.05	1.27	1.01	0.93	1.05	1.07	1.26	1.20

		1984	1985	1986	1987	1988	1989
Canada	0A	0.64	0.61	0.67	1.31	0.92	0.90
Greenland	1B[2]	1.10	1.25	1.17	1.55	1.27	1.00
Greenland	1B[3]	-	-	-	1.75	1.61	1.00

[1] Indexed to 1980.
[2] Standardized index for seven trawlers (721-1,000 GRT).
[3] Standardized index for 22 trawlers, catch of shrimp >8.5 g.

Due to the uncertainty in the interpretation of these catch-rate series caused by possible changes in discarding procedures in recent years, a standardized catch-rate index for shrimp of sizes, for which discard is unlikely or at least negligible, was produced. Logbook data for Div. 1B for 22 sea-processing trawlers reporting their catches by different size categories were used in a multiplicative analysis similar to the one used for the seven Greenland trawlers. Only catches of shrimp >8.5 g (considered to be females) were included. Data were sufficient only for 1987 to 1989.

The Canadian catch-rate index remained stable from 1984 to 1986 and increased sharply in 1987 followed by a decline in 1988 by approximately 28%. In 1989 it remained at the same level as in the year before. The Greenland index showed a slightly increasing trend from 1979 to 1986, followed by an increase similar to the Canadian data. It decreased again in 1988 and 1989 by 18% and 21%, respectively.

The catch-rate index for large shrimp showed a significant decrease between 1987 and 1989 (8% from 1987 to 1988 and 38% from 1988 to 1989; Fig. 19), also for the winter period when aggregation of ovigerous females usually led to a high catch rate. Using the same model and data, but including the total reported catch of shrimp, showed a significant decrease in the mean catch of shrimp <8.5 g (i.e. mainly male and juvenile shrimp) from 1987 to 1988, while the mean catch of this group was similar from 1988 to 1989.

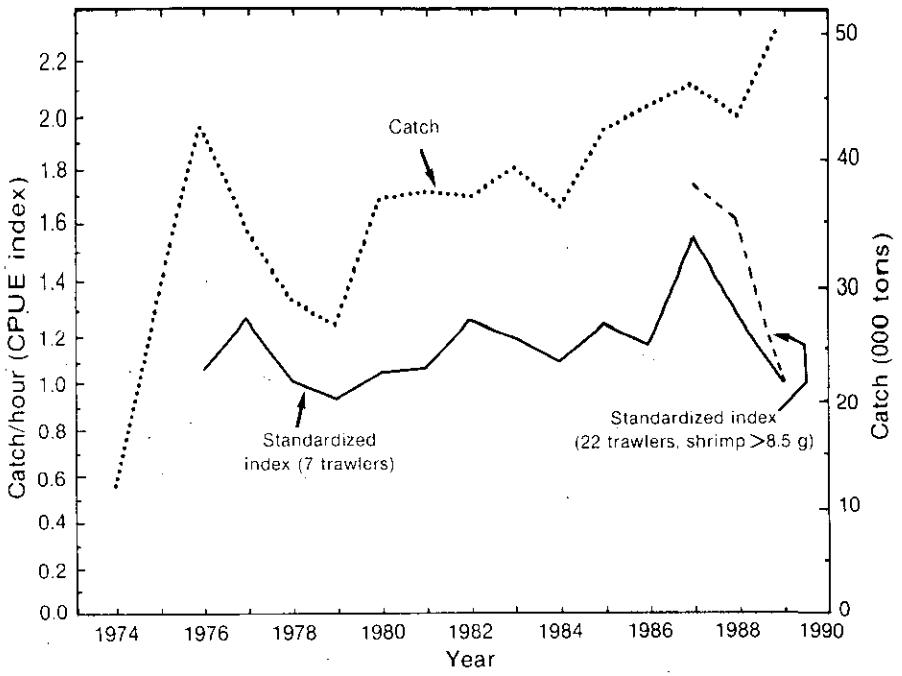


Fig. 19. Shrimp in Subareas 0 and 1: CPUE indices standardized for 1989 from Div. 1B compared with total offshore catches (excluding catches in the Northwest Greenland area north of 71°N).

STACFIS agreed that catch and effort data by area and month for all fishing areas should continue to be provided for future assessments.

Biological data. Size compositions of samples from the commercial shrimp catches in Div. 0A in 1989 were very similar to the previous two years. The reduction in numbers caught per unit of effort from 1987 to 1989 occurred over all size/age groups.

Canadian catch-at-length data from Div. 0A from 1980 to 1989 indicated that the mean size of the largest mode decreased during 1983-85.

STACFIS noted the absence of length composition data from the commercial fisheries in Subarea 1 and stressed the necessity that such data be provided on a time series basis for all fishing areas and fleets.

Shrimp discards. In Subarea 0, observers estimated discarding rates (relative to the shrimp catch) to be at the same level as in preceding years. Since 1980, the observed average discard has fluctuated between 2%

but recent changes in discarding practices are discussed under Section c.

By-catches. In Div. 0A, observer data on catch composition from June to November 1989 showed that small redfish comprised between 9% and 16% of the catch by weight, with maximum occurrence in July and August. Mean catch rates of small redfish and Greenland halibut in 1989 were close to those for 1988, namely 82 and 11 kg per hour, respectively.

No data were available on by-catches in Subarea 1.

ii) Research vessel surveys

In July-August 1989 a stratified-random trawl survey was carried out in Div. 0A and 1A-1D to assess the distribution and trawlable biomass of shrimp. The area covered was similar to that investigated in the July 1988 survey. The trawlable biomass estimate obtained by the swept area method in 1989 was 185,000 tons (± 39%) in the areas south of 69°30'N, and 11,725 tons (± 58%) in the northern areas, compared to 138,000 tons in the southern area and 24,500 tons in the northern area in 1988. In the 1988 survey it was not possible to directly measure wing spread of the trawl used, and the swept area for each haul used in calculations had to be based on a wing spread estimated from tank experiments. Model experiments suggested that the wing spread was between 24 and 29 m in 1988 and between 16 and 19 m in 1989. In-situ measurements in 1989 confirmed the latter range with a mean value of 17.2 m. Due to the difference in net geometry between 1988 and 1989 it is difficult to compare directly the biomass estimates obtained in the two years.

In 1989, a higher proportion of the stock was found in the southernmost area. In 1988, 26% of the estimated biomass was found south of 67°N, while in 1989, 41% was estimated for that area.

Shrimp samples from the 1988 and 1989 surveys indicated that, in 1988, the overall proportion between number of males and females in the surveyed stock was 72/28, while for 1989 the proportion was 86/14. The samples also indicated an overall reduction in mean weight of shrimp from 6.4 g in 1988 to 5.7 g in 1989.

c) Assessment Results

Figure 19 shows offshore catches in Subareas 0 and 1 (excluding catches from Northwest Greenland), the catch-rate index for seven Greenland trawlers in Div. 1B and the new standardized index for mean catch of large shrimp. The southward shift in the fishery in recent years may affect the interpretation of the CPUE-indices, which refer only to Div. 1B. This, however, remains the most important fishing area where about half of the total offshore catch was taken in 1989. The CPUE in the southern area increased from 1987 to 1988, and the fishing effort increased substantially from 1987 to 1989. While a number of interpretations for this increasing trend is possible, the decrease in catch rate from 1987 to 1989 in Div. 1B seems to reflect some decrease in abundance or availability over the period.

Considering that survey results indicate a relatively higher proportion of small shrimp in 1989 compared to 1988, and that the commercial catch rate of males in the index series for 22 Greenland sea-processing trawlers did not increase between the two years, higher non-reported discards in 1989 than in 1988 are indicated.

In 1989, a larger proportion of the total offshore catch in Subarea 1 was taken in Div. 1C and 1D compared to earlier years. Survey results also showed an increase in biomass south of Div. 1B. It appears, therefore, that in 1989 a higher proportion of the stock biomass was found south of 67°N. There is also an indication that the overall population is now composed of smaller shrimp than previously. The increase in the abundance seen in the southern areas may be an effect of the relatively low fishing intensity in that area in 1987 and 1988, and hopefully the northern area will show a similar increase in abundance by the lower fishing there in 1989.

d) Prognosis

All CPUE indices show a decrease since 1987 which may reflect a decline in stock abundance. Mean weight (size) of shrimp appears to have decreased between 1988 and 1989, and data suggest that the modal length of females decreased from 1983 to 1985.

These observations warrant more caution in the provision of advice for 1991. The TAC of 50,000 tons advised in 1989 for 1990 might lead to removals which are at or above what the stock can sustain. The reported catches in recent years have exceeded both the advised and the implemented TACs, and possible changes in discard practices may also have contributed to higher than advised removals from

lower catch level, but suggest caution in the short-term exploitation of this resource. Therefore, STACFIS advises that the TAC for 1991 not exceed 50,000 tons. STACFIS at the same time expresses great concern over the possibility of increasing discard rate and recommends that *direct observations on discard of shrimp in the shrimp fishery be made.*

e) The Greenland Shrimp Fishery North of 71°N (SCR Doc. 90/44 and 63)

Catches and TACs set (since 1987) for the entire history of the fishery off Northwestern Greenland are given in Table 11. Data suggest that the stock declined substantially between 1985 and 1988. Fecundity data suggest that berried females in this stock carry significantly less (20-40%) eggs than do females (of same size) at West Greenland (66°N). Therefore, reproduction in the north might be low compared to more southern stocks. This, coupled with a decrease in the abundance of large shrimp (i.e. females) might affect future recruitment to the stock. Therefore, as a cautious measure, it is suggested that the level of exploitation in 1991 should not exceed the 1989 level (2,500 tons).

21. Shrimp in Denmark Strait (SCR Doc. 90/11, 12, 42, 62, 64, 82, 91)

a) Introduction

The fishery on this stock was initiated in 1978 and increased during the following years to around 12,500 tons in 1988. In 1989 catches taken by Danish, Faroese, French, Greenlandic, Icelandic and Norwegian vessels decreased to around 10,700 tons. Reported catches and TACs throughout the history of the fishery are given in Table 13.

The shrimp fishery in Denmark Strait takes place primarily in the area of Strede Bank and Dohrn Bank as well as on the slopes of Storfjord Deep. The available fishing ground at a given time depends heavily upon the ice conditions. The main fishing area extends from approximately 65°20'N to 67°30'N and between 28°W and 33°W. During the last five years about 60 vessels participated in the fishery on the western side of the midline, and in 1987-89 about 30 vessels on the eastern side of the midline.

Table 13. Shrimp in Denmark Strait: nominal catches and TAC (tons).

Nation	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988[1]	1989[1]	1990[1]
Denmark	-	-	702	581	740	204	443	353	500	555	444	339	
Faroe Islands	-	-	4,233	713	737	443	668	674	727	595	679	595	
France	-	-	50	353	414	291	500	642	780	1,030	494	381	
Greenland	-	-	200	1004	1,115	1,467	2,250	2,596	5,781	6,627	7,456	5,981	
Iceland	363	485	759	125	-	43	742	1,794	1,150	1,330	1,424	1,326	
Norway	-	800	2,461	2,016	1,896	1,727	2,128	2,051	2,026	2,041	2,052	2,098	
Total	363	1,285	8,405	4,792	4,902	4,175	6,731	8,110	10,964	12,178	12,549	10,720	
Advised TAC	-	-	-	-	4,200	4,200	4,200	5,000	...	...	...	10,000[2]	10,000[2]
Effective TAC[3]	-	-	-	8,000	4,500	5,725	5,245	6,090	7,525[4]	7,725[4]	8,725[4]	9,025[4]	14,100

[1] Provisional data.
[2] Advised for a few years as a precautionary measure.
[3] On western side of midline only.
[4] Not including Greenland fishery north of 66°30'N.

b) Input Data

i) Commercial fishery

Fishing effort and CPUE. From 1986 to 1989 the total effort spent in the fishery doubled, while nominal catches remained at the same level. After an initial decrease catch rates remained relatively stable from 1982 to 1987 followed by a significant decrease in 1988 and a continued decrease from 1988 to 1989 (Fig. 20).

Evaluation of CPUE data from this fishery is complicated by several factors, e.g. variation in ice coverage, improvements in gear technology, incomplete data on fishing effort in some years, and unsubstantiated suggestions of changes in discard procedures in later years. In spite of these complications, the continued decrease in overall catch rates from 1987 to 1989 below the observed relatively stable level in preceding years may cause serious concern.

Biological data. Data from one French and one Norwegian trawler in March-April 1989 showed that shrimp with a modal group around 30 mm carapace length was dominating as in samples from previous years for all countries. Male shrimp were present in almost all samples, constituting by

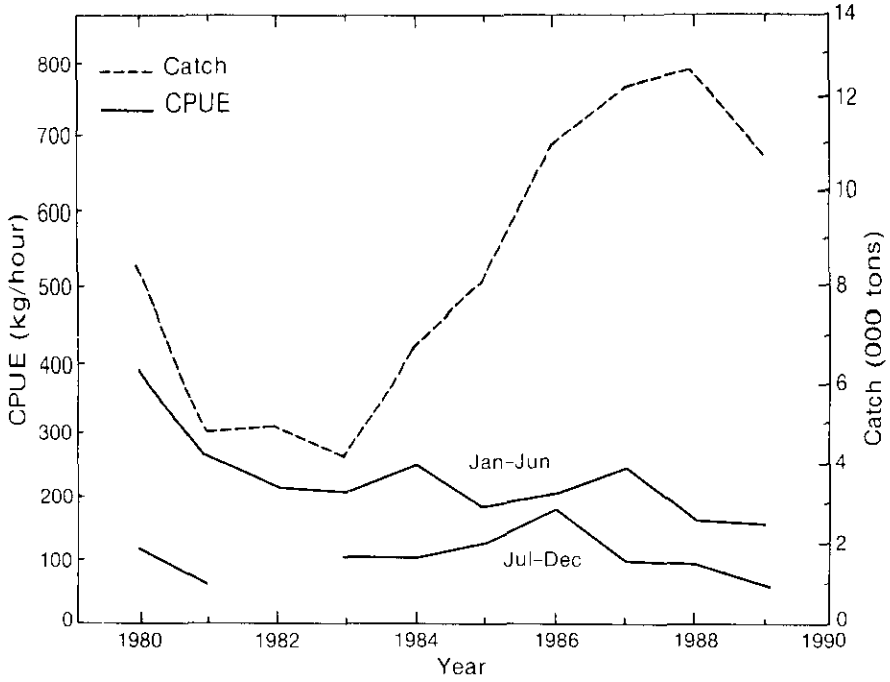


Fig. 20. Shrimp in Denmark Strait: CPUE for the January-June and July-December periods of 1980-89 compared with nominal catches.

Shrimp discards. There was no information on which reliable estimates of discards could be made. Discard procedures may have changed in later years due to market requirements for larger shrimp and development of effective grading machines. The high number of vessels in the fishery and vessel quota limitations may result in higher, not reported, amounts of discarded shrimp.

By-catches. Norwegian observer data from 1982 to 1989 indicate that the number of fish-per-kg of shrimp was substantially higher in 1987, 1988, and 1989 than in previous years. Small juvenile redfish dominated the by-catch, as has been the case in most years.

In response to a request from ICES (ACFM), STACFIS recommends that *experts having data on redfish by-catches and/or discards in the shrimp fishery forward such data to the Chairman of the ICES North-Western Working Group before the next meeting of that group.*

ii) Research vessel surveys

Since 1983 a Norwegian survey has been conducted in Denmark Strait every year in the autumn. The survey in August-September 1989 added new information on the distribution and biology of this stock. The distribution in numbers of males showed a normal pattern over the areas, being most abundant outside the grounds traditionally exploited. However, due to a decrease in numbers of females in the Dohrn Bank area, the ratio of males to females was larger east of 31°W in 1989 than earlier observed. Data from 1985 to 1989 indicate that a fairly stable proportion of the females (26-36%) do not prepare for spawning each year. 19% of the females still had head-roe (compared to about 5% in earlier years), suggesting a slight delay in spawning in 1989.

Shrimp samples showed one female mode at 30 mm carapace length as in earlier years.

Some noticeable changes in the shrimp stock were indicated for 1989:

1. The stock was more evenly distributed than previously, and over a larger area, i.e. concentrations of shrimp were less dense than in earlier years.

2. Males and females were more evenly distributed over the areas than earlier recorded.

3. In 1988 and 1989 the relative proportion of males was higher than in preceding years, but the geographical distribution was different from 1988 to 1989, as males in relation to the total number of shrimps were more frequent in the eastern part than in the western part of the survey area.

The biomass estimates by the swept area method for 1985-89 are as follows:

	1985	1986	1987	1988	1989	Average
Biomass estimate	31,300	44,200	25,200	49,600	35,000	37,060
Std Error, %	23.2	13.9	17.1	16.7	17.4	

Although a high variability was noted in the time series of survey estimates, it was agreed that the biomass has been relatively stable during these years. It was noted, that shrimp smaller than about 16 mm carapace length did not occur in survey samples, i.e. the stock component of juveniles and small males is not covered by the survey.

In 1989 a Greenland stratified-random trawl survey was conducted in the commercial area in Denmark Strait in August-September. The biomass estimated in this survey is not comparable to results of the Norwegian survey due to possible changes in stock distribution during the survey periods and to differences between gears.

c) Assessment Results

A general production model[2] using moving averages of 2- and 3-years estimated the maximum sustainable yield (MSY) to be between 10,000 and 11,000 tons. At 2/3 MSY effort, the yield was between 9,300 and 10,000 tons. It was noted that there were few observations at or beyond the MSY estimate, which suggested that the estimates were not very precise. Also, the fishery was not distributed over the entire stock area, which violates the assumptions underlying the use of such models.

d) Prognosis

Inclusion of data from 1989 in the data series shows the following trends:

1. A continuation of the decreasing trend in catch rates.

2. The Norwegian trawl survey in 1989 indicated a biomass estimate at the same level as the average from 1985 to 1988. The survey also showed that the higher occurrence of males found in 1988 continued.

Since 1986 the effort spent in the shrimp fishery has doubled, while catches have remained at the same level. This continued decrease in mean catch rate and the higher relative occurrence of males found in trawl surveys in 1988 and 1989 may indicate an increasing level of non-reported discards in the fishery, so that actual catches and catch rates in recent years may be significantly higher than recorded in landing statistics and logbooks. STACFIS found no basis for a change in advice and hence advises the TAC in Denmark Strait for 1991 be maintained at 10,000 tons.

[2] FOX, W. W., Jr. 1970. An exponential surplus-yield model for optimizing exploited fish populations. Trans. Am. Fish. Soc., 99: 80-88.

STACFIS at the same time expresses great concern over the possibility of increasing discard rate and STACFIS recommends that *direct observations on discard of shrimp in the shrimp fishery be made.*

III. RESPONSE TO FISHERIES COMMISSION REQUEST

1. Cod in Divisions 2J, 3K and 3L (SCR Doc. 90/23)

The Scientific Council was requested to: *continue to provide information, if available, on the stock separation in Div. 2J+3KL and the proportion of the biomass of the cod stock in Div. 3L in the Regulatory Area and a projection if possible of the proportion likely to be available in the Regulatory Area in future years. Information is also requested on the age composition of that portion of the stock occurring in the Regulatory Area.*

A comprehensive study of stock discrimination of Div. 2J+3KL cod was reviewed at the 1986 annual meeting (NAFO Sci. Coun. Rep. 1986, pages 121-124). The conclusions derived from that review were reiterated during the June 1989 meeting (NAFO Sci. Coun. Rep. 1989, page 111). No new analyses were currently available on this subject and hence previous conclusions remain unchanged. STACFIS noted, however, that analyses on the structure of the Div. 2J+3KL stock as well as the potential for assessing the entire management unit in smaller areas are ongoing.

Estimates of the proportion of the biomass of cod in Div. 3L in the Regulatory Area were updated with the 1989 Canadian RV survey information. Results were similar to those previously reported and are included in the following table:

Season RV survey conducted	Years RV survey conducted	Range of proportions of biomass occurring in the Regulatory Area (%)	Average proportion (%)
Winter	1985-86	23.8-26.8	25.3
Spring	1977-89	0.4- 6.1	2.7
Autumn	1981-89	0.5- 7.7	2.9

Autumn surveys in all three Divisions (2J, 3K and 3L), conducted by Canada since 1981, continued to indicate that the proportion of the cod biomass in the Regulatory Area at that time of year was less than 1%, on average, of the entire Div. 2J+3KL cod biomass. The average Divisional proportion of cod biomass derived from these surveys is as follows:

Division	Relative Proportion (%)
2J	41
3K	31
3L	28

With the assumption that the relative distribution between Divisions in autumn was similar to that of other times of the year, it was previously concluded that "the proportion of the entire Div. 2J+3KL cod biomass estimated to occur in the Regulatory Area is less than 10% in winter and less than 5%, on average, throughout the year". With the previous data series updated, this conclusion remains unchanged. It might also be reasonable to assume that, because proportions of cod biomass occurring in the Regulatory Area in Div. 3L exhibit no annual trends, proportions expected to occur would be about the same as those observed.

Age compositions derived from Canadian RV surveys in areas inside and outside 200 miles were also updated. The results of those comparisons were the same as those reported last year: during spring and autumn, when only a small portion of the Div. 3L cod biomass occurred outside 200 miles, a proportionately larger number of younger fish occurred in the Regulatory Area than the area inside 200 miles. During winter, when the maximum proportion of the Div. 3L biomass occurred in the Regulatory Area, age compositions for the area inside and outside the 200 mile zone were similar.

2. Cod in Div. 3M

The Fisheries Commission asked the Scientific Council, with respect to cod in Div. 3M, to comment on: *the appropriateness of establishing a minimum target level for the biomass, and to comment on the role of exploratory fisheries in providing data for stock assessment purposes.*

Establishing a minimum level for the exploitable biomass is not an appropriate target to judge the status of a stock, while spawning stock biomass is the relevant variable to be taken into account. The question on the spawning stock biomass was considered in last year's response to Fisheries Commission (NAFO Sci. Coun. Rep., 1989, page 112). The spawning stock biomass estimated for 1989 was judged to be below any desirable size, despite available survey data indicating that exploitable biomass could be at a level of

increase of the spawning biomass is not expected to occur before 1991, when the relatively abundant 1986 year-class becomes partially mature. This may never occur if fishing effort continues at the present level.

On the role of exploratory fisheries in providing data for the stock assessment purposes, the Scientific Council response given last year was in the light of moratorium on the Flemish Cap cod fishery which was expected to be effective (NAFO Sci. Coun. Rep., 1989, page 138). STACFIS notes that a cod fishery took place in 1989 estimated at *40;000 tons* and, presumably, is also taking place in 1990. In the light of this, catch-effort and sampling data of the fleets operating in the Flemish Cap need to be collected. If these data are available to STACFIS, together with the present survey data, they would be the bulk of the input for future analytical assessments of the Flemish Cap cod. The time series data on longline CPUE for Faroe Island vessels for the years 1973-75 were supplied as SCR Doc. 90/43, however, those values were not used in determining stock status.

3. Flounders in Divisions 3L, 3N and 3O

With respect to flounders in Div. 3LNO, the Scientific Council was requested to: *provide advice on management options that would reduce the extent to which the fisheries reduce the potential yield due to harvest of small fish.*

STACFIS noted that there were large numbers of juvenile flatfish removed in the Regulatory Area in 1989. The following tables show the comparison between the Canadian, Spanish and USA fisheries for 1) yellowtail flounder and 2) American plaice in Div. 3LNO in 1988 and 1989.

Yellowtail flounder

	1988			1989		
	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch
Canada	10,614	19.6	0.54	5,007	9.8	0.51
EEC-Spain	3,205	24.0	0.13	1,126	12.4	0.09
USA	861	1.8	0.48	319	0.7	0.44

American plaice

	1988			1989		
	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch	Catch(t)	Catch (millions of fish)	Mean wt. (kg) of fish in catch
Canada	26,900	37.9	0.71	27,900	39.9	0.70
EEC-Spain	8,900	15.9	0.56	10,600	38.2	0.28
USA	1,400	1.7	0.82	1,100	1.3	0.85

The peak lengths in the Spanish catches of flatfish in Div. 3NO in some months in 1989 were 18-22 cm. Selectivity studies for American plaice indicate that the 25% retention length for 130 mesh is 27 cm. STACFIS concluded that the effective mesh size used in the Spanish fishery for flatfish in Div. 3NO was probably much smaller than the NAFO regulation minimum size, and may have been as small as 60 mm.

Information from the Canadian fleet in 1988 showed that the discard rate of yellowtail flounder was less than 3% in all areas and that the discard rate for American plaice was at a similarly low level in almost all areas. The mesh size used by the Canadian offshore fleet is 135 mm, and the minimum acceptable size for flatfish is 28 cm.

The obvious way to reduce the loss in potential yield due to the harvest of small fish is to ensure that the regulations determining the minimum effective mesh size are adhered to. Juvenile flatfish surveys have repeatedly shown that small flatfish are concentrated on the southern Grand Bank, with a high proportion of these small fish occurring in the Regulatory Area. At the present time, closed areas and/or seasons are not possible to define without detailed information on the time, place and length frequency distribution of catches of juvenile flatfish in the Tail of the Bank area. This information was requested by Scientific Council in 1989 (NAFO Sci. Coun. Rep. 1989, page 137). With the exception of some information on the location of Canadian catch in 1986-88 and the discard rate in the Canadian fleet in 1988, both on a scale larger than 1° by 1° squares, there were no data provided at the June 1990 meeting.

4. On Catches Exceeding TACs

The Scientific Council was asked: *with respect to stocks from which catches have recently been significantly in excess of the NAFO TACs, analysis is requested on the effect such catches have had in determining present stock status.*

STACFIS noted that TACs had been significantly exceeded in recent years for the following stocks occurring in the Regulatory Area and where TAC advice was provided by the Scientific Council:

	1986		1987		1988		1989**	
	TAC agreed	Catch	TAC agreed	Catch	TAC agreed	Catch	TAC agreed	Catch
Cod 3M	13	15	13	8*	0	40*	0	40*
Cod 3NO	33	51	33	42	40	43	25	33
Redfish 3M	20	29	20	44	20	23	20	27
Redfish 3LN	25	43	25	79*	25	53*	25	24
A. plaice 3M	2	3.8	2	5.6	2	2.8	2	3.9
A. plaice 3LNO	55	65*	48	55	40	42*	30.3	44*
Yellowtail 3LNO	15	31	15	16	15	16	5	7.6*
Witch 3NO	5	9	5	8	5	6	5	4

* Includes an estimate of non-reported catches.
** Provisional, apart from those with an asterisk.

The above catches are the nominal catches as officially reported to NAFO together with non-reported catches where these are available. Non-reported catches occurred in other years and stocks than those with an asterisk but no estimates could be made.

Exceeding TACs has little effect on the ability to conduct the assessments provided that information on total catch and effort together with sampling data is made available.

The catches of non-members are difficult to both qualify and quantify. For instance, for cod in Div. 3M, although reported catches give the appearance that the moratorium has been respected, a figure of 40,000 tons has been estimated from catch and effort data of non-member countries' pair trawlers fishing for cod in Flemish Cap, and from sightings of fishing boats reported by the Canadian Department of Fisheries and Oceans (DFO) including single and pair trawlers. But due to the lack of precise knowledge on catches-at-age by fleet component for several years, an analytical assessment was not possible. The present status of that stock was evaluated from research survey data. Simultaneously, it is believed that in 1989 some proportion of the cod catches actually taken in Div. 3M are reported in Div. 3L, despite the moratorium in Div. 3M.

For other stocks, such as redfish in Div. 3M, the lack of data concerning the fishery activities of non-member countries hampered the usefulness of an analytical assessment. For determining the present stocks status, the effect of under/over-reporting and misallocating catches to areas will consequently bias the analytical stock assessments like sequential population analysis.

It is therefore recommended that *initiatives should be taken to obtain more accurate catch and effort data as well as sampling data from the fisheries in the Regulatory Area in order to assess the stocks.*

5. Stocks of Mesopelagic Species and Atlantic Saury

The Scientific Council was asked to: *review available data on stocks of mesopelagic species and on Atlantic saury that might occur in the Regulatory Area, and to provide advice on possible management measures for these stocks.*

With respect to Atlantic saury, STACFIS noted investigations conducted in late-1960s and 1970s revealed that some stock of Atlantic Saury (*Scomberesox saurus*) existed in the southern part of the NAFO area. During the June 1990 Scientific Council Meeting, no information was presented on the assessment and biology of this fish. Specialized investigations were needed to find out to what extent the Atlantic saury stock could sustain a pelagic fishery within and outside the 200-mile zone. STACFIS could provide no management advice at the present time.

With respect to mesopelagic species, STACFIS noted that several USSR investigations were done on the distribution of mesopelagic fish (mainly four species: *Benthosema glaciale, Maurolicus muelleri, Notoscopelus elongatus, Ceratoscopelus maderensis*) in the continental

shelf slope area off Labrador and Newfoundland in 1981-87. Some results of those investigations on the species and length-age composition of the catches and on the density of the species distribution in Subareas 2 and 3 covered by surveys in 1981-87 were presented to the Scientific Council as SCR documents during 1983-88. No information on the mesopelagic species were presented during the June 1990 Meeting of the Scientific Council. STACFIS agreed that the available information on the stocks of the mesopelagic species seemed to be insufficient to provide advice on possible management measures.

IV. ENVIRONMENTAL RESEARCH

1. Introduction

The ninth meeting of the Subcommittee on Environmental Research was held on 12 June 1990 with M. Stein (EEC) as Chairman. Annex 1 contains the detailed report of the meeting.

2. Review of Environmental Studies in 1989

A total of 16 documents dealing specifically with environmental issues and another 9 papers which used environmental data for analysis were reviewed. Thus, a total 25 documents referred to environmental conditions in Subareas 0-6 during 1989.

The cold air temperatures in West Greenland through most of 1989 suggested colder-than-normal sea temperatures based on previous studies. Extensive ice conditions were reported in the Davis Strait region, with the areal ice coverage during April being the largest reported in the past 20 years. A study on the variability of a shelf edge front on the NE Newfoundland Shelf indicated characteristic periods of 7 days in horizontal displacement, possibly forced from up-stream areas of the Labrador Shelf. Negative temperature anomalies in the bottom waters on the Labrador Shelf might explain the observed high catches of Greenland halibut and roundnose grenadier in waters much deeper than normal.

3. Overview of Environmental Conditions (SCR Doc. 90/83)

A review paper was presented based on several long-term oceanographic meteorological data sets as well as summary of data and results from available research documents and research reports. Near coastal surface temperatures collected from ships-of-opportunity indicated warm water from Cape Hatteras to southern Labrador during the summer and generally cold water in December. Sea-surface pressure anomalies showed an intensification of the Icelandic Low and the Bermuda-Azores High, especially in winter and spring. A westward shift of the High in spring brought warm air into much of the NAFO area which would account for the above normal summer conditions.

4. Effects of Climate Change on Fisheries (SCR Doc. 90/78)

A paper presented discussed the present state of climate models and possible implications for fish and fisheries if global warming occurred. Indications of such implications may be derived from observations of the natural variability in the system under the present conditions.

5. Election of Chairman

The chairman of the Environmental Subcommittee ends his term of office after the September meeting in 1990. An election was held by STACFIS on 16 June 1990 for the two-year term beginning in September 1990. M. Stein was unanimously elected for those two years of office. The STACFIS chairman thanked M. Stein for the two years he had served with distinction and welcomed him to another two years as chairman of the Environmental Subcommittee of STACFIS.

V. AGEING TECHNIQUES AND VALIDATION STUDIES

1. Reports on the Otolith Exchanges

a) Silver Hake

STACFIS noted that ageing done by the Canadian and the USSR age readers were now in good agreement. Given the unavoidable within-reader variability, STACFIS considered that no further improvements were likely to be forthcoming from the exchanges nor were further improvements required for the assessment of the silver hake stock. STACFIS recommends that *a manual be issued documenting the established*

methods of ageing silver hake otoliths. The STACFIS chairman thanked the Canadian and USSR laboratories for the effort put into solving the problems encountered in silver hake ageing.

b) American Plaice in Divisions 3L and 3M

An exchange of otoliths of American plaice from Div. 3L and 3M, between Canada and EEC-Spain, was conducted in 1990.

The inter-reader agreement in Div. 3L was 56%, with Spanish readers interpreting more rings than do Canadian readers. The low inter-reader agreement was due to different criteria to identify duplicated rings.

The agreement in Div. 3M was 27%, with Spanish readers reading fewer rings than Canadian readers. The more important differences were identified to be in the interpretation of the otolith nucleus.

Previous studies indicate better agreement in otolith reading of American plaice from Div. 3N, where most of the Spanish catch occurs. EEC-Portugal will participate in the exchange program in the future and STACFIS recommends that *further exchange of otoliths of American plaice from Div. 3L and 3M be conducted.* Such exchanges should be accompanied with photographs showing the criteria used in the interpretation of the nucleus and the duplicated rings.

c) Greenland Halibut

STACFIS was informed of problems with inter-reader variability between scales and otolith reading for Greenland halibut involving Canada, EEC-Portugal, EEC-Spain, Greenland, GDR and USSR. STACFIS recommends that *exchange of otoliths and scales accompanied with photograph showing criteria used in the interpretation of rings be conducted for Greenland halibut.*

VI. GEAR AND SELECTIVITY STUDIES

1. Selectivity in Shrimp Trawl (SCR Doc. 90/56)

A preliminary selectivity study was conducted in 1989 in a West Greenland fishing area to estimate the selectivity of a commercial trawl with varying mesh sizes (43 and 60 mm) and shapes (diamond and square).

The diamond mesh trawl clearly showed a selection factor (0.25-0.30), different from that of the square mesh trawl (approximately 0.40).

VII. REVIEW OF SCIENTIFIC PAPERS

STACFIS reviewed 2 research documents not reviewed elsewhere. The reviews are given below.

1. Winter Fishing for Cod in 3Pn and 4RS (SCR Doc. 90/89)

A description of the St. Pierre and Miquelon and EEC-Metropolitan France winter fishery for the 3Pn, 4RS cod stock was presented. Data were collected by the various Canadian observer programs and covered the years 1978-89.

Maps of localities of fishing stations were presented and indicated a distribution of fishing activity in a north-south direction at a modal depth of 175 meters.

The various graphs presented implied that fleet movements can be used as an indicator of cod movements. The fleet follows the annual pre-spawning migration outside the Gulf of St. Lawrence into Subdivision 3Pn and the subsequent return in April-May.

Catch rate analyses indicate high inter-annual variability with peaks in 1984 and 1986. The patterns depicted were similar to those of the biomass estimates from the winter groundfish survey. The high variability of the indices were thought to be the result of environmental influences on cod distribution in winter.

2. Shrimp at Flemish Cap (Division 3M) (SCR Doc. 90/47)

Two groundfish research cruises with 35 mm cod-end mesh size were performed on Flemish Cap in the summer of 1988 and 1989. Mean catch of shrimp over three depth strata varied from 4.5 to 10 kg. Biomass estimated by the swept area method was 2,164 tons in 1988 and 1,865 tons in 1989. Further surveys designed to study abundance and distribution of shrimp in the area are anticipated.

VIII. OTHER MATTERS

1. Review of Current Arrangements for Conducting Stock Assessments

STACFIS discussed this topic briefly but decided to defer the considerations until the September 1990 Meeting. At that meeting, STACFIS will review the "designated expert" system and make arrangements for the 1991 assessments. The "designated expert" system had been successful although still some problems remain with respect to the timely submission of data. The responsibility for documentation of data for the Scientific Council and the status of the preliminary assessments prepared by the designated experts should be clearly defined.

2. Working Group on Shrimp Ageing (SCS Doc. 89/22)

This Working Group met in Reykjavik 16-19 October 1989 and reported to STACFIS (see Annex 2 below). It was noted that several papers studied different methods aimed at establishing length-based assessments of shrimp stocks and STACFIS welcomed progress towards more analytical type assessments of shrimp stocks.

3. CAFSAC Special Invertebrate Subcommittee Meeting on Shrimp

CAFSAC had in December 1989 reviewed assessments of some shrimp stocks and the conclusions were presented to STACFIS. A system with several indicators of the development in abundance i.e. survey indices, changes in length distributions, catch rates from the commercial fishery etc. might together enable a feedback control management. Given the shortcomings in the assessments of shrimp stocks, this may well be the most viable approach available at present.

4. Special Session 1990

The progress report on contributions for the 5-7 September 1990 Special Session on "Management under Uncertainties related to Biology and Assessments" by the convenor J. Shepherd, UK, stated that 20 submissions have been announced and that the meeting arrangements are well underway.

5. Special Session in 1991.

STACFIS noted with regret the death of R. Wells, who had agreed to convene the 1991 Special Session. Holger Hovgård, Greenland had been asked and had kindly offered to convene this session, and STACFIS welcomed this. Further, it was decided to dedicate this Special Session in memory of Richard Wells.

6. Theme for Special Session in 1992

The discussion of this item was deferred to the September 1990 Meeting.

7. Adjournment

There being no further items on the agenda, the Chairman thanked the participants for their contributions, in particular those who were "designated experts". The Chairman further thanked the Secretariat for their very efficient services. He welcomed the newly elected Chairman of STACFIS who will take office after the September 1990 Meeting, and hoped that his term of office would be enjoyable.

ANNEX 1. REPORT OF THE SUBCOMMITTEE ON ENVIRONMENTAL RESEARCH

Chairman: M. Stein Rapporteur: K. Drinkwater

The Subcommittee met at the NAFO Headquarters at 192 Wyse Road, Dartmouth, Nova Scotia, Canada, on 12 June, 1990, to consider environment-related topics and report on various matters referred to it by STACFIS. Scientists attended from Canada, Cuba, Denmark (Faroe Islands/Greenland), EEC, GDR, Iceland, Japan, USSR, and USA.

The Subcommittee reviewed the following documents: SCR Doc. 90/01, 10, 13, 14, 16, 17, 24, 25, 26, 27, 32, 34, 67, 77, 78, 79, 83, and 84; SCS Doc. 90/05, 07, 08, and 14.

1. Chairman's Report

The Chairman began the meeting by noting regretfully the death of Dick Wells from St. John's, Newfoundland. Dick was an active participant within the Environmental Subcommittee for many years and will be missed.

The Chairman was happy to see an increase in the number of environmentally-related papers submitted this year. He brought to the attention of the Subcommittee a proposal for a multinational project to coordinate fishery hydrographic activities in the North Atlantic by F. Fuchs of the Institut für Hochseefischerei und Fischverarbeitung, German Democratic Republic (SCR Doc. 90/79). Dr. Fuchs proposed creating a large database of hydrographic information and fisheries statistics that could be shared among participants. After some discussion of this proposal the Chairman suggested that interested individuals should write Dr. Fuchs to give him their comments and criticisms.

2. Marine Environmental Data Service (MEDS) Report for 1989 (SCR Doc. 90/84)

MEDS is in the process of rebuilding their data handling system. This has not affected their real-time data acquisition systems but many of the recent data sent to MEDS have not yet been processed. Processing of the data is expected during the coming year.

a) Data Collected in 1989

Data from approximately 1,400 oceanographic stations were sent directly to MEDS in 1989. Additional data from 2,361 oceanographic stations were received through IGOSS (Integrated Global Ocean Services System).

The number of stations occupied whose data have not been received by MEDS was uncertain but exceeded 2,000.

The number of stations received by MEDS was about half that of last year. Many of the Canadian institutions had not sent their 1989 data to MEDS. It was expected that MEDS will receive these data once the new data handling system was in place.

b) Historical Data Holdings

Data from approximately 4,500 historical hydrographic stations were received by MEDS in 1989, which was a significant drop from last year when MEDS received a large volume of historical data from the World Data Centre.

c) Drift-buoy Data

A total of 86 drift-buoy tracks were received by MEDS during 1989 representing 143 buoy months. This amounted to an increase of 20% in buoy tracks and 6% in buoy months over last year. Most of the buoy data during 1989 were gathered in the early part of the year with fewer data collected in the summer and autumn.

d) Current-meter Data

Current-meter data collected in 1989 within the NAFO area included 35 sites, 93 instruments, and a total of 535 meter-months. This represented a large increase over last year.

e) Wave Data

There was an increase of 40% in the number of wave spectra collected this year over last including an increase in directional spectra.

f) Environmental Conditions

A review of monthly sea-surface temperature anomalies in 1989 for each of the NAFO subareas was presented.

These were based on a MEDS analysis, temperature anomaly maps published in the USA, and BIO monthly reports. Colder-than-normal conditions prevailed over most of the region during the early part of the year but temperatures were warmer than normal during the summer. By year's end temperatures had fallen below average. An exception to this pattern was Subareas 5 and 6 where cold conditions were reported throughout most of the year.

3. Review of Environmental Studies in 1989

a) Subareas 0 and 1 (SCR Doc. 90/16, 17, 32, 34, 77; SCS Doc. 90/05, 07, 14)

The Danish Research Report (SCS Doc. 90/14) noted that hydrographic observations were collected during June-July 1989 along standard sections between Fylla Bank and Disko Bay off West Greenland. The cold air temperatures in West Greenland through most of 1989 suggests colder-than-normal sea temperatures based on previous studies. Temperature anomalies during the summer cruise were found to be negative over the top 400 m of the water column.

The Canadian Research Report (SCS Doc. 90/07) noted that current meters moored at 5 sites across Davis Strait in 1988 were recovered in 1989 and five replacement moorings were deployed.

Data collected in October off Baffin Island by the USSR (SCR Doc. 90/10; SCS Doc. 90/05) indicated that near surface temperature and salinity were higher in 1989 than in 1988. The higher temperatures resulted from radiative heating in the spring and summer. Bottom waters over the Baffin Island Shelf were found to be colder than in 1988. Extensive ice was reported in the Davis Strait region, with the areal ice coverage during April being the largest reported in the past 20 years.

By May, however, the ice was just slightly above normal.

Data from standard sections off southern West Greenland show that cooling was normally accompanied by a decrease in salinity in the surface waters suggesting an influence of polar waters from East Greenland (SCR Doc. 90/17). Such an effect was observed in 1989 during the autumn. Also, higher numbers of icebergs than normal were found in the region in 1989.

Drift-tracks of buoys released east of Iceland and off southeast Greenland were reported in SCR Doc. 90/32. They confirmed historical circulation patterns in the region; buoys flowed southward along East Greenland, northward along West Greenland and then moved westward between 61° and 64°N.

Data were presented on variability in the temperature and salinity of waters on Fylla Bank over several days (SCR Doc. 90/16). The implications of such variability on the determination and reliability of annual anomalies were discussed.

A paper was presented (SCR Doc. 90/77) on the processes controlling the temperature and salinity of the waters at Fylla Bank. The importance of both local air-sea fluxes and advective processes forced by the large-scale atmospheric circulation patterns was discussed.

A study of cod otoliths was described (SCR Doc. 90/34) in which it was noted that different hydrological conditions affect cod growth. The discussion went on to suggest the possibility of using otoliths to investigate past climate conditions. Subcommittee members pointed out, however, that other factors also affect cod growth and that using otoliths to investigate climate changes might be very imprecise.

b) Subareas 2 and 3 (SCR Doc. 90/10, 67; SCS Doc. 90/05, 07)

The Canadian Research Report (SCS Doc. 90/07) noted that the current meter mooring program that has been ongoing for over 10 years was continued during 1989.

Extensive hydrographic work was also reported throughout the area including the occupation of the standard transects. Important physical oceanographic studies were also undertaken on the Southeast Shoals and at the ice edge (LIMEX--Labrador Ice Margin Experiment) during 1989.

A study of the variability on the temperature/salinity/density front at the shelf edge on the NE Newfoundland Shelf was described (SCR Doc. 90/67). The greatest variability was found at periods of 7 days. The cause of this variability was not locally generated but was believed to be forced on the Labrador shelf and advected onto the NE Newfoundland Shelf. The warming of the cold intermediate layer on the NE Newfoundland Shelf appeared to commence in late July to early August at the time of the annual occupation of the Bonavista Line for NAFO. It was pointed out that this might significantly alias any annual anomalies calculated from the transect data.

Data collected in autumn by the USSR indicate that, similar to the Baffin Island Shelf, the near surface waters were warmer than normal whereas in the bottom half of the water column temperatures were colder than average (SCR Doc. 90/10; SCS Doc. 90/05). These anomalies were attributed to atmospheric conditions, a warm spring and summer, and a cold winter. Colder-than-normal water near bottom was also reported over extensive areas of the Grand Banks and northern Newfoundland Shelf. The GDR Subcommittee member noted that the cold bottom waters on the Labrador Shelf might explain the high catches of Greenland halibut and roundnose grenadier in waters much deeper than normal (up to 1,600 m) during the GDR fishing season in the second half of 1989. The cold conditions on the shelf might have forced Greenland halibut and roundnose grenadier deeper to reach their preferred temperature regime dependent on the physiological stage.

c) Subareas 4, 5, and 6 (SCR Doc. 90/01, 13, 14, 24, 25, 26, 27, 66; SCS Doc. 90/07, 08)

Major oceanographic studies reported by Canadian researchers (SCS Doc. 90/07) included nutrient investigations in upwelling regions of the Gulf of St. Lawrence, current and hydrographic field studies on Georges Bank, hydrographic measurements in the Gulf of St. Lawrence and on the Scotian Shelf, and completion of the Fisheries Ecology Program on Browns Bank.

The USA Research Report provided analyses of data collected as part of a study of the Hudson Shelf area which showed a strong association between wind and currents.

Hydrographic measurements were collected throughout Subareas 5 and 6 including Georges Bank in connection with a study of the resurgence of the Georges Bank herring stock.

Environmental information collected in 1988 as part of a study on silver hake distributions on the Scotian Shelf were reviewed (SCR Doc. 90/01, 14).

Data collected on the US bottom trawl research surveys for the years since 1963 were presented in terms of anomalies within four regions between Nova Scotia and Cape Hatteras (SCR Doc. 90/13).

A paper on the life histories of warm-core rings in the Slope Water region west of 60°W was presented (SCR Doc. 90/25). Ten rings were formed in 1989, one more than the 1974-1988 average.

Results from temperature and salinity monitoring along transects across the Gulf of Maine and in the mid-Atlantic Bight south of New York were reported (SCR Doc. 90/26, 27). In 1989, Gulf of Maine sea-surface temperatures were below normal during the first part of the year, above normal during spring and summer and were below normal by the end of the year. In the mid-Atlantic Bight, cold temperatures recorded at the beginning of the year persisted throughout the summer and appeared to move inshore in the latter half of the year.

In 1989, the shelf-water temperature front between Georges Bank and Cape Hatteras was located near the long-term (1974-83) mean position (SCR Doc. 90/24). Its variability was near to its long-term average. Large fluctuations were associated with the passage of warm-core rings.

4. Overview of Environmental Conditions in 1989 (SCR Doc. 90/83)

A review paper was presented based on several long-term oceanographic and meteorological data sets as well as summarized results from available research documents. *Highlights* not covered in Section 2 are listed below.

a) Annual coastal sea temperatures at Halifax, St. Andrews, and Boothbay Harbor were below their 1951-80 means.

b) Offshore surface temperature data collected from ships-of-opportunity showed a positive annual value throughout the NAFO area except for the western slope waters.

c) Near coastal surface temperatures collected from ships-of-opportunity indicated warm water from Cape Hatteras to southern Labrador during the summer and generally cold water in December. Similar results were observed at standard coastal temperature stations and at oceanographic stations off St. John's, Newfoundland, and in the Bay of Fundy.

d) Near-bottom temperatures at Station 27 off St. John's, Newfoundland, were colder-than-normal for the seventh consecutive year.

e) The number of icebergs crossing 48°N was 301, an increase of over 100 from last year.

f) Mean annual air temperatures were negative over most of the NAFO area in 1989. This was a result of colder-than-normal conditions in the winter and autumn. Summertime temperatures, however, were generally above normal.

g) Sea-surface pressure anomalies showed an intensification of the Icelandic Low and the Bermuda-Azores High, especially in winter and spring. A westward shift of the High in spring brought warm air into much of the NAFO area which would account for the above average summer air and sea temperatures.

5. Other Matters

a) No changes in the national representatives responsible for submitting oceanographic data to MEDS were reported to the Subcommittee. These representatives are R. Keeley (Canada), R. Dominguez (Cuba), E. Buch (Denmark), Ch. Brockman (Federal Republic of Germany), Francois (France), W. Thiele (German Democratic Republic), Y. Uozumi (Japan), R. Leinebo (Norway), A.J. Paciorkowski (Poland), G. Withee (USA), G.I. Luka (USSR), and P. Edwards (United Kingdom).

b) The Chairman noted the increasing concern with the CO_2 problem and global warming. He felt that the effects of climate change on fisheries should be addressed. To this end he presented a paper (SCR Doc. 90/78) on the present state of the climate models and the implications for fish and fisheries. During the discussion which followed it was noted that the natural variability in the system has provided us with some indications of what might happen if global warming does occur. Others pointed out, however, that a change in the mean state (i.e., higher mean temperatures) might produce a significantly different response.

c) The Subcommittee discussed some possible topics for the 1992 Special Session. Among these were the possible effects of CO_2-induced warming on fisheries and a review of environmental conditions during the 1980s. It was suggested that members of the Subcommittee who wished to propose a certain topic do so in writing to STACFIS.

6. Acknowledgements

The Chairman closed the meeting by thanking the participants for their contributions and cooperation.

ANNEX 2. REPORT OF WORKING GROUP ON PROGRESS IN AGE DETERMINATION OF *PANDALUS*

Chairman: D. G. Parsons Rapporteur: Various

1. Introduction

A working group on progress in age determination of *Pandalus* met at the Marine Research Institute, Reykjavik, Iceland, during 16-19 October 1989. The meeting was convened by U. Skúladóttir (Iceland) and chaired by D. G. Parsons (Canada). A total of 15 scientists attended the meeting representing Canada, Greenland (Denmark), Iceland, Norway, Sweden and USA and 10 papers were presented (SCR Doc. 89/89 to 89/98, inclusive). In addition, there were demonstrations of various software packages as well as digital calliper data collection systems.

The objective of this meeting was to determine what progress had been made in age determination of *Pandalus* since the 1981 workshops held in Canada in May and November. At the 1988 June Meeting of the Scientific Council, it was agreed that the meeting should take the form of a working group rather than a workshop, with the presentation of prepared papers. It was hoped that attendance would include the participants of the 1981 Workshop as well as others who might have relevant information to present. The list of participants and documents presented at the meeting were given in the *NAFO Sci. Coun. Rep.*, 1989.

2. Specific Topics of Presentations

a) Characteristics of Various Shrimp Stocks

There were five papers presented on the characteristics (growth, migration, mortality) of various shrimp stocks. Areas considered in the presentations included the Gulf of Maine, the Gulf of St. Lawrence and the Davis Strait in the Northwest Atlantic, Pavlof Bay in the western Gulf of Alaska and the Gullmarfjord on the Swedish west coast.

The high variability in the length frequency distributions (LFDS) of the Gulf of St. Lawrence shrimp population was analyzed with cluster analysis, dissimilarity variograms and multivariate correlograms. LFDs were never randomly organized but showed well-defined homogeneous assemblages which occurred over the grounds every year. The spatial organization, associated somewhat with the topography of the shrimp grounds, resulted from large gradients apparently related to the ontogenic depth migration of the shrimps. The growth rate was not stable over the spatial structures because of the effects of the migration of shrimps in the temperature gradient. The same approach, using a cluster analysis to combine similar samples, was taken to study the age and growth of shrimp in the Davis Strait. In general, modes occurred from year to year at approximately the same sizes both for males and females. However, there were several inconsistencies on a smaller scale that could be the results of differences in the growth rate of individual cohorts and/or in the spatial organization of the LFDs. The comparison of the results from Davis Strait with more southern areas of the Northwest Atlantic indicated that the general pattern conformed well to the fact that growth and maturation are delayed in colder water, resulting in increased longevity. The participants agreed that multivariate analysis could be a very objective tool to pool samples in order to analyze them and therefore, in describing the spatial organization of a shrimp population. There was some discussion on whether or not the samples should be weighted by the catch when pooled together. It was apparent that computing numbers-at-age is not a simple task and that there is a need to integrate simultaneously the spatial structures and the density patterns of a population.

Data on LFDs from a collection of suprabenthic samples of the Gulf of St. Lawrence were also presented and indicated that the mean size of the first age-group in the shrimp population was about 7 mm (carapace length). Annual growth of the first three age-groups found at low temperatures (0.5-1.5°C) was 4-5 mm/year. Summer growth rates were three times as high as those in the rest of the year. It was noted that the L-infinity value was very high for this area and was probably due to incomplete data for the older ages.

Based on LFDs of monthly trawl samples of the Gullmarfjord, von Bertalanffy growth curves were calculated for the 1982-85 year-classes. Variations in CPUE, sex ratios and LFDs before and after the water exchange indicated that new demographic patterns were produced as a result of migration of shrimp over the sill area

during the water renewal period (late winter-early spring) each year. However, these demographic patterns can develop without migration during the stagnation period each year. It was apparent that seasonal variations in growth seem to be the rule in this fjord. The data indicated that growth rate differed between sexes and it was felt that this should be further investigated along with the correlation between variations in growth and ecological factors (e.g. temperature, primary and secondary production).

LFDs collected from annual surveys of the Pavlof Bay shrimp stock over an 18 year period were studied to estimate age and mortality. Differences were observed in growth and mortality between dominant year-classes under a high density regime and a series of year-classes under lower abundance conditions. Discussions focused on density dependence *vs* temperature, high mortality due to cod predation and the apparent lack of fishery effects.

Elements of the assessment of the northern shrimp stock in the Gulf of Maine were presented. Landings, effort and CPUE in the 6 month fishery have all increased slightly in 1989. The summary research cruise index in numbers of >22 mm shrimp per tow increased as well in 1989, indicating the beginning of recruitment of the strong 1987 year-class. Discussion of the assessment centred around the effects of occasional strong year-classes on modal analysis. The concept of availability of shrimp to the research and commercial trawls and its effects on biomass estimates and quotas were also discussed as was the necessity of obtaining oceanographic data (temperature and water mass displacement) to help explain the observed differences in growth and to see if there is a link with the population or the cohort density. The participants also agreed on the importance of identifying the very young cohorts (age 0 an 1) for all populations.

b) Models and Applications

There were five presentations on various models and their application to shrimp length frequency data in order to determine the age structure or the numbers-at-age of the studied population. Samples of shrimp in Davis Strait were analyzed with the MIX program to investigate the sensitivity of modal analysis. It appeared that, in terms of goodness of fit, several "correct" answers could be obtained assuming different numbers of components for a single set of data. Also, for a single set of data and a given number of components, the starting values for standard deviations or the preparation of data may have a strong influence on the proportions of the components estimated by the analysis, particularly in cases in which the components are overlapped. Based on the observations, it appeared that it would be very difficult, in certain cases, to produce reliable catch-at-age data with this type of analysis, given the sensitivity of the estimated proportions to the input parameters.

A method for simultaneously analyzing multiple length frequency data sets (MULTIFAN) was presented. The proportions of animals at age in each sample and the parameters of the von Bertalanffy growth equation are estimated objectively using a robust maximum likelihood method. The ability to simultaneously analyze multiple samples permits the method to exploit the extra information not available when analyzing samples one by one. The method was applied to LFDs from the pink shrimp (*P. jordani*). The participants agreed that the method was very interesting and the discussion centred on the use of MULTIFAN with respect to the presence of seasonal growth, sampling bias associated with the first modes, the numbers of age-groups and the relationship between the variance and the mean length. The calculation of mortality rates using MULTIFAN requires sample weighting so that the length frequencies are representative of the population density. It was also felt that the variations in growth rates of cohorts could cause problems. However, constraints on means and proportions can be incorporated if more structure is needed.

Shepherd's length composition analysis (SRLCA) was applied to research trawl survey catches of Gulf of Maine northern shrimp to test the ability of the method to interpret the age structure of annual length frequency distributions incorporating significant variation in growth and recruitment rates. The performance of the method was evaluated by comparing the von Bertalanffy growth parameters provided by SRLCA and subsequently derived age frequencies and instantaneous total mortality rates with previously accepted results using simple visual inspection of the annual LFDs. Shepherd's method was able to provide an interpretation of the data close to a priori assumptions, although some information external to the procedure was needed in order to select the best interpretation from among several locally optimal solutions. Participants noted

that SRLCA might provide reasonable results for this stock in part because the growth rate results in annual LFDs that often exhibit very distinct modal structure. It was felt that for other shrimp stocks with a slower growth rate and some overlapped components, the modal structure of the LFDs may not be suitable for the SRLCA analysis.

A virtual population analysis was performed on data from a fjord in Iceland. Samples from the fishery and the February research surveys were used to build the catch-at-age matrix, using the method of Macdonald and Pitcher (1979) to determine the proportions and the mean length-at-age. The biomass of the most important year-classes of the shrimp stock obtained from the VPA was regressed against the corresponding indexes obtained from the research surveys (area swept method). There was a significant agreement between the two methods. Moreover, it was shown that the results for the biomass estimates of the 1-3 year olds could be used to predict a value for the research survey the following winter. Although the participants found the VPA promising because there was indeed good agreement between the two methods, they were concerned that there was generally a very high fishing mortality calculated for the age four animals (the oldest being age five). However, the authors pointed out that the convergence of the F-values was very rapid so the results for the younger age-classes should be reliable.

A new method was presented for a simultaneous analysis of length and age data of the Gulf of St. Lawrence shrimp. The model essentially asks what synthetic population can be constructed which best fits the observed commercial catch and research survey length distributions? The model, called synthetic age population analysis (SAPA), uses a simultaneous cohort equation to build a population from the commercial sampling which is then fitted to the research data by using a non linear least squares technique. The required inputs are an estimate of the natural mortality, a template of the size distributions at each age, a pattern of selectivity and an estimate of the terminal F. The parameters to be fitted by the model are the starting F and the catchability coefficients. The participants felt that the model could be very useful in analyzing shrimp data from some exploited populations. The simultaneous use of length and age facilitates an analysis using all available data, an important point considering the uncertainties involved with shrimp ageing. However, it was felt that the starting values for selectivity and mortality could be improved and it was stressed that the data must be representative if such analyses are to be valuable.

3. General Discussion and Conclusions

Following the presentation of papers, a session was held to focus the discussions on important issues related to the study of age and growth in Pandalid shrimp. It was generally agreed that progress had been made in age determination since the 1981 meeting and, based on the presentations, research appears to be proceeding at a rapid pace. Although it was noted that many of the questions concerning shrimp biology remain unanswered, the models currently being investigated show potential for resolving some of them. Information was presented addressing the problem of identifying the 0 age class and previous inconsistencies in describing stages of sexual development for transitionals and females with sternal spines have been corrected by the acceptance of the term "primiparous females".

Considerable discussion was generated concerning the assumption that modes in the length frequency data represent different cohorts. It was recognized that this assumption might not always be correct in that one age group could be represented by many modes or many ages could be contained within a single mode. Seasonal growth, lack of synchronicity in moulting, sex inversion and timing of sampling are factors which affect the interpretation of the length frequency distributions. Sampling throughout the year can provide valuable information to verify the existence of modes and follow growth on a finer time scale. Possible mixing of populations in a given area and spatial organization by size were also identified as contributions to the problem of modal interpretation and it was agreed that cluster analysis of length frequency data would be a useful method to investigate biogeographical relationships. It was further agreed that, in any exercise in modal analysis, it is advisable to consider sex composition and other biological parameters. Finally, the need to investigate new methods of age determination was stressed and it was noted that some work is currently being done in this area (e.g., cluster analysis of data on enzymes, age pigment, isotopes, etc.).

Density dependence was discussed extensively as a topic of special interest. Data from several areas, including Alaska, Iceland and the Gulf of Maine, indicated that density dependent factors might be affecting growth, mortality and/or maturity. It was noted that exceptionally strong year-classes tended to exhibit the perceived density dependence

particularly well and that any detectable changes in growth rate should be looked at as an indicator of changes in stock size. There was some strong disagreement on whether or not the observations were related to density or environmental factors such as temperature and it was felt that further study of the data was required before firm conclusions could be reached. Such studies should taken into account any existing data on temperature.

One important issue identified at the 1981 workshop, the potential for bias in sampling, was discussed further at this meeting. Vertical migration was identified as a major factor contributing to sampling bias and it was recognized that the extent of this behaviour varies between areas. It was suggested that, when biomass is used as an index of abundance, sampling should be done the same way year after year. It was also suggested that time series models might be worth investigating for the analysis of such data. The role of hydroacoustics to address this problem also was discussed and it was generally agreed that much development was needed in the field before the methodology can be effectively applied to shrimp research. If there is potential, it might best be applied for stocks which are highly concentrated. Alternative survey designs were also discussed in relation to reducing bias in sampling and suggestions were made for stratification including temperature data (based on results from a hydrographic survey), two-phased surveys, spline approximation and systematic surveys rather than random surveys. Several of these options are currently being used in shrimp research in certain areas. Trawl selectivity also was discussed and, although it was recognized as a problem for introducing bias in length frequency data, it was noted as well that some studies have shown little or no selectivity in trawls after a certain amount of catch has been taken.

Consensus was reached on a number of issues and it was agreed that they should be listed in the report.

a) There is need to develop a growth model specifically for shrimp. The von Bertalanffy model was felt to be adequate in the meantime but it was stressed that seasonal growth should be incorporated for stocks for which the data are available.

b) More work should be focused on the definition of stocks and populations and their spatial organization. Mixing of different stocks in certain areas and mixing of samples from different locations might introduce bias in the description of growth for the whole area.

c) More data are needed on instars (moulting sequence), especially for fast growing populations, to ensure that modes in the length frequency distributions actually represent separate age groups. It was suggested that a shell condition index might be useful in this respect. It was also felt that the timing of the survey was an important factor when studying the age structure of a population. If seasonal growth is significant, it would be advisable to conduct surveys at the end of the growing season.

d) Density estimates should be expressed in common units for comparative purposes. It was agreed that density should be given as numbers per sq km, specifying mesh size and mean carapace length.

e) Hydrographic data should be collected more carefully and extensively to investigate the importance of changing environmental conditions in shrimp population dynamics.

f) Further efforts should be made to identify the age of the first mode in the length distributions from areas for which uncertainty remains.

g) More research needs to be directed towards identifying the factors that govern growth in Pandalid shrimp, including temperature, density and food availability.

h) New methods to separate modes in the length frequency distributions and to incorporate age and length simultaneously in population analysis were presented and discussed. It was agreed that these methods show potential and should be explored more extensively.

It was also obvious from the discussions that there were important biological differences between the populations of shrimp from the various areas. It was agreed that the questions which need to be answered would also vary between populations and that any research or management strategies adopted for one area might not necessarily apply to others.

4. Recommendations

The working group agreed that several of the points of discussion were worthy of being carried forward as specific recommendations to the Scientific Council of NAFO and these are given below.

a) It has been found since the 1981 workshop that, by examining the stomachs of important shrimp predators and by sampling in shallower areas with various benthic sleds, much information can be gained on the size of the 0 age class. Such methods should be continued in areas where the age of the first mode occurring in trawl catches still remains questionable.

b) In order to compare density estimates between areas, the information should be expressed in numbers of shrimp per square kilometre, specifying mesh size and mean carapace length. Also, efforts should be increased to obtain more extensive temperature data in an attempt to closely monitor changes in environmental conditions over time.

c) Studies should be initiated to determine the possibility of immigration into certain stock areas. In many areas there are refugia, unfishable grounds where it is not known what the shrimp densities are or how and if they contribute to the fishable stock. The use of cluster analysis to describe the biogeography and investigate the possibility of immigration is encouraged.

d) Research should be directed towards finding an independent method of determining the age of shrimp. Growth in weight, variations in isotopes or enzymes over time and age pigment were discussed as possibilities and these should be investigated further.

5. Future Meetings

Although no formal proposals were made for a future meeting in terms of mandate and location, all participants agreed that the present meeting was extremely beneficial and that any new initiatives, either through NAFO or local institutions, should be communicated to all participants. It was also noted that there was no representation from the USSR or Japan and it was agreed that any future meeting should try to attract attendance from those countries, as well.

ANNEX 3. REPORT OF THE WORKSHOP ON SILVER HAKE DATABASE

Chairman: H. Lassen

Rapporteur: Various

The workshop on silver hake assessment data and analysis was held at the Greenland Fisheries Research Institute, Copenhagen, Denmark during 8-12 January 1990. Representatives attended from Canada, Denmark (Greenland), European Economic Community (EEC), and Union of Soviet Socialist Republics (USSR). The Assistant Executive Secretary was in attendance. The list of participants is given in Part C of this volume.

The Chairman welcomed everyone, and requested the Assistant Executive Secretary to act as general rapporteur while scientists dealing with specific topics were requested to prepare those reports. It was noted that no new SCR Documents would be presented at this meeting, although previously issued SCR and SCS Documents and new data tabulations the scientists had brought to the meeting would be reviewed.

With respect to the agenda (see Section 8 below), the six topics identified at the September 1989 Meeting were first reviewed and the Chairman noted that the outline prepared in September 1989 for the workshop was complete and suitable. In general it was noted that the silver hake fishing regime changed in 1977 when the Canadian new management plan came into effect. It was therefore decided that only the time series from 1977 would be considered.

Each topic was then discussed.

1. Sampling the Commercial Fisheries for Length and Ageing Material

It was agreed that the Canadian and USSR methods of sampling would be completely described for the purpose of this workshop.

The Canadian sampling scheme by the International Observer Program (IOP) had been described by Kulka and Waldron (1983) and the USSR scheme had been described by Noskov and Rikhter (1985). It was noted that the Canadian and USSR sampling schemes were very similar. However, a discrepancy had been observed between the Canadian data, and the Cuban and USSR data at fish lengths below 20 cm for 1988. The Canadian data seemed to have a higher proportion of the age 1 year-class compared to the USSR and Cuban samples, and that needed to be resolved.

Historic and current data from Canada and USSR were tabulated to reconcile the discrepancies as noted above (Table 1). Data from 1984-89 focusing on fish less than 28 cm showed no significant difference between the data sets except in the 1988 set where the Canadian IOP data showed a wider distribution in the smaller size groups. It was recognized that because of the larger sample size of the IOP data, they would exhibit such details. Figure 1 indicates the comparability of both datasets for lengths below 28 cm, except for 1988.

The group was confident that the IOP length sample database represented an extensive sampling of the commercial fishery. This was the preferred database for estimating length composition of the commercial catches.

It was noted that Canada and USSR were both sampling biological data onboard the vessels with similar objectives. The group therefore felt that when observers from both parties were onboard the same vessel, the parties should explore the possibility of cooperatively collecting the biological data, rather than duplicating their efforts.

Details of sampling methods for ageing material by Canada (Kulka and Waldron, 1983) and USSR (Noskov and Rikhter, 1985) were reviewed. Similar methods were being employed. The ageing effort by Canada and USSR, with each party ageing approximately 1,500 otoliths annually, was also comparable and the numbers were considered adequate.

2. Ageing Methods

The results of Canadian and USSR otolith exchange reported by Hunt (1989) showed high levels of agreement within and between age readings from both sources. Previous studies had shown much lower levels of agreement.

The group felt that combining age data from both Canada and USSR could be advantageous. However, the agreement obtained recently by the otolith exchange program was not reflected in the Canadian and USSR age-length keys (ALK), which showed marked differences (as discussed under Item 3. It was therefore concluded that the data should not yet be combined.

Table 1. Comparison of Canadian and USSR commercial sampling of silver hake. Lengths given as percent by numbers (after adjustment to catch). Canadian data cut off at 28 cm.

	1984		1985		1986		1987		1988		1989	
Length	Canada	USSR	Canada	USSR	Canada	USSR	Canada	USSR	Canada	USSR	Canada	USSR
10												
11												
12									0.01			
13	0.01		0.02						0.02		0.01	
14	0.01		0.02		0.01				0.06		0.06	
15	0.06		0.04		0.10		0.05		0.10		0.15	0.20
16	0.35		0.06		0.42	0.30	0.10	0.10	0.21		0.29	0.40
17	0.91		0.15	0.10	1.08	0.60	0.26	0.30	0.29		0.38	0.50
18	1.68	0.30	0.27	0.20	1.79	1.10	0.44	0.30	0.16		0.41	0.50
19	2.47	0.60	0.38	0.40	2.02	1.20	0.34	0.30	0.17		0.47	0.40
20	3.10	1.10	0.61	0.70	2.12	1.60	0.26	0.20	0.21		0.65	0.50
21	2.71	1.50	0.83	0.80	1.57	1.40	0.16	0.10	0.20		0.99	1.30
22	2.13	1.60	0.92	1.00	1.11	1.00	0.39	0.20	0.13		1.17	1.70
23	1.48	1.30	0.97	1.10	0.71	0.80	2.28	1.20	0.16	0.10	1.00	1.70
24	0.99	1.00	1.13	1.20	0.48	0.60	7.42	5.50	0.94	0.50	1.68	1.60
25	1.45	0.70	2.32	1.80	0.78	0.80	14.57	12.20	2.54	1.80	3.09	3.00
26	3.64	0.60	5.52	4.20	2.22	2.00	17.25	15.20	5.03	4.90	4.43	4.80
27	7.95	1.90	9.65	8.80	5.57	4.50	14.11	13.20	10.16	10.90	5.02	5.20
28	12.31	5.10	11.95	11.40	9.93	8.20	9.49	9.00	16.05	17.50	8.12	7.30
29		10.00		11.00	14.73	13.10	6.79	7.20	18.79	19.80	13.18	11.60
30		16.20		11.30	16.36	16.90	6.15	7.30	16.79	16.20	16.53	15.20
31		16.30		11.20	13.90	14.80	5.95	6.90	11.52	11.80	15.21	15.00
32		14.00		9.80	10.52	12.80	4.76	6.70	7.05	7.00	11.53	12.20
33		9.20		8.30	6.63	8.70	3.57	4.90	3.90	4.00	6.84	7.50
34		6.30		5.90	3.74	4.50	2.44	3.40	2.35	2.70	3.62	4.00
35		4.40		4.00	1.66	2.40	1.35	2.20	1.26	1.30	1.87	2.20
36		2.80		2.50	0.93	1.40	0.65	1.30	0.69	0.70	1.12	1.20
37		2.10		1.50	0.57	0.60		0.80	0.42	0.30	0.72	0.80
38		1.30		0.90	0.31	0.40		0.50	0.23	0.10	0.46	0.40
39		0.60		0.70	0.20	0.20		0.30	0.11	0.10	0.34	0.30
40		0.50		0.40	0.15	0.10		0.20	0.07		0.19	0.20
41		0.30		0.30				0.10			0.11	0.10
42		0.20		0.20				0.10			0.10	0.10
43		0.10		0.10							0.07	0.10
44				0.10							0.06	
45				0.10							0.04	
46											0.02	

The group agreed that the causes of these discrepancies needed to be identified. In spite of the successful otolith exchange, the group still felt that the ageing methods were a significant part of the problem and, if required, the Canadian and USSR age readers should meet in an attempt to develop more appropriate methods of improving inter-reader and intra-reader agreement.

3. Methods Used in the Construction of Yearly Catch Compositions

The group reviewed the raising procedures used by Canada and USSR to achieve the estimated age composition of the total annual catches. Both use a single season ALK. As discussed under Item 1, the group felt that the ALK should be applied to the IOP length composition estimate.

The method by which length frequency and age data from Canada and USSR could be aggregated, and how those data could then generate catch-at-age matrices in time for the June STACFIS assessment meetings, was considered.

Three age compositions of the 1989 commercial catches were constructed, based on the length composition of the catch originating from the IOP samples. For the first the Canadian ALK was used and for the second dataset the USSR ALK was used. The third dataset was based on a combined Canada-USSR ALK (Table 2). The estimated number caught for age groups 2 and 4 differed markedly and it was obvious that a combined ALK would not give a reasonable estimate. If the age composition was based on a single ALK, the outcome of an analytical assessment would be very different depending on which dataset it was based. The group was not able at this time to resolve why these ALKs differed, but noted that while the problem remained, a reliable analytical assessment of the silver hake stock was not possible. The solution of this problem was therefore most urgent.

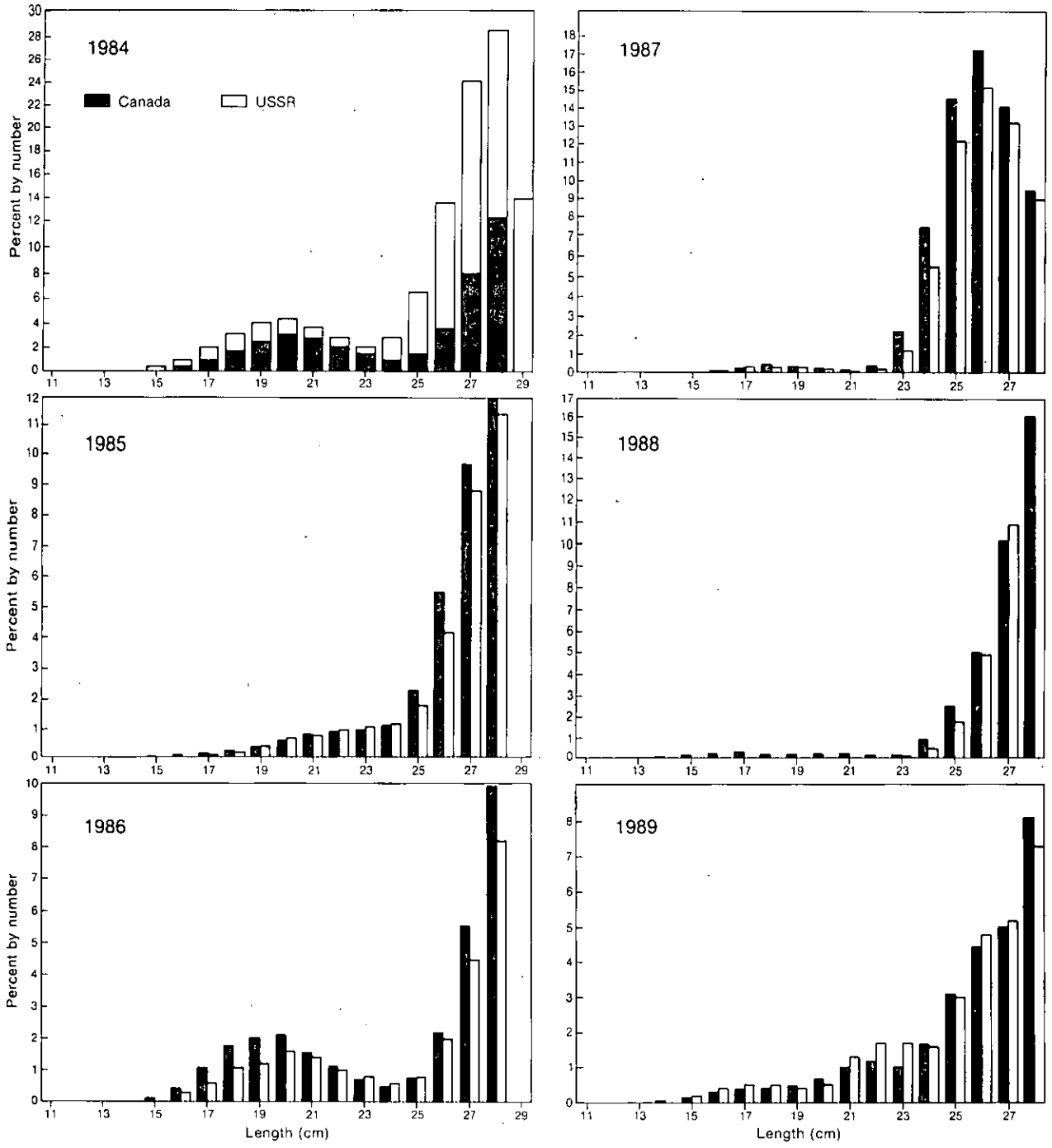


Fig. 1. Comparison of Canadian and USSR silver hake length data given as percent by number for lengths below 28 cm.

4. Research Vessel Survey Data

Two research vessel survey data series currently being used for assessment purposes were described. These were (1) the Canadian groundfish surveys conducted in July of each year since 1970, and (2) the Canadian-USSR juvenile silver hake surveys conducted in October/November each year since 1981 on a consistent basis.

Table 2. Catch-at-age ('000) for 1989 calculated from the International Observer Program (IOP) length composition applied to the age-length key (ALK) from USSR, ALK from Canada and from combining these two ALKS.

Age	USSR	CANADA	CAN + USSR
1	20,311	25,721	23,132
2	153,800	92,039	128,293
3	189,630	169,903	175,231
4	88,856	153,666	113,614
5	17,700	21,289	20,735
6	3,800	9,975	11,037
7	1,129	1,669	2,291
8	323	1,274	1,213
9	70	41	69
10	0	22	6
11	0	35	5

The Canadian groundfish series consisted of a multispecies stratified-random bottom trawl survey covering the entire area. This represented an unbiased dataset with coefficients of variation of mean abundance of silver hake comparable to those obtained for other species estimated by this survey. High interannual variability was suggested by Waldron *et al.* (1989) the reason for which was not understood. The group noted that high variability could make it difficult to use this data series for calibrating an SPA. It was proposed that adding extra stations to the survey, which could be achieved without modifying the database, may help. The stratification of the survey was reviewed and it was noted that strata along the shelf break could be subdivided, for the purpose of estimating silver hake abundance, to increase the number of stations in the silver hake high density areas.

The Canada-USSR juvenile silver hake survey series is a pelagic survey targeting silver hake age 0. This is randomly stratified using an IGYPT net and is conducted in strata 60 to 78, which is the core area of juvenile silver hake distribution. The Scientific Council made a decision in 1986, which it reiterated in 1987, as to how the survey index of abundance should be calculated. This forms the basis of the Canadian database. The accepted protocol was discussed by Koeller *et al.* (1986) and the resulting mean abundance estimates are given in Table 3. Survey results presented by Waldron *et al.* (1989) suggest the survey method was acceptable and there were no observed difficulties in the generated data.

Table 3. Stratified mean catch/tow for the joint Canada/USSR juvenile silver hake survey. Strata 60-78 only.

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Stratified mean catch/tow	579.0	8.0	232.2	43.4	284.8	198.0	102.0	204.8	131.5
Standard error of mean	0.11	0.14	0.11	0.16	0.22	0.19	0.11	0.17	0.14
Number of Sets	77	61	64	71	82	74	105	116	

5. Commercial Catch-Rate Data Series

The group noted that two sets of data were currently being collected. The USSR data are taken from daily summaries when the fishery was directed to silver hake. The other data series originates from the IOP which has a 100% coverage of the silver hake fishery on a set-by-set basis. The IOP takes its data from all vessels, particularly Cuban, Japanese and USSR, fishing silver hake. This latter dataset therefore has the USSR data as a subset. When national catch and effort data are reported to the NAFO Statistical database, these contributions are compiled on a monthly basis. These constituted the monthly catch rate data and have been used in preference to the IOP dataset for assessment purposes.

The catch-rate series has previously been standardized using multiplicative models. However, the group noted that the inclusion of data for each additional year would cause variation within the estimation accuracy, and therefore a fixed time series of standardized catch rates could not be constructed using the accepted procedure. The group investigated this standardization procedure and met with simple computer problems which will have to be resolved before the June 1990 Meeting. The database on catch-effort is given in Table 4.

Table 4. Commercial silver hake catch and effort used in the multiplicative model.

Catch	Effort	Source	Month	Year	Area	Regime	Country
14	10	1	8	77	450	2	1
3295	1841	1	4	77	460	2	1
3721	1933	1	5	77	460	2	1
1796	889	1	6	77	460	2	1
8261	4117	1	7	77	460	2	1
1704	435	1	8	77	460	2	1
470	332	1	9	77	460	2	1
2423	1083	1	4	77	470	2	1
1576	875	1	5	77	470	2	1
236	82	1	6	77	470	2	1
1051	524	1	7	77	470	2	1
232	186	1	4	78	450	2	1
2995	1406	1	5	78	450	2	1
326	203	1	6	78	450	2	1
1591	1087	1	4	78	460	2	1
5219	4812	1	5	78	460	2	1
6169	5196	1	6	78	460	2	1
7847	5626	1	7	78	460	2	1
4183	2031	1	8	78	460	2	1
330	247	1	4	78	470	2	1
133	88	1	5	78	470	2	1
1064	649	1	6	78	470	2	1
27	38	1	7	78	470	2	1
13	10	1	8	79	450	2	1
2103	1244	1	4	79	460	2	1
8847	4874	1	5	79	460	2	1
8390	4985	1	6	79	460	2	1
7470	3948	1	7	79	460	2	1
2014	1338	1	8	79	460	2	1
713	411	1	9	79	460	2	1
65	31	1	4	79	470	2	1
739	436	1	5	79	470	2	1
98	65	1	6	79	470	2	1
1531	1176	1	4	80	460	2	1
9033	7902	1	5	80	460	2	1
11333	9056	1	6	80	460	2	1
9018	7083	1	7	80	460	2	1
3665	5683	1	8	80	460	2	1
168	118	1	5	80	470	2	1
1639	906	1	6	80	470	2	1
4494	2725	1	7	80	470	2	1
66	113	1	8	80	470	2	1
117	80	1	6	81	450	2	1
363	275	1	7	81	450	2	1
601	490	1	4	81	460	2	1
13317	6091	1	5	81	460	2	1
11804	8717	1	6	81	460	2	1
9940	7100	1	7	81	460	2	1
763	543	1	8	81	460	2	1
220	192	1	6	81	470	2	1
17	14	1	8	81	470	2	1
2165	386	1	4	82	460	2	1
16644	3895	1	5	82	460	2	1
20985	5441	1	6	82	460	2	1
6653	2348	1	7	82	460	2	1
5134	1726	1	4	83	460	2	1
13127	6030	1	5	83	460	2	1
7110	4935	1	6	83	460	2	1
229	267	1	7	83	460	2	1
15732	3794	1	5	84	460	2	1
17276	7077	1	6	84	460	2	1
21453	8735	1	7	84	460	2	1
2838	904	1	8	84	460	2	1
8400	3702	1	5	85	460	2	1
26230	10541	1	6	85	460	2	1
15956	13623	1	7	85	460	2	1
5751	2069	1	8	85	460	2	1

Table 4. Continued.

Catch	Effort	Source	Month	Year	Area	Regime	Country
435	184	2	7	77	460	1	1
50	41	2	7	77	460	2	1
771	712	2	8	77	460	1	1
16	72	2	8	77	460	2	1
18	16	2	8	77	470	1	1
225	128	2	9	77	460	1	1
527	408	2	4	78	460	1	1
1233	776	2	5	78	460	1	1
17	17	2	5	78	470	1	1
16	19	2	5	78	470	2	1
1375	493	2	6	78	450	1	1
2136	1557	2	6	78	460	1	1
116	63	2	6	78	460	2	1
72	40	2	6	78	470	1	1
774	310	2	7	78	450	1	1
2745	1645	2	7	78	460	1	1
47	32	2	7	78	470	1	1
74	29	2	8	78	450	1	1
3195	1316	2	8	78	460	1	1
110	102	2	9	78	460	1	1
1510	690	2	5	79	460	1	1
1684	847	2	5	79	460	2	1
105	81	2	5	79	470	1	1
11	15	2	5	79	470	2	1
3174	1604	2	6	79	460	1	1
2097	1188	2	6	79	460	2	1
41	46	2	6	79	470	1	1
83	87	2	6	79	470	2	1
2239	899	2	7	79	460	1	1
1017	455	2	7	79	460	2	1
392	259	2	8	79	460	2	1
9423	2240	2	5	86	460	2	1
11905	3292	2	6	86	460	2	1
5531	1803	2	7	86	460	2	1
63	16	2	6	86	470	2	1
1049	175	2	7	86	470	2	1
2300	638	1	5	82	460	2	2
3437	1491	1	6	82	460	2	2
5469	2542	1	7	82	460	2	2
1565	515	1	4	83	460	2	2
3003	2124	1	5	83	460	2	2
2564	2640	1	6	83	460	2	2
286	150	1	7	83	460	2	2
2614	724	1	4	84	460	2	2
6254	2364	1	5	84	460	2	2
5415	2351	1	6	84	460	2	2
213	192	1	7	84	460	2	2
2889	863	1	4	85	460	2	2
6098	3035	1	5	85	460	2	2
7014	2797	1	6	85	460	2	2
1682	831	1	7	85	460	2	2
869	744	2	8	86	460	2	2
2682	489	2	4	86	460	2	2
2482	850	2	5	86	460	2	2
950	503	2	6	86	460	2	2
342	353	2	9	86	460	2	2
5216	742	2	4	87	460	2	2
9411	1658	2	5	87	460	2	2
4641	2407	2	6	87	460	2	2
237	121	2	7	87	460	2	2
3173	597	2	5	87	460	2	1
15895	6758	2	6	87	460	2	1
18291	7438	2	7	87	460	2	1
24	11	2	7	87	470	2	1
247	139	2	8	87	470	2	1
20663	4789	2	4	88	460	2	1
782	274	2	4	88	460	2	2

Table 4. Continued.

Catch	Effort	Source	Month	Year	Area	Regime	Country
18870	6050	2	5	88	460	2	1
2279	1079	2	5	88	460	2	2
12328	5864	2	6	88	460	2	1
4184	2384	2	6	88	460	2	2
3254	976	2	6	88	470	2	1
93	56	2	6	88	470	2	2
1233	1462	2	7	88	460	2	1
1796	973	2	7	88	460	2	2
650	60	2	3	89	460	2	1
30044	5110	2	4	89	460	2	1
19098	5255	2	5	89	460	2	1
9749	4245	2	6	89	460	2	1
4667	1552	2	7	89	460	2	1
4347	823	2	4	89	460	2	2
6844	2207	2	5	89	460	2	2
2999	1536	2	6	89	460	2	2
457	244	2	7	89	460	2	2
182	39	2	4	89	470	2	1
171	35	2	5	89	470	2	1
6128	1683	2	6	89	470	2	1

The catch and effort (hrs) series is composed of both NAFO statistics and IOP data as described above. The categories used are: data source (NAFO or IOP), month, year, fishing regime (fishing method) and country (Cuba and USSR). During the period 1977-79, 4 Soviet vessels were licensed to fish silver hake with 40 mm trawl codends and operate in areas landward of the small mesh gear line. The group agreed that those data should be included in the model in accordance with previous STACFIS assessments.

6. Assessment Methods

As a result of the problems identified in the database, the group realized that an analytical assessment would not be likely in June 1990.

The assessment would therefore have to be based on those elements of the database which were undisputed. Those seemed to be:

- Total catches and effort
- Length compositions of total catches
- Survey results when those results do not involve ageing e.g. biomass
- Canadian-USSR juvenile survey results

Investigation into the ALKs of Canada and USSR may indicate that ageing of 0 and 1 groups are undisputed and the research surveys may therefore provide indices of abundance of certain age groups as follows:

0 group - from Canada-USSR juvenile survey
1 group - from Canada-USSR juvenile survey, and Canadian groundfish survey
2+ group - from Canadian groundfish survey

This breakdown may also be made using decomposition of the length compositions from the surveys.

Based on this information, either additive or multiplicative models, relating catch to recruitment indices and effort may be developed. Although such models may have some predictive power, they would not provide anything about where the exploitation level ought to be. This latter question will then have to be addressed based on past experience e.g. defining a catch level which may be sustained for the time series available.

Status quo and SHOT approaches may also have some merits.

Redfish in the Flemish Cap is managed using a real-time general production model. A similar approach may be feasible for the silver hake.

7. References

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NOSKOV, A. S., and V. A. RIKHTER. 1985. Manual for collecting length and age data and for conducting biological analysis. (In Russian) Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO), 5 Dmitry Donskoy Street, Kaliningrad, 236000, USSR.

WALDRON, D. E., M. C. BOURBONNAIS, and M. A. SHOWELL. 1989. Size of the Scotian Shelf silver hake population in 1988 with projections to 1990. NAFO SCR Doc. 89/48, Serial No. N1626, 36 p.

8. Agenda

The Scientific Council recommended at its June 1989 meeting that a workshop be held on "silver hake assessment data and analysis" and that the workshop should be held in early 1990.

The workshop was scheduled for 8-12 January 1990, at the Greenland Fisheries Research Institute, Tagensvej 135, 1, DK-2200, Copenhagen, Denmark, with Hans Lassen (STACFIS Chairman) as Chairman.

The objective of the workshop was to review data available for silver hake assessment, resolve the apparent discrepancies and establish an agreed database.

Six topics were identified:

1. Sampling for Length and Ageing Material

   Discrepancies between length frequencies collected by several countries have been noted. Therefore sampling methods for all countries should be reviewed (e. g. sample size, randomization scheme, equipment used and measurements taken).

2. Ageing Methods

   Results of the otolith exchange programs between Canada and USSR were reported in June 1989, and a bias was still apparent in the data. The workshop should therefore attempt to resolve those problems.

3. Methods Used in the Construction of Yearly Catch Compositions

   Procedures for aggregating age and length data should be reviewed, particularly stratification schemes. The database at present only went back to 1977. While data for the 1962-76 period were available, they had not been analyzed yet.

4. Research Vessel Survey Data

   Stratification schemes, sampling and raising procedures should be reviewed. The ageing and length measurement problems referred to above would also influence the survey results.

5. Commercial Catch Rate Data Series

   There was a break in the nature of the data series so two periods needed to be addressed: 1970-85 and 1986-89.

6. Assessment Methods

   The methods which were currently employed to assess silver hake should be reviewed and new methods should be evaluated before they were used in assessments.

Output of the Workshop

For items 1-5 listed above, the agreed database and how it was constructed should be fully documented. Further, effects on the assessment as a consequence of any changes in the database should be documented.

For item 6, validation of the methods should be sought.

Standard methods of sampling, stratification, length measurement etc. should be established wherever possible.

APPENDIX II. REPORT OF STANDING COMMITTEE ON RESEARCH COORDINATION (STACREC)

Chairman: W. B. Brodie Rapporteur: E. F. Murphy

The Committee met at NAFO Headquarters at 192 Wyse Road, Dartmouth, Nova Scotia, Canada on June 13, 14, and 16, 1990. Representatives from Canada, Cuba, Denmark (Faroe Islands/Greenland), EEC, GDR, Iceland, Japan, and USSR and observers from FAO, Tanzania and USA were present.

1. Fisheries Statistics

a) Progress Report on Secretariat Activities in 1989/90

i) Acquisition of STATLANT 21A and 21B reports for recent years

STACREC once again expressed concern about the delays in the provision of STATLANT 21A and 21B reports. The STATLANT 21A reports for 1989 from EEC-France (M), France (SP) and Norway had not been provided.

The STATLANT 21B reports for 1988 from Canada (N), Greenland and the USA have yet to be provided.

While the deadline date for submission on STATLANT 21B reports for 1989 was 30 June 1990, STACREC noted that Cuba, EEC-FRG, Netherlands, EEC-Spain, GDR and Poland have submitted reports to date.

STACREC recommends that *every effort be made by the statistics reporting offices to have the STATLANT 21A and 21B reports submitted on time.*

ii) Publication of statistical information

After a long delay in receiving the STATLANT 21B report from Canada (N) and the use of STATLANT 21A reports to compile the Faroe Island data, NAFO Statistical Bulletin Vol. 36 was published in October 1989, approximately two years behind schedule.

The publication of NAFO Statistical Bulletin Vol. 37 was delayed until April 1990 (approximately eighteen months) by late submission of STATLANT 21B reports from Canada (N), EEC-France (M) and France (SP).

The publication of NAFO Statistical Vol. 38 has been delayed pending the submission of STATLANT 21B reports of Canada (N), Greenland and the USA.

The preparation of the 1989 Provisional report for use in the assessments at the June 1990 meeting was pending the reception of STATLANT 21A reports from EEC-France (M) and France (SP) but the Committee decided to release the report with a note to indicate the missing French data.

iii) Updating of fisheries statistics database

STACREC was informed by the Assistant Executive Secretary that the updating of catch and effort data had been proceeding well, with data dating back to 1963 and half of the 1962 statistics completed. The revised statistics would be available to the Scientific Council upon request on IBM compatible PC diskettes.

The usefulness of continuing the updates back past 1960 was questioned by the Assistant Executive Secretary because of the increasing occurance of catches that were grouped and reported as categories such as Flatfishes and Groundfish. Concern was expressed as to the difficulties in separating such catches into a useable form. STACREC agreed that the Secretariat should update only those data that would be meaningful.

STACREC noted that due to the changes and addition made to the NAFO database in recent years, it would be advisable to repeat the exercise conducted 8 years ago to identify and eliminate the discrepancies between the NAFO, FAO and EEC(EUROSTAT) databases. Whereas the previous exercise had been restricted to data for EEC Member States, the proposed study should cover data for all NAFO Contracting Parties. The initial work on identifying the discrepancies would be done by EUROSTAT but their elimination could only be achieved with the collaboration of the NAFO Secretariat.

b) Review of Reporting Requirements for Submission of STATLANT 21A and 21B Statistics

STACREC addressed the question as to how data for EEC-France (M) and France (SP) were to be handled because, for the period 1983-85, only aggregated data had been received. However, data in a disaggregated form were probably available and the EEC (EUROSAT) representative undertook to request the French authorities to consider providing the required disaggregation. The Secretariat said any updates would be published in a subsequent Statistical Bulletin.

The ever increasing problem of catches by non-contracting parties was discussed at length. There were suggestions of publishing estimates of these catches. STACREC concluded that it would not be appropriate to include such estimates in the annual Statistical Bulletin, however, these estimates should be included in the stock assessments. It was decided that advice on the handling of estimates should be sought by the Scientific Council from General Council as such estimates are often used in assessment documents.

STACREC reviewed an EEC (EUROSTAT) proposal to harmonize STATLANT data submissions in view of its implications to Scientific Council users and its implications to the coordination and compilation of data by the Secretariat. The EEC(EUROSTAT) representative voiced the opinion that the foreseen problems were minimal and that he would help NAFO with the conversion of the computer programs. STACREC asked that the EEC representative keep the Committee updated as to the progress in refining the proposal.

The FAO observer raised the question of keeping separate statistics for the Regulatory Area. This item was discussed only briefly as it was not an agenda item. It was felt that if FAO provided a working paper in the future, discussion would be generated on this topic.

STACREC noted that there are problems using the Portuguese catch and effort data as reported in catch-per-day. It was noted that catch-per-hour was the more useful unit. An EEC-Portugal representative felt that it was possible to comply and hoped to revise the data for 1985-89.

c) Fourteenth Session of CWP, February 1990

The Assistant Executive Secretary tabled the Report presented by the Secretariat to CWP on NAFO Statistical Program, Publications and ADP. He noted that the location of CWP Session was changed from Miami, USA to Paris, France. As recommended (NAFO Sci. Coun. Rep., 1989) the Assistant Executive Secretary, the Chairman of STACREC, and representatives of the USSR attended.

A summary of the Report of the Fourteenth Session of the Coordinating Working Party on Atlantic Fishery Statistics CWP (NAFO SCS Doc. 90/19) was tabled. It was noted that the full report had not been incorporated in the submission at this meeting but would be presented in the SCS document to be circulated in the near future. The Committee's attention was drawn to matters of particular interest to NAFO, namely the near completion of the first part of the Handbook on Fishery Statistics (to be published by FAO) and proposed harmonization of STATLANT reports. As a result of one of the CWP agenda items, STACREC noted the need for more detailed reporting of the Elasmobranch catch in FAO Area 21 (the NAFO Convention Area). In agreement with discussions at CWP, STACREC recommended that *the Scientific Council extend an invitation to CWP to hold the Fifteenth Session of CWP at NAFO Headquarters in Dartmouth, Nova Scotia, Canada from 8 to 14 July 1992 and to prepare for that meeting that the Assistant Executive Secretary attend the Ad-hoc Inter-Agency Consultation which is to precede the 79th Statutory Meeting of ICES, in October 1991.*

2. Biological Sampling

a) Progress Report on Activities in 1989/90

The Provisional List of Biological Sampling Data for 1988 was tabled (SCS Doc. 90/9 and an addendum). It was requested that representatives check this list to facilitate the publishing of the 1985-89 list. Representatives were also urged to provide the Secretariat with lists of any other sampling data which may be outstanding.

b) Forms and Deadlines for Submission of Data

No changes reported.

3. Biological Surveys

a) Review of Survey Activities in 1989

The Inventory of Biological Surveys conducted in 1989 was presented by the Secretariat (Table 1) and included information from 9 countries (or components). STACREC was informed that the stratified-random survey conducted by EEC-FRG at West Greenland in 1988 had been omitted inadvertantly from the inventory of biological surveys for 1988 published in the Scientific Council Reports, 1989 (page 126).

It was suggested that it would be helpful if the Inventory of Surveys reflected the time series of annual surveys as well as the list of surveys applying to each stock reviewed by STACFIS.

Discussion on this suggestion resulted in designing a standardized format for tabulating surveys by stock area, giving a range of information including time series, depth and survey design. Designated experts completed these tables with the available information at this meeting and they were incorporated in SCS Doc. 90/22. STACREC recommended that *the list of surveys on a stock-by-stock basis as detailed in SCS Doc. 90/22, be compiled by Designated Experts annually.*

b) Survey Plans for 1990 and Early 1991

An inventory of surveys planned for 1990 and early 1991 was prepared by the Secretariat and included information from 10 countries (Table 2).

c) Review of Stratification Schemes

A paper (SCR Doc. 90/45) dealing with the addition of strata in the Gulf of St. Lawrence was presented. Six new strata have been added to the existing sampling scheme in 1987. Two of these new strata cover the 30-50 fathom range in Div. 4R while the remaining four are located in the St. Lawrence estuary at depths over 100 fathoms. Sampling of the new strata in Division 4R may be opportunistic, as ice cover may limit sampling during the January survey and the presence of fixed gears hampers coverage during the summer survey. The new strata in NAFO Div. 4T (St. Lawrence estuary) have been sampled since August 1987 but are not surveyed in January because of ice coverage.

d) Coordination of Surveys in 1990-91

Nothing reported.

e) Survey Design and Procedures - Working Group Report

The final report of the STACREC Working Group (SCR Doc. 90/20) was tabled. This was prepared in response to the recommendation by the Scientific Council in 1989 (NAFO Sci. Coun. Rep., 1989, page 128), and contained the relevant information from the Scientific Council Reports of 1985-89 in a chronological order, as well as documentation available to and produced by the Working Group to analyze survey data.

4. Other Matters

a) List of Fishing Vessels for 1989

Data for this list are outstanding from 12 countries. Since this list is due to be published this year, representatives are urged to check with the appropriate sources and have all outstanding data forwarded to the Secretariat as soon as possible (see Circular Letter 90/06).

b) Tagging Activities Reported for 1989

A review of tagging was presented by the Assistant Executive Secretary, SCS Doc. 90/11, reporting the activities of six countries or components. Any outstanding information should be made available to the Secretariat, so that a revised list could be produced if necessary.

Table 1. Inventory of biological surveys conducted in the NAFO Area during 1989.

Sub-area	Div.	Country	Months	Type of survey	No. of sets
				STRATIFIED-RANDOM SURVEYS	
E. Greenl.		DEN-G	8-9	Shrimp trawl survey	87
		JPN	9-10	Groundfish (G. halibut)	53
		E/DEU	9	Bottom trawl, groundfish	145
0	B	SUN	9-10	G. halibut, grenadier temperature, salinity	78
0,1	ABCD	DEN-G	7,8	Shrimp trawl survey	137
0+2+3	BGHJK	CAN-N	7	Shrimp	120
1	BCD	JPN	4-5	Groundfish (G. halibut)	61
	BCDEF	E/DEU	10,11	bottom trawl, groundfish	140
2	GH	SUN	10-11	G. halibut, grenadier, temperature, salinity	73
	J	CAN-N	11	Groundfish	110
2+3	JK	CAN-N	11-12	Groundfish	145
3	K	CAN-N	12	Groundfish	105
	KLNO	SUN	4-6	Groundfish, temperature, salinity	469
	L	CAN-N	5	Groundfish	196
		CAN-N	10-11	Groundfish	195
	LNO	CAN-N	1	Redfish	43
		CAN-N	4-5	Groundfish	206
		CAN-N	8-9	Juvenile flatfish	151
	LO	CAN-N	9	Juvenile flatfish	70
	M	SUN	6-7	Groundfish, temperature, salinity	170
		E/ESP	7	Groundfish	129
	N	CAN-N	8	Scallop	201
	NO	CAN-N	11	Groundfish	34
	Ps	CAN-N	1-2	Groundfish	182
		CAN-N	4-5	Scallop	250
3+4	PnRST	CAN-Q	1	Groundfish	131
4	RS	CAN-Q	8,9,10	Shrimp survey	122
	RST	CAN-Q	8-9	Groundfish	164
	S	CAN-Q	6	Scallop survey	-
	T	CAN-G	8-10	Bottom trawl survey (Nephrops trawl)	160
		CAN-G	9	Groundfish abundance survey	169
		CAN-G	11	Groundfish migration and distribution	25
	TVn	CAN-G	11	Herring acoustic surveys	2
	VWX	CAN-SF	7	Groundfish survey	194
		SUN	10-11	Juvenile silver hake	111
		SUN	12-1	Juvenile silver hake	71
	WX	CAN-SF	5	Scallop survey	124
	X	USA	4	Spring bottom trawl	11
		CAN-SF	6	Scallop survey	110
		CAN-SF	7	Scallop survey	136
		CAN-SF	9	Scallop survey	160
		USA	10,11	Autumn bottom trawl	13
4,5	XZe	CAN-SF	8	Scallop survey	145
5	YZ	USA	3,4	Spring bottom trawl	150
		USA	7	Surf-clam-ocean quahog	87
		USA	7,8	Sea scallop	154
		USA	10	Autumn bottom trawl-trawl -plankton	170 66
	Ze	CAN-SF	2,3	Groundfish survey	93
6	ABC	USA	2,3	Spring bottom trawl	138
		USA	6,7	Surf-clam-ocean quahog	292
		USA	6,7,8	Sea scallop	279
		USA	9	Autumn bottom trawl	151
				OTHER SURVEYS	
E.G+1	DEF	DEN-G	8-9	Cod: marking	-
-					
1	A	DEN-G	8	G. halibut: marking	18
	BCDE	DEN-G	6,7	Hydrography	45
		DEN-G	7,8	Young cod	208
		DEN-G	10,11	Cod inshore	128
	CDE	DEN-G	7,8	Whales: photo-ID, biopsi	-
	DE	DEN-G	6	Whales: photo-ID, marking	-
2	G	SUN	9	Myctophidae, temperature salinity	2
	J	CAN-N	7-8	Cod sampling	-
-					
2+3	JK	CAN-N	10	Capelin (acoustic)	24
	JKL	CAN-N	9-10	Salmon	10
2-4	NEC-EPD	USA	1-9	Monitoring of sludge dump site recovery, New York Bight	216
3	K	CAN-N	5-10	Hydrography	
3	K	SUN	9	Grenadier, G. halibut, temperature, salinity	25
	KL	CAN-N	2	Cod (acoustic)	45
		CAN-N	5-6	Capelin	-
		CAN-N	6	Cod (acoustic)	59
	L	CAN-N	2	Herring	-
		CAN-N	3,5,9	Bottom sampling	-
		CAN-N	3-7,9,11	Oceanography	-
		CAN-N	4-5	Acoustic trials	-
		CAN-N	5	Capelin (acoustic)	41
		CAN-N	5	Capelin tagging	-
		CAN-N	5,6,8,9,10	Crab	211
		CAN-N	6	Cod (acoustic)	-
		CAN-N	9-10	Cod tagging (acoustic)	-
	LNO	SUN	5	Capelin, temperature, salinity	25
		SUN	11-12	Larvae of capelin, temperature salinity	40
	M	SUN	6-7	Eggs, larvae, temperature, salinity	33
	NO	CAN-N	6-7	Capelin (acoustic)	18
	Ps	CAN-N	7	Toxicology	-
		CAN-N	7-8	Redfish (acoustic)	23
		CAN-N	8-9	Cod tagging	-
4	R	CAN-G	5-9	Trap, diving (SCUBA) and trawl	20
		CAN-Q	11-12	Herring Acoustics	-
	S	CAN-Q	3-4	Snow crab collection	-
		CAN-Q	4-5	Snow crab photography	-
		CAN-Q	5	Whelk gear selectivity	-
		CAN-Q	6-7	Mackerel larvae	65
		CAN-Q	9	Shrimp hydroacoustics	-
	T	CAN-G	4-5	At sea sampling on board commercial fishing vessels	10
		CAN-G	4,7,12	Juvenile herring surveys	92
		CAN-G	5	Cod for aquaculture	-
4	T	CAN-G	5	Tagging ripe adults for stock identification studies	-
		CAN-G	5-6	Trap (snow crab conventional trap) survey	150
		CAN-G	5,6,8	Commercial sea sampling lobster	35
		CAN-Q	6	Mussel growth	-
		CAN-Q	6-7	Cod, halibut, plaice, snow and spring crab collection for aquaculture	-
		CAN-Q	6-7	Crab in the saguenay	-
		CAN-Q	7	Impact of dregging on mussel growth	-
		CAN-G	7	Juvenile cod survey	30
		CAN-G	7	Juvenile herring distribution	12
		CAN-Q	7-8	Scallop assessment	-
		CAN-G	7-10	At sea sampling on board commercial fishng vessel	10
		CAN-G	7,8,9,10	Lobster tagging	8
		CAN-Q	8-9	Snow crab growth	-
		CAN-G	9	Spawning bed	-
		CAN-G	9	Distribution on spawning bed	-
		CAN-Q	9	Gear trial	77
	VnN	CAN-SF	8	Sealworm/benthic	-
	Vs	CAN-SF	5	Haddock tagging	218
	VsN	CAN-SF	6	Clam survey	97
		CAN-SF	9	Square-diamond	?
		CAN-SF	10	Square-diamond	?
	VWX	CAN-SF	3	Acoustic experimental	10
		CAN-SF	4	Deep trawling/mesopelagic	86
		CAN-SF	4,5	Gear test/square-diamond	?
		CAN-SF	6	Deep trawl/mesopelagic	49
		CAN-SF	6	Sealworm survey	5
		CAN-SF	8	Deep trawl/mesopelagic	61
		CAN-SF	9,10	Square-diamond	?
		CAN-SF	9,10	Sealworm survey	61
		CAN-SF	10	Juvenile fish survey	55
	W	CAN-SF	1	Herring acoustics	11
		CAN-SF	7	Live halibut	109
		CAN-SF	12	Gear trials, groundfish	4
	WX	CAN-SF	2	International observer training	-
	X	CAN-SF	4	Lobster trawling	45
		CAN-SF	5	Ichthyoplankton, Juvenile	104
		CAN-SF	6	Juvenile herring	26
		CAN-SF	8,9	Swordfish survey	-
		CAN-SF	8,9	Juvenile herring	-
		CAN-SF	9,10	Acoustics experimental	-
		CAN-SF	10,11	Scallops gear trials	10
4+5	XZe	CAN-SF	7	Lobster larvae	?
			10,11	Larval herring	226
5	YZ	USA	1	Larval herring and oceanographic - plankton	132
			1	- CTD	127
		USA	11	Larval herring - plankton	119
				- CTD	119
			11,12	Larval herring/sandlance -plankton	125
				-CTD	125
	Ze	CAN-SF	10,11	Larval/adult herring	122
	Z	USA	8	Juvenile fish	49
6	A	USA	6	12-mile dump site	127
			8	12-mile dump site	139

Table 2. Biological surveys planned for the NAFO Area in 1989 and early 1990.

Country	Area	Type of Survey	Dates
		STRATIFIED-RANDOM SURVEYS - 1990	
Can-G	4T	Bottom trawl survey for bio-mass estimation (NS, NB & PEI)	Jun-Aug
		Abundance of groundfish survey	Sep
		Migration and distribution of groundfish	Nov
CAN-N	0B+2GHJ+3K	Shrimp	04-21 Jul
	2GH	Groundfish	24 Sep-12 Oct
	2J+3KL	Groundfish	02 Nov-13 Dec
	3L	Groundfish	18 Oct-07 Nov
		Redfish	06-21 Aug
	3LNO	Groundfish	18 Apr-29 May
		Juvenile flatfish	23 Aug-25 Sep
		Scallop	10-22 Aug
	3NO	Groundfish	09-28 Nov
	3Ps	Scallop	25 Apr-07 May
CAN-Q	4RST	Groundfish + intervessel calibration	20 Aug-11 Sep
		Shrimp survey	01-19 Sep
CAN-SF	4VW	Groundfish survey	13-23 Mar
	4X	Scallop survey	18-29 Jun
			03-19 Jul
			27 Aug-07 Sep
			15-19 Oct
	4VWX+5Ze	Groundfish survey	03 Jul-04 Aug
	4WX+5Ze	Scallop survey and juvenile distribution	23 Apr-18 May
	5Ze	Groundfish survey	19 Feb-09 Mar
		Scallop survey, juvenile scallops	07 Aug-01 Sep
DEN-G	E.Greenl.	Shrimp trawl survey	12 Aug-15 Sep
	1ABCD	Shrimp trawl survey	15 Jul-11 Aug
E/FRG	E.Greenl.	Bottom trawl - groundfish	12 Sep-17 Oct
	1B-F	Bottom trawl - groundfish	20 Oct-30 Nov
E/ESP	3M	Groundfish (acoustic)	Jul
JAP	1BCD	Groundfish - G. halibut	Jun
	5A 1	Groundfish - G. halibut	Sep
USSR	0B	Trawl: G. halibut, grenadier, hydrography	28 Sep-30 Oct
	0B+2GH	Long-line: G. halibut	15 Aug-17 Dec
	1BCD	Trawl: G. halibut, grenadier hydrography	Oct
	2G	Trawl: G. halibut, grenadier hydrography	30 Oct-14 Nov
	2H	Trawl: G. halibut, grenadier hydrography	14-22 Nov
	2J+3K	Trawl: G. halibut, grenadier, hydrography	Sep & Nov
	3LK	Trawl & acoustic: groundfish, hydrography,	25 Apr-31 May
	3M	Trawl & acoustic: groundfish, hydrography	27 Jun-22 Jul
	3NO	Trawl & acoustic: groundfish, hydrography	05-25 Apr
	4VWX	Juvenile silver hake	Oct-Nov
USA	4X+5YZ	Spring bottom trawl	05-23 Mar
	+6ABC		26 Mar-06 Apr
			09-18 Apr
		Autumn bottom trawl	11-28 Sep
			01-12 Oct
			15-26 Oct
	5Z+6ABC	Sea scallop	26 Jul-04 Aug
			07-21 Aug
		OTHER SURVEYS - 1990	
CAN-G	4R	Trap, diving (Scuba) and trawl survey (Bonne Bay, Nfld.)	May-Oct
	4T	Bottom set gillnets for juvenile herring near Bathurst, N.B.	Feb
		Sampled juvenile herring by-catch in commercial smelt bagnet fishery in Restigouche River channel	Mar
		Flounder drag sets around Bay of Chaleur to monitor juvenile herring on or near bottom	Apr
		At sea sampling on board commerial fishing vessels (NB & PEI)	Apr-Jun
		Commercial at sea sampling (lobster)	Aug-Oct
		Fyke nets set near shore in Bathurst region to monitor in/offshore movements of juvenile herring and cod	May-Sep
		Monthly trawl survey on snow crab population characteristics (Baie des Chaleurs)	May-Dec
		Trap survey for catchability & selectivity study (Baie des Chaleurs)	Jun
		Underwater 30D photography of scallop bed	Jul
		Scallop dredging, plankton sampling	Jul
		Scallop dredging, plankton sampling	Sep
		Scallop dredging, plankton sampling	Sep-Oct
		Scallop dredging, plankton sampling	Oct
		Scallop dredging, plankton sampling	Nov
		Juvenile cod survey	Jul-Aug
		Lobster monitoring of biological fishing vessels (NS)	
CAN-G	4T	Lobster monitoring of biological characteristics (growth, movements)	Jul-Sep
		At sea sampling on board commercial fishing vessels (NS)	Jul-Oct
		Distribution and aggregative of winter flounder relative to herring spawn	Aug-Sep
		Sample spawning herring on Fishermen's Bank for size and and age overtime (gillnets)	Sep
CAN-N	2J	Cod sampling	23 Jul-17 Aug
		Oceanography	17-29 May
	2+3	Salmon tagging	27 Sep-16 Oct
	2J+3K	Cod (acoustics)	30 May-16 Jun
		Capelin (acoustics)	05-31 Oct
	2J+3KLMNOP	Oceanography	13-29 Jul
	3KL	Herring survey	15 Oct-30 Nov
		Oceanography	15 Oct-01 Nov
	3L	Acoustic trials	20-25 Apr
		Capelin tagging	04-13 May
		Crab studies	14-22 May
		Capelin (acoustics)	09-27 May
		Oceanography	17-25 May
		Crab survey	23-31 May
		Capelin tagging	01-08 Jun
	3LPs	Capelin tagging	28 May-11 Jun
	3NO	Juvenile flatfish tagging	31 May-07 Jun
		Capelin (acoustics)	18 Jun-02 Jul
	3P+4V	Redfish (acoustics)	23 Jul-08 Aug
CAN-Q	4RS	Herring acoustics	03-21 Dec
	4RST	Intervessel calibration	10-31 Aug
	4S	Snow crab taggng	13 Aug-04 Sep
	4T	Scallop survey	19 May-02 Jun
		Mackerel larvae plus Saguenay	04-30 Jun
		Rock crab recapture	06-23 Jun
		Exploratory Saguenay	-
CAN-SF	4VWX	Sealworm survey	01-14 Feb
			06-17 Aug
			15-23 Oct
	4W	Herring acoustics	04-26 Jan
		International observer training	26-30 Mar
		Sealworm survey	25-31 May
		Interntional observer training	18-23 Sep
	4WX	Acoustic trials	25-30 Mar
		Gear trials	25 Jul-04 Aug
			09-19 Oct
	4X	Lobster trawl survey	02-12 Apr
		Gear trials	22-26 May
			22-26 Oct
		Ichthyoplankton, juvenile gadids	11-25 Jun
		Ichthyoplankton	04-13 Jul
		Herring survey	13-25 Aug
		Juvenile lobsters	17 Sep-02 Oct
	4X+5Ze	Swordfish survey	03-14 Sep
		Larval herring survey	22 Oct-05 Nov
	5Ze	Ichthyoplankton	17-27 Apr
		Groundfish/herring acoustics	27 Sep-01 Oct
		Larval/adult herring survey	25 Oct-16 Nov
		Pollock tagging	03-12 Dec
DEN-G	E.Greenl.	Greenland halibut	19 Aug-15 Sep
		Cod: marking	16-29 Sep
	1A	Greenland halibut	05 Aug-01 Sep
	1ABCDE	Hydrography	17 Jun-07 Jul
	1ABCDEF	Whales: photo-ID, biopsi	01-21 Jul
	1BCD	Shrimp/by-catch	28 Oct-17 Nov
	1BCDEF	Young cod	01-28 Jul
	1DEF	Cod: marking	28 Oct-10 Nov
	1F	Cod: maturity, stomach	18-31 Mar
USSR	2J+3K	Acoustic: capelin	Oct-Nov
	3LNO	Acoustic: capelin, hydrography	01-15 Jun
		Trawl: capelin larvae, temperature	Nov-Dec
	3M	Eggs, larvae, hydrography, zoo-plankton	19-27 Jun
	4VWX	Adult silver hake	May-Jun
		Hydrography, plankton	May-Jul
USA	2-4 NEFC-EPD	Inshore fishery habitat	Sep-Dec
USA	5YZ	Larval herring/sand lance	04-19 Jan
			20 Feb-02 Mar
			28 Nov-13 Dec
		Larval herring	29 Oct-21 Nov
	5YZ+6ABC	Marine mammal sighting	05-18 Aug
	5YZ+6ABC	Trawl door testing	13-21 Nov
	5Z	Herring, sand lance & mackerel	23 Apr-04 May
			07-18 May
	6B	106-mile dump site: sediment trap deployment	21-26 May
		106-mile dump site: mid-water fish & oceanographic	06-18 Aug
		106-mile dump site: sediment & megafauna	20-31 Aug
		106-mile dump site: sediment trap recovery & redeployment	04-08 Sep
		SURVEYS PLANNED FOR EARLY 1991	
CAN-N	2J+3KL	Groundfish (stratified)	01-22 Feb
	3Ps	Groundfish (stratified)	01-21 Feb
CAN-Q	3Pn+4RST	Groundfish (stratified)	10-30 Jan
CAN-SF	4VW	Groundfish survey (stratified)	04-15 Mar
	4W	Herring acoustics	03-29 Jan
	4WX	International Observer Training	04-09 Feb
	5Ze	Groundfish survey (stratified)	12 Feb-01 Mar

c) Review of Relevant SCR and SCS Documents (Not Considered in Items 1 to 4 Above)

No documents were reviewed.

5. Acknowledgements

There being no other business, the Chairman thanked the rapporteur and the participants and extended special thanks to the NAFO Secretariat for their assistance in the preparation of information for this meeting. The meeting was then adjourned.

APPENDIX III. REPORT OF STANDING COMMITTEE ON PUBLICATIONS (STACPUB)

Chairman: V. P. Serebryakov Rapporteur: W. R. Bowering

The Committee met at the NAFO Headquarters at 192 Wyse Road, Dartmouth, Nova Scotia, Canada on 12 and 18 June 1990. In attendance were V. P. Serebryakov (USSR) (Chairman), W. R. Bowering (Canada), P. Kanneworff (Denmark/Greenland), J. Messtorff (EEC), V. A. Rikhter (USSR), A. Vazquez (EEC) and the Assistant Executive Secretary (T. Amaratunga) and the Executive Secretary (J. C. E. Cardoso) attended on 12 June 1990.

1. Review of STACPUB Membership

J. Messtorff informed the committee that due to his impending retirement he would not be maintaining his STACPUB membership beyond the present meeting of the NAFO Scientific Council. The Committee extended its gratitude to J. Messtorff for his long-standing and valuable contributions to STACPUB, and wished him well in his retirement.

The Committee noted that the Scientific Council nominated and elected M. Stein (EEC) to join STACPUB as his replacement.

2. Review of Scientific Publications since June 1989

a) Volume 9(1) containing 7 papers and 3 notices (95 pages) was published as planned with the publication date of September 1989.

Volume 9(2) containing 6 papers, 3 notices and 2 obituaries (62 pages) was published as planned with the publication date of December 1989.

An issue of the journal is in preparation with respect to papers presented at the Special Session on "Changes in Biomass, Production and Species Composition of the Fish Populations in the Northwest Atlantic Over the Last 30 Years, and Their Possible Causes" held in Brussels, September 6-8, 1989 with M. J. Fogarty as convener. Another single issue for the invitational paper titled "The Delimitation of Fishing Areas in the Northwest Atlantic" received from R. G. Halliday and A. T. Pinhorn on 2 February 1990 is also in preparation. As well, one paper was received at the Secretariat for its final preparation for the next regular issue of the Journal.

b) NAFO Scientific Council Studies

Studies Number 13 containing 5 papers and 3 notices (81 pages) was published as planned with the publication date of November 1989.

Studies Number 14 containing 6 papers, 3 notices and 2 obituaries (78 pages) was published as proposed with the publication date of May 1990.

Three papers are in their late stages of preparation for publication in Studies Number 15.

c) NAFO Statistical Bulletin

After the very late receipt of STATLANT 21B data from Canada-N (6 Sep 1989), and data for Faroe Islands were adapted from 21A reports, *NAFO Statistical Bulletin* Vol. 36 was published in October 1989 (within 1 month after all data were received). Due to the late submission of some data, this publication was delayed by about 2 years.

After the late receipt of data from some countries (February/March 1990), *NAFO Statistical Bulletin* Vol. 37 was published in April 1990 just 1 month after all data became available. This issue was, however, also considerably late.

Deadline for submission of STATLANT 21B reports for 1988 was 30 June 1989. As of June 1990, data were still outstanding from 8 countries. The delay in the acquisition of final data will again have impact on the timely publication of *NAFO Statistical Bulletin* Vol. 38.

d) NAFO Scientific Council Reports

The volume (180 pages) containing reports of the 1989 meetings of the Scientific Council was published and distributed in December 1989.

e) List of Fishing Vessels

This triennial publication was published soon after the June 1988 Scientific Council Meeting (published in July 1988) when all outstanding data were received.

"List of Fishing Vessels, 1986" (47 pages) contains 1986 and previous years' data.

f) Index and List of Titles

The provisional index and lists of titles of 98 research documents (SCR Doc.) and 22 summary documents (SCS Doc.) which were presented at the Scientific Council meetings during 1989 were compiled and presented in SCS Doc. 90/06 (24 pages). The five year publication (1985-89) is due to be published in mid-1990.

3. Production Costs and Revenue for Scientific Council Publications

Production costs and revenues for the various publications related to the activities of the Scientific Council were reviewed by the Committee. No significant departures from those of previous years were observed.

It was noted that at least one additional issue of the Journal is due to be published within the next year. The Committee agreed that possible extra production costs should be considered during fiscal planning.

4. Promotion and Distribution of Scientific Publications

a) Publicity and Response Regarding the Journal

It was noted that Journal subscriptions had remained relatively stable during the last 6 years. However, the Committee noted that publication rates of both the Journal and Studies had increased through the year. It was hoped that the improved turn-around time for publications and the new appearance of the Journal (in the form of a new cover) would further help the promotion of the Journal.

b) Invitational Papers for the Journal

The Assistant Executive Secretary informed STACPUB that the invited paper by R. G. Halliday and A. T. Pinhorn was now in its final stages of review for publication, and every effort was being made for it to appear in the next issue of the Journal. The Committee agreed that invitational papers and other future issues of the Journal with special status (e.g. the issue for the 1989 Special Session) should use the format of Journal Vol. 4 issued in 1983.

STACPUB was pleased to learn that J. Messtorff and Sv. Aa. Horsted had responded positively to the Assistant Executive Secretary's inquiries with regards to the possibility of preparing invitational papers. STACPUB accordingly extended invitations to them to submit such papers, and was pleased to learn that J. Messtorff would consider submitting a paper in the near future in the general theme of the history of the development of surveys, particularly the stratified survey schemes, in the Convention Area.

c) New Cover for the Journal

The Committee noted that the new cover for the Journal had been accepted and approved at the September 1989 meeting. Publication with the new cover will begin with the next issue. It seemed appropriate that it would be Volume 10, representing a decade of NAFO Journal publications. It also seemed appropriate that the first invitational paper could be the first issue of the Journal with the new cover.

5. Editorial Matters Regarding Scientific Publications

a) Editorial Activities

Of the 13 papers nominated at the June 1989 Meeting, 8 papers have been submitted (in one instance 2 SCR documents were combined to a single submission).

Authors who presented papers at the September 1989 Special Session were invited to upgrade their papers and submit them for consideration for a single issue of the Journal. Of the 16 documents proposed at the September 1989 Meeting, 9 had been submitted by June 1990.

In addition, 15 papers from outside of the STACPUB nomination process, including the first invitational paper, have been submitted since June 1989.

STACPUB noted taht a total of 39 papers were currently in various stages of editorial review for the Journal. Of these, 28 papers were in the hands of the Editorial Board. The 9 Special Session papers were being independently edited, while the invitational paper was also receiving an independent review process. In addition, there were 7 papers in various stages of review for the Studies.

In all, 24 papers were published (13 in the Journal and 11 in Studies) since June 1989.

b) Progress Review: Journal Issue of 1989 Special Session

All September 1989 Special Session papers were under consideration for publication as a special issue of the Journal of Northwest Atlantic Fishery Science by M. J. Fogarty (Convener). To date, 9 papers have been received for consideration and at least one review has been received for each. It is expected that most papers would be acceptable with further editorial changes but that several would require substantial revision and it may be necessary to simply list some in abstract form. Alternatively, some of the papers may, after revision, be more suitable as notes or short communications.

Four potential contributions have not yet been received, however, the Convener understands that they are in some stage of review and are expected to be submitted in the near future. The remaining 2 papers would be available only in the form of abstracts.

c) Review of General Editorial Process

The Committee recognized certain Associate Editors had greater workload than others and STACPUB felt the general editorial process needed to be reviewed in relation to turnaround times.

d) Review of Editorial Board

i) Workload of Associate Editors and Consideration of an Additional Associate Editor for Vertebrate Fisheries Biology

The Assistant Executive Secretary informed STACPUB that the workload of Associate Editors for Vertebrate Fisheries Biology had increased due to the number and nature of the papers being submitted. However, STACPUB agreed that further consideration of the necessity of an additional Associate Editor for Vertebrate Fisheries Biology be deferred until the September 1990 meeting.

ii) Appointment of Associate Editor for Vertebrate Fisheries Biology (Dr. Grosslein has resigned)

The Assistant Executive Secretary informed STACPUB that M. J. Grosslein had decided with regret that his plans for the next few years required him to terminate his service as Associate Editor. While he planned to finish the papers he had in hand, he requested STACPUB to seek an immediate replacement.

The Committee requested that the Chairman, on behalf of the members, write to Dr. Grosslein and express their gratitude and appreciation for his years of service and devotion to the promotion of the Journal and wish him well in his future endeavours.

The Committee invited Dr. R. K. Misra, Department of Fisheries and Oceans, Science Branch, Halifax, Canada as his replacement and was pleased to have a scientist of Dr. Misra's reputation to consider serving on the Editorial Board.

6. Papers for Possible Publication

a) Review of Proposals for 1989 Meetings

STACPUB was pleased to note that, compared to previous years, submissions in 1989 had improved substantially.

b) Review of Contributions to the 1990 Meeting

STACPUB considered all 91 SCR documents and 21 SCS documents presented to the Scientific Council, and nominated SCR Doc. 90/17, 34, 36, 41, 63, and 78. The Committee requested the Assistant Executive Secretary to invite authors of those documents to submit them in a suitable form for consideration for publication in the Journal or Studies.

STACPUB recognized that as a result of the large number of papers presented to the meeting, members could not in the limited time available adequately scrutinize the papers to determine their suitability. STACPUB therefore emphasized that the above nominations did not preclude submission of papers by authors who felt that their papers deserved consideration.

STACPUB observed that the "Final Report of the STACREC Working Group on Survey Design and Procedures" (SCS Doc. 90/20) contained important and valuable information that should be available in NAFO literature in a referenceable form. STACPUB agreed to invite the convener of the STACREC Working Group to consider preparing the Report with the necessary redrafting and editing for publication in Studies.

7. Microfiche Projects

a) Review of Requests for Microfiche of ICNAF Documents

The ICNAF Microfiche Project covered the documents produced during 1951-79 and was completed in November 1986. The Secretariat purchased 30 sets of the fiche and to date have sold 13 sets (7 in 1987, 3 in 1988 and 3 in 1989). NAFO continues to advertise the fiche in each issue of the Journal and Scientific Council Studies.

b) Question of Microfiching NAFO Documents

The Executive Secretary was requested to make whatever progress was possible with microfiching NAFO documents should opportunities arise within annual budgets. The view, however, was continued that specific funding should not be requested in the publications budget for this item until the ICNAF microfiche project recovers its full cost. This would require that seven more sets are sold.

8. Other Matters

a) Request for a Special Issue of the Journal

As part of a USSR-Canada Scientific Bilateral agreement, a symposium entitled "Biology and Fishery for Capelin in the Northwest Atlantic" will be held in St. John's during 27-30 November 1990. To date, a total of 21 titles have been submitted by Canadian and Soviet contributors. More are expected and it is probable that a total of approximately 30 papers will be presented at the meeting. Because of the relevance of these papers to NAFO, the Conveners of the Meeting proposed that STACPUB consider inviting the conveners and authors to submit suitable papers to NAFO with the objective of publishing them in a single issue of the *Journal of Northwest Atlantic Fishery Science*.

STACPUB recognized the relevance of the subject to NAFO and agreed that the Journal would be an appropriate place for publishing the papers.

Assuming that the majority of the papers would be submitted for publication, this would place a substantial additional burden on the Journal editorial board. Consequently, STACPUB agreed that the Canadian convener, J. Carscadden (a former Associate Editor of the Canadian Journal of Fisheries and Aquatic Sciences), be invited to serve as a special editor to expedite peer-review and editing of this series of papers. It was hoped that submissions would be received by the end of 1990 and the editorial process would be completed in 6-8 months.

STACPUB also felt it would be appropriate to invite the co-conveners to prepare a one-page introduction to the series of papers with a brief description of the history and purpose of the meeting. The Assistant Executive Secretary was requested to inform the convener of the decision on behalf of STACPUB.

9. Acknowledgements

The Chairman thanked the Rapporteur (W. R. Bowering) for outstanding records of the meeting and the Assistant Executive Secretary for excellent work in preparing background working papers for the consideration of STACPUB. There being no other business the Chairman then adjourned the meeting.

PART B

Scientific Council Annual Meeting, September 1990

CONTENTS

REPORT OF SCIENTIFIC COUNCIL

Annual Meeting, September 1990

Chairman: B. W. Jones Rapporteur: T. Amaratunga

I. PLENARY SESSIONS

The Scientific Council met at the Lord Nelson Hotel, Halifax, Nova Scotia, Canada, during 10-13 September 1990, to consider and report on various matters listed in the provisional agenda (see Part C, this volume). Representatives attended from Canada, Denmark (Greenland), European Economic Community (EEC), Japan and the Union of Soviet Socialist Republics (USSR) and an observer from United States of America (USA). The Assistant Executive Secretary was in attendance.

The meeting was preceded by the Special Session on "Management Under Uncertainties Related to Biology and Assessments, With Case Studies on Some North Atlantic Fisheries", which was held during 5-7 September 1990 with J. Shepherd as Convener and participation by scientists from Canada, Denmark (Greenland), EEC, Japan, New Zealand, USA and USSR.

The opening meeting was called to order on 10 September 1990 at 1025 hr.

The Chairman welcomed the representatives to the 12th Annual Meeting. The Assistant Executive Secretary was appointed rapporteur. The Council adopted the agenda recognizing that the General Council or the Fisheries Commission might have specific requests that the Council would have to address.

Although the Report of the June 1990 Scientific Council had been adopted at the June meeting, the Chairman requested that he be notified of any errors[1]. It was noted that there could be a problem with the format of the stock summary sheet. The time series of recommended TACs gives a single value for each year, whereas the advice is now normally formulated as a range of management options. The indication of a single value for the recommended TAC could therefore be misleading. It was agreed that there should be further discussion to decide on a format that would resolve this problem.

The session was adjourned at 1040 hr.

On 12 September 1990, the meeting was called to order at 0910 hr.

The Scientific Council was addressed by the Fisheries Commission at its meeting on 11 September 1990 to respond to a number of requests for information and questions posed by Contracting Parties. The following were the responses:

1. In response to the request concerning the calculation of the estimated catch of 40,000 tons of cod in Div. 3M, the Council reported that the figure of 40,000 tons was derived as follows:

   - Catches of non-member country pair trawlers determined on the basis of logbook data for one of those vessels = 15,000 tons.
   - Unreported catches of member country vessels sighted in the area = 8,000 tons.
   - Unreported by-catch from the redfish fishery in depths less than 400 m = 7,000 tons.
   - Additional catches of other member and non-member non-pair trawler vessels from sightings = 10,000 tons (very rough estimate).

2. In response to the request for additional information on the spawning stock biomass for redfish in Div. 3M, the Council reported that there were no specific data on the size of the spawning stock biomass but the strong 1980 year-class is now maturing and the expectation is that this will result in an increase in spawning stock biomass.

3. In response to the request for information on the effect of fishing Div. 3NO capelin at levels higher than the recommended 10%, the Council reported that the normal biological reference points are not relevant for species such as capelin. The recommended 10% exploitation rate is a relatively conservative one which takes into account uncertainty about the size of recruiting year-classes and also the importance of capelin in the ecosystem.

[1] Minor errors were noted and corrected before publication in Part A of this issue.

4. In response to the request for information on the state of the stock of cod in Div. 3M in view of recent high catches, the Council reported that the exploitable biomass in 1989 was estimated to be about 100,000 tons. Even allowing for growth, catches since then are likely to have reduced the biomass to about half this level.

5. Information was requested on the origin of the previously proposed target level for exploitable biomass of 85,000 tons for cod in Div. 3M, and the question was asked: As this target had been exceeded in 1989, was there a need to continue the moratorium? The Council reported that the previous target for exploitable stock biomass was a strategy proposed by the Fisheries Commission for which the Scientific Council was requested to provide the appropriate figure for the stock size. The Scientific Council advocates that any target stock size should be set in terms of spawning stock biomass. Although the exploitable stock biomass exceeded 85,000 tons in 1989, the spawning stock biomass was still below any desirable level and it is to allow a recovery of the spawning stock that a continuation of the moratorium is advised.

6. With respect to cod in Div. 3NO, the Council was asked: a) are the reasons for the decline in recruitment known? and b) is information available on discards of cod in view of the small mesh sizes used in some flatfish fisheries? The Council reported that: a) no information is available concerning the reasons for declining recruitment, and b) directed fishing for cod is carried out by a different fleet (pair trawlers) from those fishing for flatfish (otter trawlers). A legal mesh size is used in the cod fishery. The by-catch of cod in the flatfish fishery is low and, as those caught are retained on board, discarding is minimal. No information is available, however, on the size composition of the cod by-catch.

7. The question was asked: in view of recent high catches in excess of the TACs, does the Scientific Council have confidence in the catch of 24,000 tons reported for 1989 for redfish in Div. 3LN? The Council reported that some reduction in catch is expected as a result of vessels diverting to fish for redfish in Div. 3M or for Greenland halibut. The provisional figure for 1989, however, does not include catches made by South Korea which could be in the range of 10,000-15,000 tons.

8. The Council was asked: does the stock of American plaice in Div. 3LNO provide a clear example of how a stock declines from overfishing in spite of constant recruitment? The Council reported that recruitment has been at a relatively stable level in recent years but at a lower level than in the 1970s. Fishing mortality has been increasing on fully recruited age groups, and has now reached $F = 0.6$ compared with $F_{max} = 0.51$. Fishing in excess of the TACs has contributed to the reduction of the stock but it is not a stock that would be cited as a classic example of overfishing.

9. The Council was asked: is the advice for yellowtail flounder in Div. 3LNO optimistic in view of the changed exploitation pattern? The Council reported that the advice will be slightly optimistic. The changed exploitation pattern will result in a lower yield-per-recruit but, because there is no analytical assessment, no quantitative evaluation can be given.

The session was then adjourned at 1015 hr.

The Council reconvened at 1330 hr on 12 September 1990 and adopted the reports of the Standing Committees: Appendix I - Report of Standing Committee on Fishery Science (STACFIS), Appendix II - Report of Standing Committee on Research Coordination (STACREC), Appendix III - Report of Standing Committee on Publications (STACPUB).

The session was adjourned at 1400 hr.

On 13 September 1990 the meeting was convened at 1300 hr, to consider a request from the Fisheries Commission for advice on the possibility of restricting the redfish fishery in Div. 3M to deeper depths to minimize the by-catch of cod.

The advice of the Scientific Council is that if redfish fishing were to be restricted to depths greater than 400-500 m, a significant reduction in the by-catch of cod would be expected. However, available information suggests that catch rates of redfish are lower in the deeper water. In addition, *Sebastes marinus* are only found in shallower waters and would not be caught if the fishery was restricted to the deeper waters. The TAC advice was based on a biomass estimate for both redfish species combined (*S. mentella* and *S. marinus*) and it is not possible at present to estimate the biomass for each species separately. Therefore the advised TAC would not be applicable to a redfish fishery restricted to depths in excess of 400 m. In order to provide advice on the overall implication of restricting to depths greater than 400 m, detailed information on the seasonal and interannual distributions of both redfish and cod would be required. These data are currently not available.

The session was adjourned at 1345 hr.

The concluding session of the Scientific Council was called to order at 1745 hr on 13 September 1990.

Brief summaries of Standing Committee Reports and other matters considered by the Council are given below in Sections II-VIII. The agenda, the list of participants and the list of research (SCR) and summary (SCS) documents are given in Part C of this volume.

The meeting was adjourned at 1900 hr.

II. FISHERY SCIENCE (see STACFIS Report, App. I)

1. Stock Assessments

The Council was unable to assess the capelin in Div. 3L at the June 1990 Meeting because of calibration problems with acoustic survey data for 1990. Since then attempts to solve those problems were made, although with limited success, and the stock was assessed during this meeting. Details of the assessment are given in the Report of STACFIS in Appendix I, while a Summary Sheet of the assessment is given below.

2. Special Session on Management Under Uncertainties

The Council endorsed the general discussions and conclusions presented to STACFIS by the convener, J. Shepherd (EEC-UK), at the end of the Special Session (Annex 1 in the Report of STACFIS). The Council made special note that participants considered the Special Session to be a very successful meeting and resulted in highlighting observations regarding management under uncertainties. Congratulations were extended to the convener for a job well done.

The Council noted that the two recommendations forwarded by the convener to STACFIS were addressed and reported by STACFIS and STACPUB in their respective reports.

The Council agreed with the view of STACFIS that the name "Special Session of the Scientific Council" might have created the impression that it was a closed meeting of the Scientific Council. In order to have the widest possible participation, the Council agreed that the forthcoming meeting should be named "Symposium hosted by the NAFO Scientific Council", and requested the Assistant Executive Secretary to insert an appropriate statement in the announcements to indicate that the meeting is open to the scientific community.

3. Review of Current Arrangements for Conducting Stock Assessments

a) Selection of Designated Experts

The Council noted that STACFIS had assigned laboratories with the responsibility of providing Designated Experts on a stock by stock basis. The Council urged the various laboratories to confirm to the Assistant Executive Secretary their willingness to provide such services and to provide names of the nominated scientists. This process should be concluded before 1 November 1990 to enable the Designated Experts to contact other scientists to arrange for exchange of data, well in advance of the 1991 assessments.

b) Documentation of Assessments

The Council noted that STACFIS discussed the format of scientific documents prepared by Designated Experts, and the Report of STACFIS and the Scientific Council for presentation of the assessments. The Council endorsed the recommendations made by STACFIS in this respect.

4. Future Special Sessions

a) Special Session in September 1991

The topic for September 1991 was discussed by STACFIS and the Council endorsed the new title "Changes in Abundance and Biology of Cod Stocks and Their Possible Causes" for the meeting to be convened by H. Hovgård (Denmark-Greenland). The Council was pleased to note that the general theme and specific topics were finalized and preparations were well underway.

SUMMARY SHEET - Capelin in Division 3L

Source of Information:

Year	1983	1984	1985	1986	1987	1988	1989	1990	Max	Min	Mean	Years
Recommended TAC	60	38	60	130	283	90	335	350	350	16	128	1979-90
Agreed TAC	30	26	26	55	25	45	46	56	56	10	33	1979-90
Actual landings	25	33	25	48	19	54	51		54	12	30	1979-89
Sp. stock biomass[1] ('000 tons)	473	382	596	1300	2830	900	3345	3500				
Recruitment[2] (age 2) (10^9)	20.0	73.2	73.2	63.7	87.8	380.4	314.8					
Mean F	*No information available*											

[1] Spawning stock biomass not measured. These were projected from acoustic estimates.
[2] Recruitment at age 2 in the year shown. Recruitment 1982-85 were projections from acoustic surveys. From 1986 to present, measured directly from acoustic surveys.

Catches: All catches are inshore and determined by market. The dominant market is Japanese roe market.

Data and Assessment: Inshore indices of abundance from catch rates and aerial survey. Projections from acoustic survey estimates of year-class abundance.

Fishing Mortality: Not estimated but very low. Recommended TACs based on exploitation rate of 10%. Catches were much lower than recommended TAC in recent years.

Recruitment: Estimated from acoustic surveys. There was no estimate on the strength of the 1988 year-class.

State of Stock: Highest biomass in late-1980s due to two consecutive strong year-classes (1986 and 1987).

Forecast for 1990: No projection possible.

Option Basis	Predicted catch (1991)	Predicted SSB (1.1.1992)
$F_{0.1}$ =		
F_{89} =		
F_{max} =		

Recommendation: No recommendation for 1991.

Special Comments: Past TACs have been determined on the basis of market forecast.

Catches in 1991 at around 50,000 tons, as taken in recent years, will be well below the 10% exploitation level.

The Council agreed that the meeting should be described as "Symposium hosted by the NAFO Scientific Council" and that announcements should state that the meeting is open to the scientific community.

b) Proposed Theme for Special Session in September 1992

Three possible topics were discussed by STACFIS, and the Council endorsed the proposal to arrange a workshop on "State-of-the-Art in Fish Stock Assessment: a Tutorial/Workshop on Calibration Methods and Their Practical Use". The Council welcomed the suggestions for the selection of co-conveners. The Council agreed that this workshop would retain the status of Special Session of the Scientific Council.

III. RESEARCH COORDINATION (see STACREC Report, App. II)

1. Fisheries Statistics

The Council noted with concern that some STATLANT 21B reports for 1988 were still outstanding. Several STATLANT 21B reports for 1989 had been received since June, but many reports were yet outstanding. Only one STATLANT 21A report for 1989 was outstanding. The Council noted that delays in providing timely reports meant that data were not available for stock assessments, and that some publications such as *NAFO Statistical Bulletin* Vol. 38, could not be produced on schedule.

IV. PUBLICATIONS (see STACPUB Report, App. III)

1. Review of Editorial Board

The Council noted the decision by STACPUB that an additional Associate Editor for Vertebrate Fisheries Biology was not required for the present.

2. Invitational Papers

The Council was pleased to note the progress made on the first invitational paper.

3. Review of Papers

In view of the very important observations regarding uncertainties in fisheries management highlighted at the Special Session, the Council endorsed the recommendation by STACPUB that the papers and proceedings of the Special Session be published in a special issue of the *NAFO Scientific Council Studies* to allow for expedient circulation.

V. FUTURE MEETING ARRANGEMENTS

1. June 1991 Meeting of Scientific Council

The Council confirmed that the Scientific Council together with its Standing Committees and Subcommittee would meet during 5-19 June 1991 at NAFO Headquarters in Dartmouth, Nova Scotia, Canada.

2. Special Session and Annual Meeting, September 1991

The Council confirmed that the Annual Meeting of the Scientific Council would be held during 9-13 September 1991 in Halifax, Nova Scotia, Canada. The meeting would be preceded by the Symposium titled "Changes in Abundance and Biology of Cod Stocks and Their Possible Causes" with H. Hovgård (Denmark-Greenland) as convener during 4-6 September 1991.

3. June 1992 Meeting of Scientific Council

The Council agreed on the tentative dates of 3-17 June 1992 for the meeting of the Scientific Council.

VI. OTHER BUSINESS

1. Questions by the Fisheries Commission

Responses to several requests for information and questions from the Fisheries Commission forwarded to the Council during the meeting are given above (see I. Plenary Sessions).

VII. ADOPTION OF REPORTS

1. Committee Reports of Present Meeting

The Council reviewed and adopted the reports of the Standing Committees as presented by the respective Chairmen on 12 September 1990.

VIII. ADJOURNMENT

There being no further business, the Chairman expressed his appreciation to the Chairmen of the Standing Committees (H. Lassen, W. B. Brodie and V. P. Serebryakov) and all the participants for their contributions in the cooperative spirit to make this meeting a success. Having received appreciative words from Fisheries Commission delegates for the clarity of the Scientific Council Report, the Chairman said his personal thanks were due to everyone, particularly H. Lassen, for their support. Noting that H. Lassen steps down from the most demanding job in the Council as Chairman of STACFIS, he extended thanks for guiding STACFIS through the last two years in an efficient and friendly way. He then welcomed D. B. Atkinson, the incoming Chairman of STACFIS.

The Chairman, on behalf of the Council, bid farewell to Sv. Aa. Horsted and extended the very best wishes to him for a long and happy retirement.

APPENDIX I. REPORT OF STANDING COMMITTEE ON FISHERY SCIENCE (STACFIS)

Chairman: H. Lassen Rapporteur: Various

The Committee met at the Lord Nelson Hotel, Halifax, Nova Scotia, Canada, during 10-12 September 1990, to consider and report on various matters referred to it by the Scientific Council. Representatives attended from Canada, Denmark (Greenland), EEC, Japan and USSR, and an observer from the USA.

The meeting was preceded on 5-7 September 1990 by the Special Session on "Management Under Uncertainties Related to Biology and Assessments, with Case Studies on Some North Atlantic Fisheries". STACFIS received the report of the Special Session from the convener J. Shepherd (EEC-UK) (see Annex 1 this report).

Matters which were considered at both meetings are outlined below.

I. STOCK ASSESSMENTS

1. Capelin in Division 3L (SCR Doc. 90/07, 59, 60)

a) Introduction

Nominal catches of capelin in this Division were less than 4,000 tons between 1970 and 1973, then increased to 58,000 tons in 1974 and declined to 12,000 tons in 1979. No offshore fishing has occurred since 1978. Provisional statistics for 1989 indicated a total catch of 51,000 tons in the inshore fishery by purse seines, traps and beach seines during June and July. In recent years, the final TAC has been based on the market forecast for roe capelin.

Recent TACs and catches ('000 tons) are as follows:

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Advised TAC	16	30	-[1]	60	38	60	130	283	90	335	350
TAC	16	30	30	30	26	26	55	25	45	46	56
Catch	14	24	27	25	33	25	48	19	54[2]	51[2]	

[1] No STACFIS advice
[2] Provisional data

b) Input Data

i) Commercial fishery

A logbook survey of the inshore capelin fishery in Div. 3L, designed to provide estimates of catch-per-unit effort, was initiated in 1981. Trapnets and purse seines (where catches were derived from the addition of the quantities actually landed and the quantities of discards from logbooks) show relatively high catch rates in recent years. Both indices showed an increase from 1988 to 1989 such that the 1989 trap index was the second highest in the series and the 1989 purse seine catch rate was the highest.

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Trapnets (tons/day)	2.9	3.1	3.4	2.9	4.6	4.6	8.8	6.2	6.7
Purse seines (tons/day)	9.4	16.4	18.8	14.3	16.4	19.0	18.1	20.7	24.3

Discarding rates (which included dumping of dead capelin as well as releasing fish alive) in 1989 for purse seines were 21% and 23% for traps which were slightly higher than the 14% and 17% respectively in 1988 and considerably lower than the 35% and 74% respectively in 1987.

The 1986 and 1985 year-classes accounted for 75% and 21% of the 1989 commercial catch (by numbers) respectively.

ii) Research data

Aerial surveys of capelin in Trinity and Conception Bays have been

conducted in June and July since 1982. Total surface area of schools, estimated from aerial photographs, provided an index of abundance. Aerial coverage of the four transects was variable due to poor weather conditions but the 26 hours of flying time was only slightly lower than the 1982-88 average of 29 hours and ancillary information indicated that the peak spawning run was covered. The 1989 estimate of total school surface area was the second highest in the series and approximately 83% of the highest (1987).

The aerial survey index, the two inshore catch rates and the projected biomass from acoustic surveys have shown the same general trends.

The USSR conducted an acoustic survey in Div. 3LNO during 18 May-5 June 1989, and this resulted in a biomass estimate of 2,458,000 tons. A similar survey during 1988 provided a biomass estimate of 3,950,000 tons. In the 1989 survey, the 1986 year-class was dominant accounting for 51% of the numbers and 64% of the biomass. An estimate for the Div. 3L stock from the overall estimate for Div. 3LNO could not be extracted.

Larval surveys have been conducted by the USSR since 1983 and the results of these surveys were discussed in the assessment report of capelin in Div. 3NO (see Report of the June meeting).

Final biomass estimates from a Canadian acoustic survey conducted during 9-27 May 1990 were not available due to calibration problems. However, preliminary analysis of the data indicated that capelin were distributed throughout the survey area and distribution patterns were comparable to those observed during 1988 and 1989. Age compositions in research midwater trawl catches were similar to previous years with two-, three- and four-year-olds accounting for 58%, 28% and 9% respectively.

c) Estimation of Parameters

The major contributors to the mature population in Div. 3L during 1991 will be the 1987 and 1988 year-classes. The most recent estimates of the 1987 year-class were from acoustic surveys conducted during May 1989. These estimates indicated that this year-class may have a range from about 34% (USSR estimate) to 85% (Canadian estimate) of the strength of the strong 1983 year-class as 2-year-olds. A portion of the 1987 year-class will have matured and spawned during 1990 and thus, since the 1989 estimate, this year-class will have been reduced in abundance due to natural mortality, spawning mortality and fishing mortality. STACFIS noted that the acoustic estimates derived in 1989 and the estimates of spawning mortality and age specific maturation rates used in projections have potentially large variances. Consequently, STACFIS concluded that projections of this year-class from 1989 acoustic estimates to the 1991 spawning season would not be appropriate.

There is no estimate of the abundance of the 1988 year-class available and consequently, no projections could be made. However, based on qualitative evidence from the 1990 Canadian acoustic survey and indications from the USSR 0-group survey, STACFIS concluded that there was no cause for concern about the abundance of this year-class.

There are neither estimates of biomass for 1990 nor estimates of the strength of the 1988 year-class available. Consequently, STACFIS is unable to provide TAC advice in relation to the management target level established in 1979 of an exploitation rate of 10% of mature biomass. There have been no signs of any significant decline in abundance during 1987-89 and it is noted that the advised TAC corresponding to the 10% exploitation rate has been around 300,000 tons during three of the last four years. The actual TAC is set on market considerations and in most recent years, 1988-90, around 50,000 tons. STACFIS concluded that even with the limited information available, this level of catch in 1991 would be well below a 10% exploitation rate.

II. REPORT OF SPECIAL SESSION (see Annex 1)

1. Special Session on Management Under Uncertainties

STACFIS received the report of the 5-7 September 1990 Special Session on "Management Under Uncertainties Related to Biology and Assessments, with Case Studies on Some North Atlantic Fisheries" from the convenor J. Shepherd (EEC-UK). Many aspects of biological uncertainties had been discussed (see complete report in Annex 1) and STACFIS recognized the value of the contributions. STACFIS endorsed the convener's recommendation that *the papers presented to the Special Session should be published either in full , or as extended abstracts for papers to be published elsewhere (e.g. the J. Northw. Atl. Fish. Sci.), in a special volume of the NAFO Scientific Council Studies series,* and requested STACPUB to consider this recommendation and to consider an appropriate review procedure

for such a volume.

Following discussions based on the convener's recommendation, STACFIS agreed that the name "Special Session of the Scientific Council" might have created the impression that this was a closed meeting of the Scientific Council. STACFIS was anxious to have the widest possible attention to such sessions and agreed it was desirable to change the name to:

"Symposium hosted by the NAFO Scientific Council"

and further proposed that the Council ask the Assistant Executive Secretary to insert in the next flyer announcing the 1991 symposium, an appropriate sentence indicating that the meeting is open to the scientific community.

III. REVIEW OF CURRENT ARRANGEMENTS FOR CONDUCTING STOCK ASSESSMENTS

1. Designated Experts

The following laboratories were identified by STACFIS for providing Designated Experts for the June 1991 assessments:

Cod	SA 1	GFRI, Denmark[1]
	Div. 3M	IIM, Vigo[2]
	Div. 3NO	DFO, Newfoundland[3]
Redfish	SA 1	BFA, Hamburg[4]
	Div. 3M	PINRO, Murmansk[5]
	Div. 3LN	DFO, Newfoundland[3]
Silver Hake	Div. 4VWX	DFO, Dartmouth[6]
American plaice	Div. 3M	IIM, Vigo[2]
	Div. 3LNO	DFO, Newfoundland[3]
Witch flounder	Div. 3NO	DFO, Newfoundland[3]
Yellowtail flounder	Div. 3LNO	DFO, Newfoundland[3]
Greenland halibut	SA 0+1	GFRI, Denmark[1]
	SA2+Div. 3KL	DFO, Newfoundland[3]
Roundnose grenadier	SA 0+1	GFRI, Denmark[1]
	SA 2+3	DFO, Newfoundland[3]
Wolffish	SA 1	GFRI, Denmark[1]
Capelin	Div. 3L	DFO, Newfoundland[3]
	Div. 3NO	DFO, Newfoundland[3]
Squid	SA 3+4	DFO, Newfoundland[3]
Northern shrimp	SA 0 + 1	GFRI, Denmark[1]
	Denmark Strait	Iceland[7]

[1] Greenland Fisheries Research Institute, Tagensvej 135, 1,
DK-2200 Copenhagen N, Denmark
Telephone - 31 85 44 44; Telefax - 31 85 01 66; Telex - 19405

[2] Instituto Investigaciones Marinas
Muelle de Bouzas, Vigo, Spain
Telephone - 86 23 19 30; Telefax - 86 29 27 62

[3] Northwest Atlantic Fisheries Centre
Department of Fisheries and Oceans
P. O. Box 5667, St. John's, Newfoundland, Canada
Telephone - 772-2030; Telefax - 772-2156; Telex - 016-4698

[4] Institut fur Seefischerei
Palmaille 9, D-2000 Hamburg 50, Federal Republic of Germany
Telephone - 040 38905194; Telefax - 040 38905129

[5] Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
6 Knipovich Street, Murmansk, 18363, USSR
Telex - 64-126357

[6] Bedford Institute of Oceanography, Marine Fish Division
P. O. Box 1006, Dartmouth, Nova Scotia, Canada
Telephone - 426-9347; Telefax - 426-2256; Telex - 01931552

[7] Marine Research Institute, Skulagata 4, P. O. Box 1390
121 - Reykjavik, Iceland
Telephone - 354-1-20240; Telefax - 354-1-623790; Telex - 7400746

2. Documentation of Assessments

STACFIS discussed the respective contribution of the various NAFO scientific documents/reports in the communication of stock assessment results and of general information on the fisheries and resource status. For instance, it was noted that the sections entitled "Description of the Fishery" are often sketchy and insufficient to provide an appreciation of the main characteristics of a particular fishery (e.g. gear composition, seasonality of landings, etc.). With respect to the presentation of scientific analysis and their results, a better balance between completeness and relevancy must be found.

STACFIS noted that the Scientific Council Reports serve at least three purposes at present and suggested that these purposes would be better served if some clear distinction of the underlying functions were introduced. From their initial drafting to their publication, the STACFIS/Scientific Council reports serve a number of objectives:

a) They form the basic vehicle for the development of consensus among the scientists attending the meetings with respect to the various questions raised.

b) They serve as a record of the assessments and recommendations made at particular meetings. As such, they constitute a compromise since they do not contain as much information as detailed minutes of the deliberations. However, the information presented is, in general, sufficiently detailed to provide an account of the major recommendations made, and of their background.

c) The reports serve as the official vehicle for communicating scientific advice to the Fisheries Commission or the organizations that requested advice.

In summary, it is difficult to achieve all goals in a single report. However, STACFIS recognized that the task of creating an alternative form for scientific/communication reports was not a trivial one and proposed to take a progressive approach. In particular, STACFIS recommends that: *the main research (SCR) document related to the assessment of a given stock serves as the focal point for integrating the scientific information pertinent to the assessment of that stock and that it be updated, as soon as possible after the scientific meeting, so as to reflect the analyses performed in support of the final assessment.* STACFIS noted that the tendency in recent years had been to update the SCR documents shortly after its meeting but recommends that:

a) *the practice of updating the SCR document be generalized and streamlined to ensure that the final SCR document contains all data and analyses needed to substantiate the conclusions agreed upon by STACFIS,* and

b) *the Summary Sheets be enhanced so as to provide a broader historical perspective with respect to catch trends and to the status of the resource (e.g. recruitment, spawning stock biomass, fishing mortalities).*

The main focus of the Summary Sheets must remain on "the results" as opposed to "how the results were obtained", which will remain the main thrust of the STACFIS/Scientific Council Reports.

IV. FUTURE SPECIAL SESSIONS

1. Special Session in September 1991

The topic and theme for the 1991 Special Session was discussed. It was stressed that the theme "Atlantic Cod" should attract groups studying the causes of recent abrupt changes in growth and in abundance. This should call for contributions from scientific groups not usually involved with NAFO. The title was amended and a draft of a flyer was prepared.

2. Proposed Theme for Special Session in September 1992

STACFIS discussed three topics:

a) A Symposium hosted by NAFO Scientific Council titled "Impact of marine mammals on commercial fisheries in the North Atlantic".

b) A Symposium hosted by NAFO Scientific Council titled: "Impact of Changes in Environmental Conditions in the North Atlantic: a Decadal Review". This topic should focus on how the North Atlantic system had gone through extremes in the early- to mid-1980s and returned to normal (?) *versus* the end of the decade. Also

outlooks into the 1990s would be welcome.

c) A Special Session of the Scientific Council titled "State-of-the-Art in Fish Stock Assessments: a Tutorial/Workshop on Calibration Methods and Their Practical Use".

STACFIS decided that Topic c) be chosen for 1992.

STACFIS asked D. B. Atkinson and H. P. Cornus to solicit co-conveners from both sides of the North Atlantic and present a document to the June 1991 Meeting with the details worked out. It was recognized that this Special Session would have to have limited attendance depending on availability of rooms, computers and lecturers. It was agreed that the Special Session would have three main areas of activities:

- Lectures on the various methods and computer packages.
- Exercises using the computer packages with simulated datasets.
- Exercises on real data.

It was also recognized that tutorial material should be prepared specifically for this Session, and if the tutorial material would be of suitable quality and of a reasonable wide scope, publication of the material in the form of a manual should be considered.

V. OTHER MATTERS

1. Review of Scientific Papers

The 3 papers submitted to STACFIS on:

a) Tizol, R., M. Isaac, and G. Arencibia. Age determination of silver hake by chemical composition of otoliths. (SCR Doc. 90/03, Serial No. N1706)

b) Saborido, F., and J. Paz. Distribution and abundance of cod on the Flemish Cap, July 1988 and 1989. (SCR Doc. 90/92, Serial No. N1824)

c) Paz, J., and M. G. Larraneta. Year-class variations of American plaice and yellowtail flounder in Div. 3LNO and the abundance of other commercial fish (SCR Doc. 90/114, Serial No. N1850).

These were found to be relevant to stock assessments and STACFIS agreed to review these documents at the June 1991 Meeting, when assessments would be carried out.

2. Acknowledgements

In closing the meeting, the Chairman noted that his term of office had come to an end. He thanked the members of the Committee for their co-operation and support during the last two years. He also expressed his appreciation of the help of the Secretariat and especially the help of the Assistant Executive Secretary. He welcomed the incoming Chairman, B. Atkinson (Canada), and wished him well in the coming two years.

ANNEX 1. REPORT OF SPECIAL SESSION ON MANAGEMENT UNDER UNCERTAINTIES RELATED TO BIOLOGY AND ASSESSMENTS, WITH CASE STUDIES ON SOME NORTH ATLANTIC FISHERIES

1. Introduction

The Special Session on "Management under uncertainties related to biology and assessments, with case studies on some North Atlantic fisheries", with J. Shepherd (EEC-United Kingdom) as convener, was held at the Lord Nelson Hotel, Halifax, Nova Scotia, Canada, during 5-7 September 1990. A total of 23 presentations were made (SCR Doc. 90/93 to 90/113 and 90/115), in four sessions concerned with: sources of uncertainty, case studies, interactions with policy, and provision of advice.

The formal presentations were followed by a panel discussion, the panel members being: J. Shepherd (Chairman, EEC-UK), A. Rosenberg (USA), A. Sinclair (Canada), H. Lassen (Denmark/Greenland) and C. Francis (New Zealand). The Session was attended by scientists from Canada, Denmark (Greenland), EEC, Japan, New Zealand, USA, and USSR.

2. Specific Topics

a) Sources of uncertainty

Almost everything that concerns the provision of management advice is uncertain to a greater or lesser extent, and the effect of these uncertainties on the advice is quite variable. Specific areas of uncertainty are:

- the state of the stock (biomass, age structure, ..., etc.);
- the state of exploitation (fishing mortality, exploitation pattern, ..., etc.);
- stock identity (completeness, composition, mixing, migration);
- biological parameters (natural mortality, growth, maturity, ..., etc.);
- system structure (single or multispecies, nature of fleets, effects of environment);
- future recruitment (short-term, long-term, stock-recruitment relation);
- data (catches, effort, surveys, ..., etc.); and
- objectives of management (maximum yield, earnings, profit, gastronomy, social aspects, minimum stock size, stability of catches, effort, etc.).

In the session on this topic, the presentations concerned uncertainties due to multispecies interactions, recruitment variability, stock identity and mixing, discards, fecundity and growth parameters, but it was recognized that these were only a selection and by no means an exhaustive list. In general, the effects of sampling or measurement error could be assessed relatively easily: the consequences of structural error (e.g. model mis-specifications) are much more difficult to handle. However, it may be that even simple observation errors are sufficient to obscure the effects of structural changes (such as inclusion/exclusion of multispecies effects (SCR Doc. 90/112)) so that these cannot be determined. In general, simulation methods (including bootstrap estimation and related techniques) are excellent and powerful tools for studying and assessing the effects of uncertainty in complex systems.

Recruitment variability is an invariable feature of fish stocks. There is now clear evidence of different levels of variability between species groups, and strong evidence for higher variability at the extremities of geographical ranges (SCR Doc. 90/101). Recruitment fluctuations are not usually random, but are often serially correlated (positively) indicating persistence in the stock or its environment, and this seems to be associated with late first exploitation and/or high latitude stocks.

Mis-specification of stock structure can lead to severe mis-estimation of the effects of fishing (SCR Doc. 90/106). The effects can be explained by modelling for specific situations, but at the moment, general conclusions have not been deduced.

Commercial statistics invariably relate to landings of fish, and do not give accurate estimates of removals when discarding is prevalent. This may lead to serious mis-estimation of the state of a stock, and the effects of management options. The quantities discarded may be estimated directly (e.g. by observers) but this is expensive. When large quantities are discarded, these may be estimated by comparison of length compositions of landings with those of the stock as estimated by research vessel surveys, provided these are sufficiently precise (SCR Doc. 90/110). The effects can be estimated by comparative modelling. The dependence of discard rates on external factors (e.g. year-class strength, market conditions) is most important and really needs to be determined by statistical analysis before accurate allowance can be made in forecasts.

The survival of young fish from eggs to recruitment is extremely variable, and responsible for much of the scatter of stock recruitment diagrams. For some (most ?) stocks, fecundity is also very plastic, varying considerably even from year to year (SCR Doc. 90/115). It is therefore desirable for stock recruitment studies to be based on egg production (population fecundity) rather than spawning stock biomass. This is not possible unless routine observations of fecundity are carried out, which is quite expensive, but a case can be made for fecundity estimation being as desirable as age determination. Indicator levels of population fecundity (e.g. in effect, spawning stock size) can be derived as follows:

- A safe population level, given by dividing the size of a good year-class by a moderate value of survival.

- A critical population level, given by dividing the size of a good year-class by a high level of survival.

Errors in growth parameters due to sampling error in length/age determination may be substantial, and are highly (inversely) correlated. The effect on yield curves and $F_{0.1}$ and F_{max} estimates can be estimated by Monte Carlo simulation (SCR Doc. 90/94).

b) Case Studies

An extensive investigation of the consistency and precision of some assessments of Northwest Atlantic fish stocks was carried out by a CAFSAC workshop (SCR Doc. 90/96 + Addendum). For most stocks considered, there was a tendency to underestimate F and overestimate population size, as determined by both retrospective studies and simulation tests. The cause has not yet been clearly identified, but candidates are: misreporting, incorrect estimation of M in the presence of a trend in F, and mis-specification of the partial recruitment (exploitation) pattern (perhaps). Monte Carlo simulation of the assessment procedure using ADAPT is feasible and yields valuable information on the confidence intervals of the assessments. Retrospective tests could also be carried out routinely, and might even be used to estimate correction factors for current assessments, if a systematic tendency is observed.

Case studies of stocks at Greenland indicate that severe uncertainty can lead to a situation where no advice can be offered (SCR Doc. 90/99). This is tolerable when exploitation levels are low, but is a severe problem if this is not so. For cod, the future catch can only be forecast once the fish are 2- or 3-years old, since 0-and 1-group recruitment estimates have been completely misleading in some cases. Errors are much less troublesome if there is a long lead-time before first exploitation of a year-class, several year-classes contribute substantially to the fishable stock, and the yield curve is reasonably flat. Long-term management advice is however almost impossible to provide because of extreme fluctuations of year-class strength and the effects of unpredictable episodes of emigration. The shrimp fishery shows that a steady TAC policy is feasible only when exploitation rates are low and recruitment is steady.

Historical analysis of assessments for cod in Div. 3Pn and 4RS also show a consistent overestimation of stock size (SCR Doc. 90/105). Simulation testing shows that the most important variables are recruitment, the method of assessment used, and growth (weight-at-age). The management (F_{max}, $F_{0.1}$, etc.) has relatively little influence and would not have prevented stock decline in this case. It is not possible to determine whether the current assessment may still be biased, but with improved methodology (e.g. ADAPT) and increased reliance on survey data, this is thought to be less likely.

A similar historical analysis for American plaice in Div. 3LNO also indicates a consistent overestimation of stock size as judged by the current interpretation (SCR Doc. 90/97). In this case too, a wide variety of assessment procedures were used over the last 10-20 years, but this does not fully explain the effect, since retrospective analyses show the same feature. There seems to be some discrepancy between the SPA results and the CPUE and RV indices for this stock, which may be caused by problems with the basic catch data, perhaps because of unrecorded discarding.

The cod stock in Div. 2J+3KL has been analyzed extensively because of recent difficulties with the assessment, triggered by a change to modern methodology in 1988 (SCR Doc. 90/104). The main cause of the sudden change in the assessment was however not due to this, but to a change in the confidence attached to the survey results for 1984 and 1985 (which were low for environmental reasons) and that for 1986 which is now clearly seen to be an outlier, although this could not have been known at the time. Nevertheless, excessive reliance on subjective methods and a failure to combine all available data with appropriate weighting contributed to the problem.

c) Interactions with Policy

Extensive Monte Carlo simulations used current methodology have also been carried out for Div. 2J+3KL cod to assess the precision of current assessments (SCR Doc. 90/103). The results are of course wholly conditional on the current assessment model, and the assumed error levels in the data and assumptions used. Nevertheless, they give a clear indication of the confidence regions attached to current results, and show that fishing mortality estimates have a CV of about 14%. Catch forecast estimates for a *status quo* calculation have a considerably tighter confidence region than those for immediate reductions to F_{max} or $F_{0.1}$, as expected. The calculations required are moderately time-consuming (about 1 work station day) but by no means excessive.

Errors in the estimation of biomass from surveys need to take account of the possible spatial autocorrelation between results from nearby stations (SCR Doc. 90/109). This is especially important for handling the results of hydroacoustic surveys along transects, but may also be relevant to trawl surveys when stations are sufficiently close to one another. The spatial statistics often indicate anisotropy, and this can be allowed for. The results may be used for posterior estimation of survey error, and also for survey planning (e.g. choosing the distance between transects or stations to obtain a desired precision).

The procedure by which quotas are selected once an assessment is complete (quota policy) depends on a complex interaction of biological, social and economic factors (SCR Doc. 90/107). Traditional (constant F or constant escapement) policies may not be optimal when judged by objective criteria. By parameterising possible families of quota policies, parameter optimisation methods may be used to determine appropriate strategies. The process requires that a utility function for quotas be selected, and because of social, economic and practical factors this will usually be non-linear. This may reflect, for example, the need for stability in catch and effort, as well as the limited capacity of markets. The method provides an alternative to dynamic programming methods, and can be combined with Monte Carlo simulation to allow for uncertainties, variability of recruitment and so on. The latter factor turns out to have only a small influence on the choice of policy, whereas error in estimating stock size is influential. The results indicate that constant low fishing mortality strategies are close to optimal under a wide range of conditions, so that the $F_{0.1}$ rule-of-thumb is not an inappropriate choice in practice.

Fourier Amplitude Sensitivity Testing provides an efficient alternative to Monte Carlo methods for assessing the precision of assessments and catch forecasts (SCR Doc. 90/95). It has the additional advantage that the sensitivity to individual input parameters can be determined, so that the results are more general and more easily modified to allow for changed assumptions (e.g. those concerning data error levels). For highly exploited stocks such as North Sea cod, the catch forecasts are crucially dependent on recruitment estimates, whilst the estimates of stock size are also considerably affected by estimates of F and existing adult population levels. The method may be used to attach confidence regions to the final graphs used to illustrate management options for managers.

An analysis of the factors affecting fisheries in terms of control theory suggests that these may be modelled as the result of three interacting control processes:

due to the biological processes, the management process, and the fishery economics (SCR Doc. 90/113). Such a system has complex dynamics, and responds in a dynamic way to uncertainties and natural variability. The effects of various management strategies (constant catch, constant F, multi-year TACs, etc.) may be determined. The results suggest that attempts to track year-to-year variations may be inappropriate, given plausible levels of uncertainty in assessments.

The management of transboundary stocks presents special problems (SCR Doc. 90/98), particularly when fleets operating in different areas use different gears and exploit different stock components. The deficiencies of the data available from some fleets for flatfish stocks in Div. 3LNO make reliable assessments and catch forecasts impossible for the present. Given suitable data, however, multiple fleet catch forecast methods could perhaps be used to check the validity of assumptions about the affects of the individual components of the fishery.

d) Provision of Advice

The effect of uncertainties of various sorts in assessments can be summarized for managers by assessing risk - expressed as the probability of "something nasty" happening (SCR Doc. 90/93). The definition of "something nasty" should preferably be in terms of something immediately comprehensible to managers and/or the industry (e.g. economic loss, numbers of boats forced out of operation, etc.). Simulation tools are well adapted to the calculations required. The final presentation should, if possible, display the results for a range of risk levels, and not pre-judge the issue of what level of risk would be acceptable. The choice of time frame for the risk calculations is important and, if possible, results should be presented for a selection of time-scales of interest. The results may also be used to judge the adequacy of traditional rules of thumb (e.g. $F_{0.1}$, $SSB_{crit} = 0.2 * SSB_0$, etc., etc.).

Bootstrap estimation methods are very suitable for the estimation of confidence levels from a wide variety of assessment calculations, including forecasts from dynamic surplus production models (SCR Doc. 90/108). Fewer than 1,000 realizations may be sufficient for some calculations, and non-parametric error distributions may be used if required.

Simulations of the effects of compound management strategies, which interpolate between classical (F_{max}, $F_{0.1}$) strategies and *status quo* management, show that these are generally preferable to the conventional strategies (SCR Doc. 90/100). Results so far available relate to a case where the current F is high, and show that in this case a "split-the-difference" strategy results in lower variability of catch and effort, for a small loss in aggregate yield. Similar results are expected to apply even where the current F level is relatively low, and would still apply even when available data are very precise.

Information obtained by the beverage method on the interaction between advice and management suggests that the advice presumes a rational search for some defined optimum state, whilst the policy determination more often involves a political search for an acceptable compromise (SCR Doc. 90/102). It is suggested that increasing uncertainty shifts the balance from the former to the latter process. Given high levels of uncertainty, it is doubtful that a stock assessment is worthwhile. In addition, the rational process usually presumes a long time-scale, whilst that of the political process may be very short (less than one year).

Simulation studies of the effect of various rebuilding strategies for depressed stocks may be used to determine risk levels for various options (SCR Doc. 90/111). The results may be expected to depend crucially on the assumptions made about any possible shift of the probability distribution of recruitment as stock size changes, and also on whether or not the assessment of the current level of F is correct. The results may be presented to managers in the form of risk diagrams, as well as simple trajectories with confidence limits. Trade-offs between short-term losses and long-term gains for various options can also be displayed.

3. Panel Discussion

In opening the panel discussion J. Shepherd suggested that the Serebryakov method for determining a critical stock size could be widely applicable and would fill an important need for objective estimation of such a quantity. The "high" and "moderate" levels of recruitment and survival (or recruits-per-unit SSB) required could be estimated using 90th percentiles and medians respectively, following the philosophy used for the estimation of F_{high} and F_{med}.

He also considered that it was more useful to present results to managers in terms of risk, rather than as histograms, even if only because this was a more condensed presentation so that more information could be transmitted on a single sheet of paper. Assessment scientists should explore possible presentations in consultation with managers to find the most useful format. It would be desirable to fix a convention as soon as possible to avoid the confusion which would otherwise occur: he proposed plotting increasing risk against increasing levels of exploitation, as he felt this would be the most easily understood. It would be possible to add confidence limits to the standard graphical presentations often provided for managers, and some experiments along these lines should be tried. (Convener's note: he also thinks that upper and lower quartiles would be more appropriate than 95% confidence limits, which exaggerate the uncertainty, but did not say so at the time!)

A. Rosenberg stressed that some uncertainties (e.g. recruitment fluctuations) will not go away and cannot be reduced by management action or improved methodology. It is important to consider therefore the implications of such uncertainties for management strategy and not just the effect they have on the precision of the results. Secondly, it was important to stress that projections into the future were based on knowledge (and uncertainty) now, and would be modified in practice as times goes on, both by improved understanding of the system, and of the nature and size of the uncertainties themselves. In particular, advice (e.g. that concerning possible multiple-year TACs) would in practice be up-dated. If one were to consider active adaptive (exploratory) management, it was important first to be sure that one would be able to detect the results of deliberate perturbations: this was not obviously possible in all cases. In the discussion which followed, participants stressed that depleted stocks generally have a long time to recovery, and that the effects of triggering adverse consequences on the industry had to be taken into account. It was felt that the major uncertainties were those in the basic catch data and the stock-recruitment relationship, and it was important not to dissipate effort studying relatively minor factors. The tools for estimating precision of assessments were available. The problem of assessing absolute accuracy was much more difficult, since the possibility of model mis-specification was real and severe.

A. Sinclair commented that we had to consider whether we had the tools to provide advice at the level of precision required by managers, and whether the costs of using them (e.g. research vessel surveys) were commensurate with the benefits. In some cases less precise management was necessary simply because of the excessive costs. The management strategy was relevant, because fixed F strategies demanded more precise stock size estimates than *status quo* strategies, whilst with the latter one could never be sure that one was going anywhere useful. Minimum stock size (escapement) strategies were even more demanding of precise results. Secondly, it was important not to consider the biological system in isolation. The fishery dynamics - the reaction of the fleet to both management and natural events - was also important. Those interactions could be simple - e.g. the tendency to increased mis-reporting when restrictive TACs were in force - or quite complex, e.g. the economic response to the fleet to change. The main priority should be to get the system structure correct in models. In the discussion it was pointed out that economists (like scientists) were good at doing easy things that were not all that useful, but had troubles in answering the crucial questions (e.g. how much increased effort and/or investment should be expected in response to increased profitability?). Improved dialogue with economists was needed, and assessments should include economic considerations where appropriate. It was important however that the advice was unbiased, and not intentionally conservative (or vice versa). Clear presentation (preferably graphically) of the options and their consequences was needed.

H. Lassen suggested that we needed to move beyond single species, single fleet studies. The real problems usually concerned mixed fisheries and multiple fleets, and might indeed need to consider individual boats, as well as the existence of spatial variation across various fishing grounds. It was not clear that we were capable of providing useful results at that level of detail. Secondly, he pointed out that there were various players (scientists, managers, fishermen, politicians, bankers, processors, etc., etc.) in the problem, which could be regarded as a game in which each player acted in his own interest. It was probably an over-simplification to suggest that this could be summarized by a single utility or objective function.

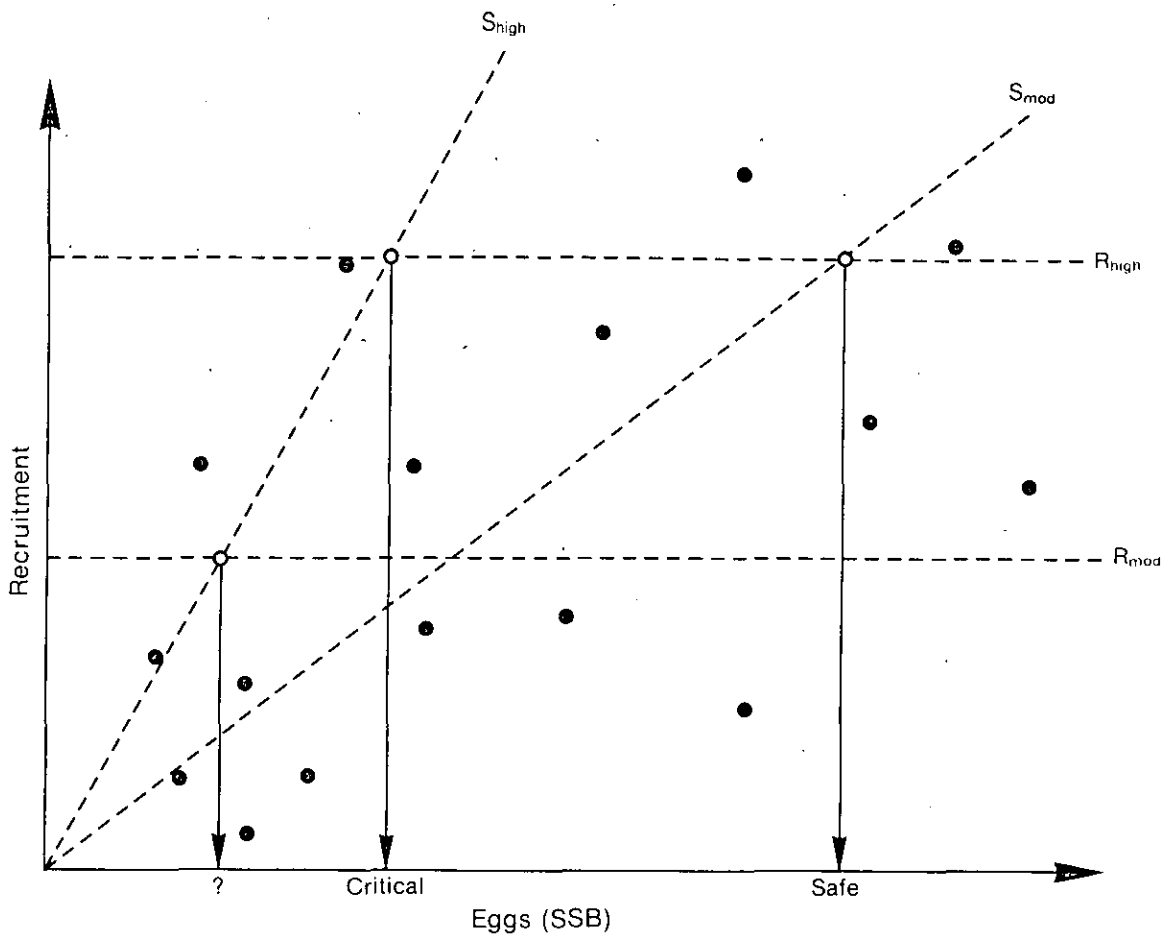
C. Francis pointed out that risk really needed to be expressed in economic terms - managers and fishermen did not appreciate messages phrased in terms of spawning stock biomass in the same way as biologists. Also, we should recognize that simple persistence (renewability) of living resources has some value, and adjust our calculation accordingly (e.g. by using lower discount rates than might be suggested by the industry; perhaps). Furthermore, it was very important to focus on the results over appropriate time-scales since there was usually a conflict between what was desirable in the short-term and the long-term. J. Shepherd suggested that computing Internal Rates of Return might be a

useful way of condensing this problem in a comprehensible way.

In his closing remarks, the convener expressed his appreciation to the authors for producing excellent and relevant papers with very little prompting (on his part, at least), and especially to the panel members for helping to ensure a stimulating discussion. He also thanked the Secretariat for their efficiency in setting up the meeting and ensuring its smooth running.

4. Conclusions

a) The indicator levels of spawning stock size proposed by Serebryakov are likely to be most useful and are commended for further study and experimental application, as adjuncts to the F_{high} and F_{med} indicator levels for fishing mortality (Fig. 1).



Population fecundity capable of giving a good year-class with:

- moderate survival ----→ safe level
- high survival ----→ critical level

Fig. 1. Determination of critical population size (after Serebryakov).

b) The relationship of the critical level so obtained to that given by the 20% rule-of-thumb proposed by Beddington and Cooke should be examined for a range of stocks.

c) The most serious uncertainties in practice may be those due to model mis-specifications, errors in basic catch data (especially mis-reporting), and uncertainty about the stock-recruitment relationship.

d) Objective methods of assessment which combine all available data with appropriate weights are to be preferred. Freedom for subjective intervention in the procedure needs to be strictly controlled (but not prevented). A strong preference for well-chosen default procedures is an appropriate framework.

e) The precision of current assessments, conditional on the assumptions made concerning model structure and data error levels, can be assessed by Monte Carlo simulation methods (especially bootstrap estimation techniques) given adequate computing resources. This is a desirable addition to standard assessment procedures wherever possible.

f) The absolute accuracy of assessments is much more difficult to determine, and the most appropriate tool available at present appears to be retrospective analysis using current methodology.

g) The effects of uncertainties may be presented to managers in the form of graphs indicating the risk of "something bad" happening as a function of management options (see e.g. Fig. 2). The definition of "something bad" should preferably be in terms of economic loss. Simulation methods are well adapted to the calculations required. Various possible presentations should be presented to managers on an experimental basis, in order to stimulate their reactions to the utility of the alternatives. It should be conventional to plot increasing risk against increasing exploitation level, in order to minimize any possible confusion.

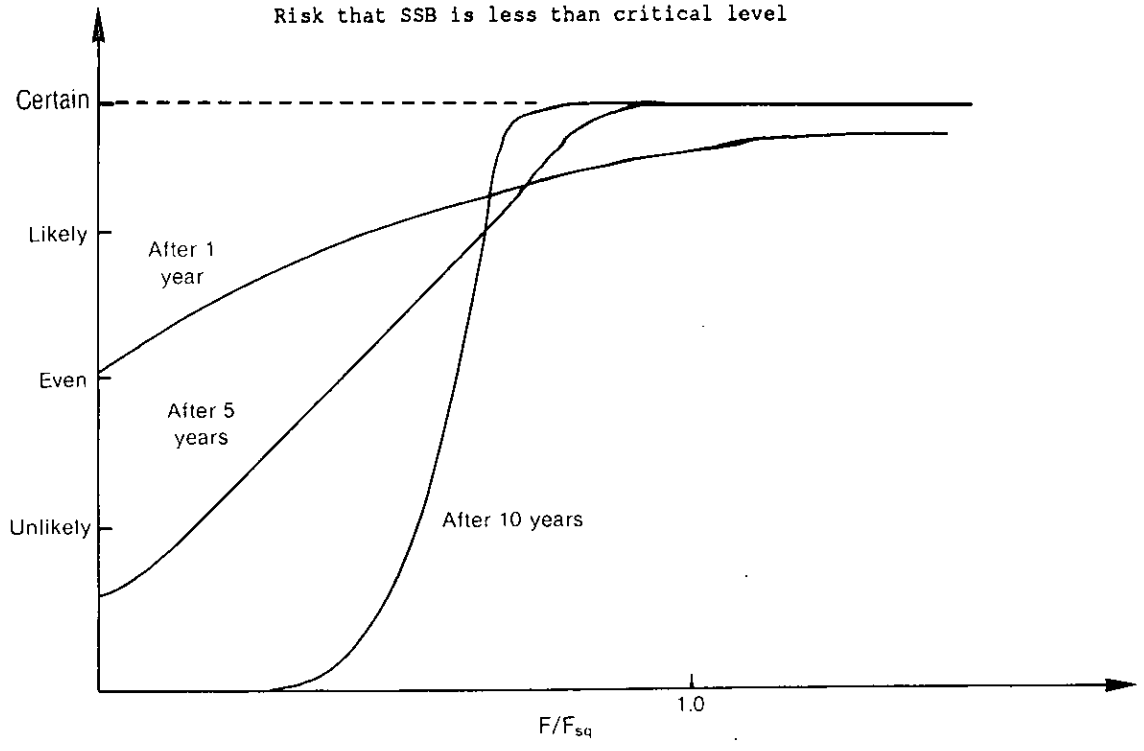


Fig. 2. Presentation of advice in terms of risk (illustration).

h) Compound management strategies which interpolate between classical strategies (F_{max}, $F_{0.1}$) and *status quo* management are found to be superior according to various criteria, and yield lower variability of catch and effort. Such strategies should be seriously considered by managers as options especially when current F values are far from the long-term target levels.

APPENDIX II. REPORT OF STANDING COMMITTEE ON RESEARCH COORDINATION (STACREC)

Chairman: W. B. Brodie Rapporteur: Various

The Committee met at the Lord Nelson Hotel, Halifax, Nova Scotia, Canada, on 10 September 1990. Representatives attended from Canada, Denmark (Greenland), EEC, Japan and USSR. The Assistant Executive Secretary was in attendance.

1. Acquisition of STATLANT 21A and 21B Reports

STACREC noted that the STATLANT 21A reports for 1989 from EEC-France (M) and France (SP) have now been received, but that the report from Norway has yet to be provided.

There have been no STATLANT 21B reports for 1988 received to date from Canada (N), Greenland and the USA.

Several STATLANT 21B reports for 1989 have been received since June, leaving as outstanding the reports for Bulgaria, Canada (all components), EEC (France, United Kingdom, and Italy), Faroe Islands, France (SP), Greenland, Iceland, Norway, Romania, and USA.

STACREC reiterated its concern about the delays in the provision of these reports and recommends that *every effort be made by the statistics reporting offices to have the STATLANT 21A and 21B reports submitted on time.*

2. Publication of Statistical Information

STACREC noted that the publication of NAFO Statistical Bulletin Vol. 38 has been delayed further, pending the submission of STATLANT 21B reports from Canada (N), Greenland, and USA.

An addendum to the provisional catches for 1989 (SCS Doc. 90/21) was released, which provided the data from the STATLANT 21A reports of EEC-France (M) and France (SP).

3. Other Matters

a) Acknowledgements

There being no other matters to consider, the Chairman thanked the NAFO Secretariat for providing updates on the statistics, and the meeting was adjourned.

APPENDIX III. REPORT OF STANDING COMMITTEE ON PUBLICATIONS (STACPUB)

Chairman: V. P. Serebryakov Rapporteur: W. R. Bowering

The Committee met at the Lord Nelson Hotel, Halifax, Nova Scotia, Canada, on 11 September 1990. In attendance were V. P. Serebryakov (Chairman, USSR), W. R. Bowering (Canada), A. Vazquez (EEC), and the Assistant Executive Secretary (Tissa Amaratunga).

1. Review of Editorial Board

The Assistant Executive Secretary informed STACPUB that the progress on papers being reviewed for the Journal was at a satisfactory level. Concerns regarding the workload had not been raised by the Editorial Board particularly Associate Editors for Vertebrate Fisheries Biology. It was agreed therefore that an additional Associate Editor for Vertebrate Fisheries Biology was not required at this time.

2. Invitational Papers

The Assistant Executive Secretary informed STACPUB that the invited paper by R. G. Halliday and A. T. Pinhorn was expected to be received for technical editing shortly following the Annual Meeting. No further progress on other invited papers was reported.

3. Review of Papers

STACPUB reviewed the papers of the Special Session held prior to the Annual Meeting. It was the collective opinion of STACPUB that the papers highlighted very important observations regarding uncertainties in fisheries management and is of significant interest to many people. It was however noted that many papers were not considered to be complete studies and were unlikely to be appropriate for the Journal. It was therefore recommended that *the proceedings be published (with the authors' permission) in a special issue of the NAFO Scientific Council Studies to allow for expedient circulation to interested parties.*

4. Other Matters

a) Acknowledgements

The Chairman expressed his gratitude to Special Session convener, John Shepherd, for presenting a review of the session. The Chairman also thanked the Rapporteur, W. R. Bowering, for outstanding records of the meeting and the Assistant Executive Secretary and the NAFO Secretariat staff for their excellent work in preparing working papers for the consideration of STACPUB. There being no other business, the Chairman then adjourned the meeting.

PART C

Miscellaneous

CONTENTS

AGENDA I. SCIENTIFIC COUNCIL MEETING - JUNE 1990

I. Opening (Chairman: B. W. Jones)

1. Appointment of rapporteur
2. Adoption of agenda
3. Attendance of observers
4. Plan of work
5. Report of proxy votes (by Executive Secretary)
6. Nomination and election of STACFIS Chairman (including consideration of period of appointment)

II. Fishery Science (STACFIS Chairman: H. Lassen)

1. General review of catches and fishing activity in 1989

2. Stock assessments

a) Stocks within or partly within the Regulatory Area, as requested by the Fisheries Commission with the concurrence of the Coastal State (Annex 1):

- Cod (Div. 3NO; Div. 3M) (*see App. III, items 4 and 1*)[1]
- Redfish (Div. 3LN; Div. 3M)
- American plaice (Div. 3LNO; Div. 3M) (*see App. III, items 2, 7 and 19*)
- Witch flounder (Div. 3NO) (*see App. III, item 8*)
- Yellowtail flounder (Div. 3LNO) (*see App. III, items 2 and 19*)
- Capelin (Div. 3NO)
- Squid (Subareas 3 and 4)
- [Note also Annex 1, Item 3 concerning cod in Div. 2J+3KL, Item 4 concerning cod in Div. 3M, Item 5 concerning flounders in Div. 3LNO and Item 7 concerning mesopelagic species and Atlantic saury in the Regulatory Area]

b) Stocks within the 200-mile fishery zone in Subareas 2, 3 and 4, as requested by Canada (Annex 2):

- Greenland halibut (Subarea 2 and Div. 3KL) (*see App. III, items 9 and 10*)
- Roundnose grenadier (Subareas 2 and 3)
- Silver hake (Div. 4VWX) (*see SCS Doc. 90/2*)
- Capelin (Div. 3L)

d) Stocks within the 200-mile fishery zone in Subarea 1 and at East Greenland, as requested by Denmark on behalf of Greenland (Annex 3):

- Cod (Subarea 1)
- Redfish (Subarea 1) (if possible, by species)
- Wolffish (Subarea 1) (if possible, for spotted and striped)
- Northern shrimp (East Greenland) (*see SCS Doc. 89/22; App. III, item 12*)
- Other finfish and invertebrates (Subarea 1)

e) Stocks overlapping the fishery zones in Subareas 0 and 1, as requested by Canada and by Denmark on behalf of Greenland (Annexes 2 and 3):

- Greenland halibut (Subareas 0 and 1) (*see App. III, item 10*)
- Roundnose grenadier (Subareas 0 and 1)
- Northern shrimp (Subareas 0 and 1) (*see SCS Doc. 89/22; App. III, item 11*)

3. Environmental research (Subcommittee Chairman: M. Stein)

a) Chairman's report
b) Marine Environmental Data Service (MEDS) Report for 1989
c) Review of environmental studies in 1989
d) Overview of environmental conditions in 1989

[1] App. III referred to herein is the List of Recommendations for 1989 which was appended to the provisional agenda issued in April 1990.

e) Marine Environmental Ecosystems Subcommittee of CAFSAC (report)
f) National representatives
g) Other matters

4. Ageing techniques and validation studies

a) Reports on the otolith exchanges on Silver hake and American plaice (Div. 3LNO)
b) Other ageing and validation studies reported

5. Gear and selectivity studies

a) Reports on gear and selectivity studies
b) Proposals for gear and selectivity studies

6. Review of SCR and SCS documents not considered in items (1) to (5) above

7. Other matters

a) Review of current arrangements for conducting stock assessment with respect to designated experts.
b) Progress report on contributions for the 5-7 September 1990 Special Session on "Management Under Uncertainties Related to Biology and Assessments, With Case Studies on Some North Atlantic Fisheries" (J. Shepherd, UK, Convener)
c) Convener for the Special Session in 1991 and any other matters in relation to this meeting
d) Theme for the 1992 Special Session
e) Other business

III. Research Coordination (STACREC Chairman: W. B. Brodie)

1. Fishery Statistics

a) Progress report on Secretariat activities in 1989/90

i) Acquisition of STATLANT 21A and 21B reports for recent years
ii) Publication of statistical information
iii) Updating of fishery statistics database

b) Review of reporting requirements for submission of STATLANT 21A and 21B statistics

c) Report on the Fourteenth Session of CWP, February 1990

2. Biological Sampling

a) Progress report on activities in 1989/90
b) Forms and deadlines for submission of data

3. Biological Surveys

a) Review of survey activity in 1989
b) Survey plans for 1990 and early 1991
c) Review of stratification schemes
d) Coordination of surveys in 1990-91 (if required)
e) Survey design procedures (Working Group report)

4. Other Matters

a) List of fishing vessels for 1990
b) Tagging activities reported for 1989
c) Review of relevant SCR and SCS documents not considered in Items 1 to 3 above
d) Other business

IV. Publications (STACPUB Chairman: V. P. Serebryakov)

1. Review of STACPUB membership

2. Review of scientific publications since June 1989

3. Production costs and revenues for Scientific Council publications

4. Promotion and distribution of scientific publications

   a) Publicity and response regarding the Journal
   b) Invitational papers for the Journal
   c) New cover for the Journal

5. Editorial matters regarding scientific publications

   a) Editorial activities
   b) Progress review: Journal issue of 1989 Special Session
   c) Review of general editorial process
   d) Review of Editorial Board
      i) Consideration of workload of Associate Editors
      ii) Consideration of necessity for the additional Associate Editor for Vertebrate Fisheries Biology

6. Papers for possible publication

   a) Review of proposals resulting from the 1989 meetings
   b) Review of contributions to the 1990 meeting

7. Microfiche projects

   a) Review of requests for microfiche of ICNAF documents
   b) Question of microfiching NAFO research documents

8. Other matters

V. Collaboration with other Organizations

1. Joint ICES/NAFO working group on harp and hooded seals
2. Fourteenth Session of CWP, February 1990

VI. Arrangements for Special Sessions

[See under Fishery Science, Section 7(b), 7(c), and 7(d)]

VII. Future Scientific Council Meetings, 1990 and 1991

VIII. Other Matters

IX. Adoption of Reports

1. Committee reports from this meeting (STACFIS, STACREC, STACPUB)
2. Scientific Council Report, June 1990 (receipt and adoption)

X. Adjournment

ANNEX 1. FISHERIES COMMISSION REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 1991 OF CERTAIN STOCKS IN SUBAREAS 3 AND 4

1. The Fisheries Commission with the concurrence of the Coastal State as regards the stocks below which occur within its jurisdiction, requests that the Scientific Council, at a meeting in advance of the 1990 Annual Meeting, provide advice on the scientific basis for the management of the following fish and invertebrate stocks or groups of stocks in 1991:

   Cod (Div. 3NO; Div. 3M)
   Redfish (Div. 3LN; Div. 3M)
   American plaice (Div. 3LNO; Div. 3M)
   Witch flounder (Div. 3NO)
   Yellowtail flounder (Div. 3LNO)
   Capelin (Div. 3NO)
   Squid (Subareas 3 and 4)

2. The Commission and the Coastal State request the Scientific Council to consider the following options in assessing and projecting future stock levels for those stocks listed above:

   a) For those stocks subject to analytical dynamic-pool type assessments, the status of the stock should be reviewed and management options evaluated in terms of their implications for fishable stock size in both the short and long term. In those cases where present spawning stock size is a matter of scientific concern in relation to the continuing productive potential of the stock, management options should be evaluated in relation to spawning stock size. As general reference points the implications of fishing at $F_{0.1}$, F_{1989} and Fmax in 1991 and subsequent years should be evaluated. The present stock size and spawning stock size should be described in relation to those observed historically and those expected in the longer term under this range of options.

      Opinions of the Scientific council should be expressed in regard to stock size, spawning stock sizes, recruitment prospects, catch rates and TACs implied by these management strategies for 1991 and the long term. Values of F corresponding to the reference points should be given and their accuracy assessed.

   b) For those stocks subject to general production-type assessments, the time series of data should be updated, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. In this case, the general reference points should be the level of fishing effort or fishing mortality (F) which is calculated to be required to take the MSY catch in the long term and two-thirds of that effort level.

   c) For those resources of which only general biological and/or catch data are available, no standard criteria on which to base advice can be established. The evidence of stock status should, however, be weighed against a strategy of optimum yield management and maintenance of stock biomass at levels of about two-thirds of the virgin stock.

   d) Spawning stock biomass levels that might be considered necessary for maintenance of sustained recruitment should be recommended for each stock.

   e) Presentation of the result should include the following:

      i) for stocks for which analytical dynamic-pool type assessments are possible:

         - a graph of yield and fishing mortality for at least the past 10 years.
         - a graph of spawning stock biomass and recruitment levels for at least the past 10 years.
         - a graph of catch options for the year 1991 over a range of fishing mortality rates (F) at least from $F_{0.1}$ to Fmax.
         - a graph showing spawning stock biomasses at 1.1.1992 corresponding to each catch option.
         - graphs showing the yield-per-recruit and spawning stock per-recruit values for a range of fishing mortality.

ii) for stocks for which advice is based on general production models, the relevant graph of production on fishing mortality rate or fishing effort.

In all cases the three reference points, actual F, Fmax and $F_{0.1}$ should be shown.

3. The Fisheries Commission with the concurrence of the Coastal State requests that the Scientific Council continue to provide information, if available, on the stock separation in Div. 2J+3KL and the proportion of the biomass of the cod stock in Div. 3L in the Regulatory Area and a projection if possible of the proportion likely to be available in the Regulatory Area in future years. Information is also requested on the age composition of that portion of the stock occurring in the Regulatory Area.

4. With respect to cod in Div. 3M, the Scientific Council is asked to comment on the appropriateness of establishing a minimum target level for the biomass, and to comment on the role of exploratory fisheries in providing data for stock assessment purposes.

5. With respect to flounders in Div. 3LNO, the Scientific Council is requested to provide advice on management options that would reduce the extent to which the fisheries reduce the potential yield due to harvest of small fish.

6. With respect to stocks from which catches have recently been significantly in excess of the NAFO TACs, analysis is requested on the effect such catches have had in determining present stock status.

7. The Scientific Council is asked to review available data on stocks of mesopelagic species and on Atlantic saury that might occur in the Regulatory Area, and to provide advice on possible management measures for these stocks.

ANNEX 2. CANADIAN REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 1991 OF CERTAIN STOCKS IN SUBAREAS 0 TO 4

1. Canada requests that the Scientific Council, at its meeting in advance of the 1990 Annual Meeting, provide advice on the scientific basis for the management of the following fish and invertebrate stocks in 1991:

Greenland halibut (Subarea 2 and Div. 3K and 3L)
Roundnose grenadier (Subareas 2 and 3)
Capelin (Div. 3L)
Silver hake (Div. 4V, 4W and 4X)

It is also suggested that, subject to the concurrence of Denmark (Greenland), the Scientific Council, prior to the 1990 Annual Meeting of NAFO, provide advice on the scientific basis for management in 1991 of the following stocks:

Shrimp (Subareas 0 and 1)
Greenland halibut (Subareas 0 and 1)
Roundnose grenadier (Subareas 0 and 1)

2. Canada requests the Scientific Council to consider the following options in assessing and projecting future stock levels for those stocks listed above:

a) For those stocks subject to analytical dynamic-pool type assessments, the status of the stock should be reviewed and the implications of continuing to fish at $F_{0.1}$ in 1991 and subsequent years should be evaluated. The present stock size should be described in relation to those observed historically and those to be expected at the $F_{0.1}$ level in both the short and long term. In those cases where present spawning stock size is a matter of scientific concern in relation to the continuing productive potential of the stock, management options should be evaluated in relation to spawning stock size. All results should be expressed in terms of stock sizes, catch rates and TACs implied for 1991 and the long term.

b) For those stocks subject to general production-type assessments, the status of the stock should be reviewed and management options evaluated in the way described above to the extent possible. In this case, the general reference point should be the level of fishing effort (F) which is two-thirds that calculated to be required to take the MSY catch in the long term.

c) For those resources on which only general biological and/or catch data are available, no standard criteria on which to base advice can be established. The evidence on stock status should, however, be weighted against a strategy of optimum yield management and maintenance of stock biomass at levels of about two-thirds that of the virgin stocks.

P. Meyboom
Deputy Minister
Department of Fisheries and Oceans
Ottawa, Canada

ANNEX 3. DENMARK (GREENLAND) REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT OF CERTAIN STOCKS IN 1991

1. Denmark on behalf of Greenland, requests the Scientific Council of NAFO in advance of the June 1990 Annual Meeting to consider the following stocks occurring in Subarea 1:

i) Atlantic cod
ii) Redfish (by species, is possible)
iii) Wolffish (by species, if possible)
iv) Any other stock of commercial interest of invertebrates and finfish in Subarea 1 for which data allow a status report

It is also suggested, subject to the concurrence of Canada, that the Scientific Council of NAFO include the following stocks overlapping Subareas 0 and 1 in its considerations:

i) Greenland halibut
ii) Roundnose grenadier
iii) Northern shrimp (*Pandalus borealis*)

Further, in cooperation with ICES, the Scientific Council of NAFO is requested to analyze the following stock in the Denmark Strait and off East Greenland:

i) Northern shrimp (*Pandalus borealis*)

The Scientific Council of NAFO is requested to provide advice on the status and on the biological basis for management in 1991 and as many years onwards as the data allow for all stocks mentioned above.

2. In the analyses on which management advice will be based, the following should be included:

a) For cod in Subarea 1 the catch projections should include at the following options:

i) F = F(0.1) from 1991 onward
ii) F = F(max) from 1991 onward
iii) F from 1991 onward equal to that F-value which for 1990 corresponds to the set TAC for 1990, i.e. 110,000 tons
iv) Two options both based on a steady catch level from 1991 onwards. One catch level should be 90,000 tons and the other level 110,000 tons.

v) Same as in iv) but with restriction that F is not allowed to exceed 0.6 per year.

The development in the expected length distributions particularly the size groups 40-55 cm and above 55 cm should be evaluated.

The catch level for 1990 should be set at the TAC for that year, i.e. 110,000 tons. The Scientific Council should further evaluate whether this catch level is realistic and if not then re-evaluate the above mentioned options i), ii) and iii) based on such catch level for 1990.

b) The boundary between the East Greenland cod stock and the West Greenland stock should be reconsidered and the Scientific Council invited to comment on the relevance of such a boundary under the present stock conditions.

For Greenland halibut in Subarea 0+1 the relevance and the scientific basis for the stock separation between this stock and the Greenland halibut in Subarea 2 and Div. 3KL should be reconsidered.

For Northern shrimp in Subarea 1 and in the Denmark Strait the effects of by-catch of small finfish (redfish and Greenland halibut) on these stocks should be analyzed if data allow. Further the effect of discards of shrimp should be analyzed.

3. The Scientific Council should feel free to report on such other invertebrate and finfish stocks in Subarea 1 and on such other scientifically-based management options for the above mentioned Subarea 1 stocks, as it feels applicable.

Jens Paulsen
Head of Division
Department for Fisheries & Industry
Nuuk, Greenland

AGENDA II. SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1990

I. Opening (Chairman: B. W. Jones)

1. Appointment of rapporteur
2. Adoption of agenda
3. Plan of work

II. Fishery Science (STACFIS Chairman: H. Lassen)

1. Stock assessments

   a) Capelin (Div. 3L) (See SCS Doc. 90/23)

2. Report of Special Session on "Management Under Uncertainties Related to Biology and Assessments, with Case Studies on Some North Atlantic Fisheries" (5-7 September 1990 with J. Shepherd as Convener).

   a) General Theme

   The intention of the Special Session is to explore the implications for management of the uncertainties in both the dynamics of fish stocks, and those in the assessment of their past, present and future states. It is hoped that it will be possible to discuss some case studies from the North Atlantic, but theoretical contributions are also welcome. Some suggestions for special topics are given below, but these are not exhaustive. Contributions from management work of living marine resources other than fish stocks (e.g. whales) would offer opportunity for wider discussion.

   b) Specific Topics

   Sources of uncertainty: their magnitude and effects
   The interaction of biological uncertainties with management policies
   Communication of advice

3. Review of current arrangements for conducting stock assessments.

   a) Selection of designated experts

   b) Status of preliminary assessments done by designated experts. Documentation of data and of assessments.

   c) Format and contents of Scientific Council Reports.

4. Future Special Sessions

   a) Special Session in September, 1991 on "Atlantic Cod: The Understanding on Physiology, Dynamics, Ecology and Environmental Relationships"

   b) Proposed theme for Special Session in September 1992

5. Other Matters

III. Research Coordination (STACREC Chairman: W. B. Brodie)

1. Acquisition of STATLANT 21A and 21B reports

2. Publication of statistical information

3. Other matters

IV. Publications (STACPUB Chairman: V. P. Serebryakov)

1. Review of Editorial Board

2. Invitational papers

3. Review of papers for possible publication

   a) Review of proposals from past meetings
   b) Contributions to present meeting
   c) Other contributions

4. Other Matters

V. Review of Future Meeting Arrangements

1. June 1991 Meeting of the Scientific Council

2. Special Session and Annual Meeting, September 1991

3. June 1992 Meeting of Scientific Council

VI. Other Business

VII. Adoption of Reports

1. Committee Reports of present meeting

2. Report of Scientific Council, September 1990

VIII. Adjournment

LIST OF RESEARCH AND SUMMARY DOCUMENTS, 1990

RESEARCH DOCUMENTS (SCR)

SCR No.	Ser. No.	
90/01	N1701	SHERSTJUKOV, A. I. Distribution and abundance of 0-group silver hake on the Scotian Shelf in autumn 1988. (16 pages)
90/02	N1702	SHERSTJUKOV, A. I. The young silver hake growth in the Scotian area, 1977-1888. (11 pages)
90/03	N1706	TIZOL, R., M. ISAAC, and G. ARENCIBIA. Age deter-mination of silver hake by chemical composition of otoliths. (5 pages)
90/04	N1707	FUONG, N. More on the question of inconsistencies in studying the Scotian Shelf silver hake growth rate by Soviet and Canadian scientists. (13 pages)
90/05	N1716	BULATOVA, A. Yu. Assessment of the cod stock in Div. 3NO and 3KL from the 1989 trawl-acoustic survey. (14 pages)
90/06	N1717	SAVVATIMSKY, P. I. Variations in catch composition of roundnose grenadier from the Northwest Atlantic during 1971-1989. (16 pages)
90/07	N1718	BAKANEV, V. S., A. A. VASKOV, and V. N. PETROV. Results of the Soviet acoustic survey on capelin stock in summer 1989 and 0-group capelin survey in autumn 1988 and 1989 in Div. 3LNO. (10 pages)
90/08	N1719	VASKOV, A. A., A. G. GALUZO, and I. A. OGANIN. Estimation of the stock status and TAC for redfish, *Sebastes marinus* in Div. 3M for 1991. (15 pages)
90/09	N1720	VASKOV, A. A., A. G. GALUZO, and I. A. OGANIN. Estimation of the stock status and TAC for redfish, *Sebastes marinus* in Div. 3LN for 1991. (16 pages)
90/10	N1721	BOROVKOV, V. A., and I. I. TEVS. Overview of oceanographic conditions off the Northwest Atlantic in 1989. (22 pages)
90/11	N1723	SMEDSTAD, O. M., and S. TORHEIM. Norwegian investigations on shrimp (*Pandalus borealis*) in East Greenland waters in 1989. (13 pages)
90/12	N1724	SMEDSTAD, O. M. Preliminary report of a cruise with M/T *Håkøy-II* to East Greenland waters in September 1989. (13 pages)
90/13	N1728	MOUNTAIN, D. G., and T. J. HOLZWARTH. Surface and bottom temperature and temperature anomaly time series from the Northeast Fisheries Center spring and fall bottom trawl survey program, 1963-1989. (20 pages)
90/14	N1729	SIGAEV, I. K. Ecological studies of conditions of silver hake distribution on Nova Scotian Shelf within the framework of the USSR-Canada program. (31 pages)
90/15	N1730	RIKHTER, V. A. The stock-recruitment dependence nature in some fish species from the Northwest Atlantic. (34 pages + Corrigendum)
90/16	N1733	STEIN, M. Some remarks on time-series sampled on annual intervals. (6 pages)
90/17	N1734	STEIN, M. Variation of salt and heat flow in West Greenland waters. (8 pages)
90/18	N1735	RIKHTER, V. A., and V. F. TUROK. Dependence between stock size and concentration densities for Scotian Shelf silver hake by USSR observers' data for 1979 through 1988. (11 pages)
90/19	N1736	RIKHTER, V. A., and V. F. TUROK. Distribution of silver hake, other fish species and squid on the Nova-Scotian Shelf in 1989 by USSR observers' data. (21 pages)

90/20 N1737 WALDRON, D. E., M. C. BOURBONNAIS, and M. A. SHOWELL. Status of the Scotian Shelf silver hake (Whiting) populations in 1989. (27 pages)

90/21 N1738 WALDRON, D. E., M. A. SHOWELL, and P. A. COMEAU. Scotian Shelf silver hake: 1989 commercial fishery description. (19 pages)

90/22 N1739 CÁRDENAS, E. de, and J. A. PEREIRO. Some comments about the exploitation pattern on the Flemish Cap cod stock. (6 pages)

90/23 N1740 BAIRD, J. W., C. A. BISHOP, and E. F. MURPHY. Cod in Divisions 2J+3KL - information relative to the portion of the stock beyond the Canadian 200-mile fishery zone. (11 pages)

90/24 N1741 STROUT, G. Variation in the shelf water front position in 1989 from Georges Bank to Cape Hatteras. (9 pages)

90/25 N1742 SANO, M. H., and G. B. WOOD. Anticyclonic warm-core Gulf Stream rings off the northeastern United States during 1989. (16 pages)

90/26 N1743 JOSSI, J. W., and R. L. BENWAY. Surface and bottom temperatures, and surface salinities: Massachusetts to Cape Sable, N.S., and New York to the Gulf Stream, 1988. (18 pages)

90/27 N1744 JOSSI, J. W., and R. L. BENWAY. Surface and bottom temperatures, and surface salinities: Massachusetts to Cape Sable, N.S., and New York to the Gulf Stream, 1989. (17 pages)

90/28 N1745 RIGET, F., HOVGÅRD, H., and H. LASSEN. A catch rate index for West Greenland Cod for 1975-89 based on logbook information from the commercial fleet. (11 pages)

90/29 N1746 HOVGÅRD, H., and F. RIGET. A long-line estimate of swept area abundance of cod in inshore areas off West Greenland. (12 pages)

90/30 N1747 HOVGÅRD, H., and K. H. NYGAARD. Young cod distribution and abundance in West Greenland inshore areas, 1989. (6 pages)

90/31 N4748 RÄTZ, H-J. The effect of emigration on VPA-assessments of Subarea 1 cod. (11 pages)

90/32 N1749 WIELAND, K., and B. BRÜGGE. Some considerations on the significance of larval drift for the recruitment of West Greenland cod. (6 pages)

90/33 N1750 KÖSTER, F. W., and W. SCHOBER. Cod stomach sampling in West Greenland waters 1989 - some preliminary results. (13 pages)

90/34 N1751 RÄTZ, H-J. The assessment of the migration of Atlantic cod (*Gadus morhua* L.) between the stocks off East and West Greenland by means of otolith typing. (42 pages)

90/35 N1752 BOJE, J., and O. JØRGENSEN. On the relevance of a combined assessment of Greenland halibut in NAFO Subareas 0, 1, 2 and Divisions 3KL. (7 pages)

90/36 N1753 BOJE, J., F. RIGET, and M. KøIE. Infestation of parasites in Greenland halibut in the Northwest Atlantic. (18 pages)

90/37 N1754 BOJE, J. On recaptures of Greenland halibut in Icelandic waters from tagging experiments in West Greenland fjords. (2 pages)

90/38 N1755 NIELSEN, J. R. Longline fishery for Greenland halibut in the Davis Strait, November 1989. (4 pages)

90/39 N1756 JØRGENSEN, O., and K. AKIMOTO. Results of a stratified random bottom trawl survey in NAFO Subarea 1 in 1989. (14 pages)

90/40 N1757 P-GANDARAS, G., and J. ZAMARRO. Changes in the cohort growth rate of Flemish Cap cod. (14 pages)

90/41 N1758 ZAMARRO CEBALLOS, J. Determination of fecundity in American plaice (*Hippoglossoides platessoides*) and its variation from 1987 to 1989. (10 pages)

90/42	N1759	CARLSSON, D. M., and P. KANNEWORFF. The commercial shrimp fishery in Denmark Strait in 1989 and early in 1990. (22 pages)
90/43	N1760	REINERT, J. The Faroese longline fishery for cod on Flemish Cap 1973-88, data on catch and effort from three longliners. (4 pages)
90/44	N1761	LUND, H. Greenland fishery for shrimp (*Pandalus borealis*) at north West Greenland from 1985 to 1989. (12 pages)
90/45	N1762	FRÉCHET, A., and E. LABERGE. New strata for groundfish surveys in the Gulf of St. Lawrence, NAFO Divisions 4RST. (2 pages)
90/46	N1763	CARLSSON, D. M., P. KANNEWORFF, and K. M. LEHMANN. Report on a stratified-random trawl survey for shrimp (*Pandalus borealis*) in NAFO Subareas 0+1 in July-August 1989. (16 pages)
90/47	N1764	ESCALANTE, J. L., J. VÁZQUEZ, and I. MENA. Northern prawn (*Pandalus borealis*) stock in Flemish Cap. (6 pages)
90/48	N1765	GASSUIKOV, P. S. Practical use of adaptive framework for stock assessment. (11 pages)
90/49	N1766	GASSUIKOV, P. S. Silver hake stock assessment in the 4VWX NAFO Subareas without age data use. (17 pages)
90/50	N1767	GASSUIKOV, P. S. Application of multiplicative model for fishing effort standardization in a special case. (14 pages)
90/51	N1772	BOWERING, W. R., W. B. BRODIE, and J. W. BAIRD. An assessment of the Greenland halibut stock component in NAFO Subarea 2 and Divisions 3K and 3L. (21 pages, revised)
90/52	N1773	CHUMAKOV, A. K., G. B. RUDNEVA, P. ERNST, and H. MÜLLER. Status of Greenland halibut (*Reinhardtius hippoglossoides* Walb.) stocks and feasible yield in NAFO Subareas 0, 1 and Div. 2GH. (18 pages)
90/53	N1774	KUZMIN, S. A. Stock assessment, age-length composition and maturity stages of the Flemish Cape cod. (16 pages)
90/54	N1775	BOWERING, W. R. Witch flounder in Divisions 3NO. (6 pages)
90/55	N1776	RIGET, F. Data and preliminary assessment of Subarea 1 cod. (12 pages)
90/56	N1777	CHRISTENSEN, S., and H. LASSEN. Selection in shrimp trawl. (3 pages)
90/57	N1778	BOWERING, W. R., and A. K. CHUMAKOV. Estimates of abundance and biomass of witch flounder (*Glyptocephalus cynoglossus*) in Div. 3NO and Greenland halibut (*Reinhardtius hippoglossoides*) in Div. 3KL from USSR groundfish surveys during 1987-89. (7 pages)
90/58	N1779	LEHMANN, K. M., and P. KANNEWORFF. Report on a stratified-random trawl survey for shrimp (*Pandalus borealis*) in ICES Subarea XIV b. (9 pages)
90/59	N1780	NAKASHIMA, B. S. Capelin school surface area index for NAFO Div. 3L during the 1989 spawning season. (6 pages)
90/60	N1781	NAKASHIMA, B. S., and R. W. HARNUM. The inshore capelin fishery in NAFO Div. 3L in 1989. (14 pages)
90/61	N1782	MILLER, D. S., and J. E. CARSCADDEN. A biomass estimate from a hydroacoustic survey for capelin (*Mallotus villosus*) in NAFO Division 3N and observations on the Soviet fishery for capelin in Divisions 3NO. (5 pages)
90/62	N1784	LEHMANN, K. A report of experimental trial fishery for shrimp (*Pandalus borealis*) off Southwest, Southeast and East Greenland. (6 pages)
90/63	N1785	LUND, H. Fecundity of shrimp (*Pandalus borealis*) sampled on fishing grounds at North West Greenland and West Greenland. (7 pages)

90/64	N1786	CARLSSON, D. M. Data and preliminary assessment of shrimp in Denmark Strait. (7 pages)
90/65	N1787	CARLSSON, D. M. Data and preliminary assessment of shrimp in Subareas 0+1. (9 pages, revised)
90/66	N1788	JOSSI, J. W., and D. E. SMITH. Continuous plankton records: Massachusetts to Cape Sable, N.S., and New York to the Gulf Stream, 1989. (11 pages)
90/67	N1789	NARAYANAN, S., E. B. COLBOURNE, and C. FITZPATRICK. Frontal oscillations on the NE Newfoundland shelf. (15 pages)
90/68	N1790	VAZQUEZ, A. Results from bottom trawl survey of Flemish Cap in July 1989. (25 pages)
90/69	N1791	ZAMARRO, J., and W. B. BRODIE. Results of an American plaice (*Hippoglossoides platessoides*) otolith exchange between Canada and Spain. (6 pages)
90/70	N1792	ROWERING, W. R., and A. K. CHUMAKOV. Trends in biomass and abundance estimates of yellowtail flounder (*Limanda ferruginea*) from USSR surveys in Divisions 3LNO. (11 pages)
90/71	N1793	BOWERING, W. R., and A. K. CHUMAKOV. Trends in biomass and abundance estimates of American plaice (*Hippoglossoides platessodies*) from USSR surveys in Divisions 3K, 3L, 3M and 3O. (18 pages)
90/72	N1794	BISHOP, C. A., E. F. MURPHY, and J. W. BAIRD. Biomass and age compositions derived from RV surveys for cod in Div. 3NO relative to the Canadian 200-mile fishery boundary. (6 pages)
90/73	N1795	BISHOP, C. A., J. W. BAIRD, and E. F. MURPHY. The assessment of the cod stock in NAFO Div. 3NO. (35 pages)
90/74	N1796	RIGET, F. Status of Subarea 1 cod and the fisheries. An extract of the Report of the ICES Working Group on cod stocks off East Greenland, Hamburg, 21-27 February 1990 and revision of the 1989 trawl survey abundance estimates. (22 pages)
90/75	N1797	SAVVATIMSKY, P. I., G. B. RUDNEVA, L. DANKE, H. MÜLLER, D. B. ATKINSON, and D. POWER. Roundnose grenadier (*Coryphaenoides rupestris*) in NAFO Subareas 0+1 and 2+3. (46 pages)
90/76	N1798	WALSH, S. J. Distribution of juvenile and adult American plaice on the Grand Bank, NAFO Divisions 3LNO. (19 pages)
90/77	N1799	BUCH, E., and P. B. NIELSEN. Ocean temperatures at Fyllas Bank, West Greenland related to atmospheric processes. (8 pages)
90/78	N1800	STEIN, M. Greenhouse induced changes in the North Atlantic - implications for fisheries. (12 pages)
90/79	N1801	FUCHS, F. Proposal for a multinational project on the coordination of fishery hydrographic activities in the North Atlantic. (3 pages)
90/80	N1802	BRODIE, W. R., W. R. BOWERING, and J. W. BAIRD. An assessment of the American plaice stock in Divisions 3LNO. (32 pages)
90/81	N1803	ZAMARRO, J. An assessment of the American plaice stock on the Flemish Cap (NAFO Division 3M). (4 pages)
90/82	N1804	SKÚLADÓTTIR, U. A review of the shrimp fishery (*Pandalus borealis*) in the Denmark Strait, in the years 1978-1989. (14 pages)
90/83	N1806	DRINKWATER, K. F., and R. W. TRITES. Overview of environmental conditions in the Northwest Atlantic in 1989. (19 pages)
90/84	N1809	KEELEY, J. R. Marine Environmental Data Service Report for 1989. (11 pages)

90/85	N1811	WALSH, S. J. Distribution of juvenile and adult yellowtail flounder on the Grand Bank, NAFO Divisions 3LNO. (14 pages)
90/86	N1812	BRODIE, W. B., S. J. WALSH, and W. R. BOWERING. Yellowtail flounder in NAFO Div. 3LNO - an assessment of stock status. (24 pages)
90/87	N1813	POWER, D., and D. B. ATKINSON. Status of the redfish resource in NAFO Divisions 3LN. (18 pages)
90/88	N1814	MESSTORFF, J., and H. P. CORNUS. Survey biomass and abundance for redfish (*Sebastes marinus* and *S. mentella*) off West Greenland (NAFO Subarea 1, 1989). (4 pages)
90/89	N1815	FRÉCHET, A. The Saint-Pierre and Miquelon and Metropolitan France cod fishery (3Pn, 4RS) in the Gulf of St. Lawrence from 1978 to 1989. (18 pages)
90/90	N1817	LASSEN, H., and D. M. CARLSSON. A catch-rate index for the Greenland shrimp fishery in NAFO Subarea 1. (14 pages)
90/91	N1818	SKÚLADØTTIR, U. The sustainable yield of *Pandalus borealis* in the Denmark Strait area based on data for the years 1980-89. (5 pages)
90/92	N1824	SABORIDO, F., and J. PAZ. Distribution and abundance of cod on the Flemish Cap, July 1988 and 1989. (12 pages)
90/93*	N1828	FRANCIS, R. I. C. C. Risk analysis in fishery management. (18 pages)
90/94*	N1829	PRAGER, M. H., and C. D. JONES. Effects of growth variability on estimation of the biological reference point $F_{0.1}$, with examples from Chesapeake Bay, USA. (14 pages)
90/95*	N1830	COOK, R. M., P. A. KUNZLIK, and R. J. FRYER. On the quality of North Sea cod stock forecasts. (5 pages)
90/96*	N1831	SINCLAIR, A., D. GASCON, R. O'BOYLE, D. RIVARD, and S. GAVARIS. Consistency of some Northwest Atlantic groundfish stock assessments. (35 pages, revised)
90/97*	N1832	BRODIE, W. B. A review of the assessments of the American plaice stock in Div. 3LNO in relation to the recent decline in stock abundance. (16 pages)
90/98*	N1833	BRODIE, W. B., S. J. WALSH, and W. R. BOWERING. Managing transboundary flatfish stocks - sources and consequences of uncertainty. (12 pages)
90/99*	N1834	HORSTED, Sv. Aa. Biological advice for and management of some of the major fisheries resources in Greenland waters. (25 pages)
90/100*	N1835	PELLETIER, D., and A. LAUREC. Toward more efficient adaptive TAC policies with error-prone data. (15 pages)
90/101*	N1836	MYERS, R. A. Population variability and the range of a species. (8 pages)
90/102*	N1837	LASSEN, H. Biological uncertainties in fish stock management. (6 pages)
90/103*	N1838	RESTREPO, V. R., J. W. BAIRD, C. A. BISHOP, and J. M. HOENIG. Quantifying uncertainty in ADAPT (VPA) outputs using simulation - an example based on the assessment of cod in Divisions 2J+3KL. (11 pages)
90/104*	N1839	BAIRD, J. W., C. A. BISHOP, and E. F. MURPHY. Sudden changes in the perception of stock size and reference catch levels for cod in Divisions 2J+3KL. (10 pages)
90/105*	N1840	FRÉCHET, A. A declining cod stock (3Pn, 4RS), how can we learn from the past? (15 pages)
90/106*	N1841	FAHRIG, L., and B. ATKINSON. Concurrent exploitation of multiple stocks: a redfish simulation study. (26 pages)

90/107*	N1842	MYERS, R. A. Setting quotas in a stochastic fishery. (10 pages)
90/108*	N1843	KIZNER, Z. I. Bootstrap estimation of the confidence intervals of stock and TAC assessments with the use of dynamic surplus production models. (6 pages)
90/109*	N1844	KIZNER, Z. I. The error of the biomass estimate as a function of survey parameters and the statistics of a concentration density field. (9 pages)
90/110*	N1845	TALLMAN, R. Reduction of uncertainty caused by discarding in the fisheries of the Gulf of St. Lawrence. (20 pages)
90/111*	N1846	ROSENBERG, A. A., and S. BRAULT. Stock rebuidling strategies over different time scales. (17 pages)
90/112*	N1848	SHELTON, P. A., L. FAHRIG, and R. B. MILLAR. Uncertainty associated with cod-capelin interactions: how much is too much? (13 pages)
90/113*	N1849	MOHN, R. Stability and sustainability of harvesting strategies in a modelled fishery. (14 pages)
90/114	N1850	PAZ, J., and M. G. LARRAÑETA. Year-class variations of American plaice and yellowtail flounder in Div. 3LNO and the abundance of other commercial fish. (10 pages)
90/115*	N1851	SEREBRYAKOV, V. P. Prediction of year-class strength under uncertainties related to survival in early life history of some North Atlantic commerical fish. (13 pages)

* Special Session Papers.

SUMMARY DOCUMENTS (SCS)

SCS No.	Ser. No.	
90/01	N1703	NAFO SECRETARIAT. Historical catches of selected species by stock area and country for the period 1978-88. (38 pages)
90/02	N1705	LASSEN, H. Report of the workshop on silver hake database. (14 pages)
90/03	N1714	MEYBOOM, P. Canadian request for scientific advice on management in 1991 of certain stocks in Subareas 0 to 4. (1 page)
90/04	N1715	PAULSEN, J. Denmark (Greenland) request for scientific advice on management of certain stocks in 1991. (2 pages)
90/05	N1722	CHUMAKOV, A. K., V. A. BOROVKOV, and V. A. RIKHTER. USSR research report for 1989. (21 pages)
90/06	N1725	NAFO SECRETARIAT. Provisional index and list of titles of research and summary documents for 1989. (24 pages)
90/07	N1726	COADY, L. W., M. CHADWICK, P. A. KOELLER, and A. FRÉCHET. Canadian research report for 1989. (28 pages)
90/08	N1727	BOYAR, H. C., and F. M. SERCHUK. US research report for 1989. (10 pages)
90/09	N1807	NAFO SECRETARIAT. List of biological samples data for 1988. (44 pages)
90/10	N1731	NAFO SECRETARIAT. Notes on statistical activities for the Northwest Atlantic in 1989. (2 pages)

90/11	N1732	NAFO SECRETARIAT. Tagging activities reported for the Northwest Atlantic in 1989. (6 pages)
90/12	N1768	AVILA DE MELO, A. M., M. L. GODINHO, R. ALPOIM, and M. CARNEIRO. Portuguese research report for 1989. (22 pages)
90/13	N1769	VAZQUEZ, A., and G. P. GANDARAS. Spanish research report for 1989. (13 pages)
90/14	N1770	PEDERSEN, S. A. Denmark/Greenland research report for 1989. (8 pages)
90/15	N1771	UOZUMI, Y. Japanese research report for 1989. (3 pages)
90/16	N1783	ERNST, P., and R. EGGERS. German Democratic Republic research report for 1989. (9 pages)
90/17	N1805	DOMINGUEZ, R., A. PASCHALIDIS, and S. VALLE. Cuban research report for 1989. (8 pages)
90/18	N1808	ASSISTANT EXECUTIVE SECRETARY. Report to the CWP on NAFO Statistical Program, Publications and ADP. (14 pages)
90/19	N1810	CWP SECRETARY. Report of the fourteenth session of the Coordinating Working Party on Atlantic Fishery Statistics (CWP), February 1990. (45 pages)
90/20	N1816	STACREC WORKING GROUP. Final report of the STACREC Working Group on survey design and procedures. (81 pages)
90/21	N1819	NAFO SECRETARIAT. Provisional nominal catches in the Northwest Atlantic, 1989. (44 pages + Addendum 1 page)
90/22	N1820	CORNUS, H. P., and W. B. BRODIE. A compilation of research vessel surveys on a stock by stock basis. (17 pages)
90/23	N1821	NAFO. Report of Scientific Council, June 1990 Meeting. (131 pages)
90/24	N1823	PACIORKOWSKI, A. J. Polish research report, 1989. (9 pages)
90/25	N1860	NAFO. Report of Scientific Council, Annual Meeting, September 1990. (32 pages)

LIST OF PARTICIPANTS IN SCIENTIFIC COUNCIL MEETINGS, 1990

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* A = Workshop on Silver Hake Database - January 1990
B = Scientific Council Meeting - June 1990
C = Annual Meeting - September 1990

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LIST OF RECOMMENDATIONS IN 1990

PART A

Scientific Council Meeting, June 1990

SCIENTIFIC COUNCIL REPORT

Silver Hake in Divisions 4VWX (Page 19)

STACFIS recommends the production of a manual documenting the established methods of ageing silver hake otoliths.

American plaice in Division 3M (Page 20)

STACFIS noted that there is now substantial survey data available at some national laboratories on this stock. It is therefore recommended that these data, particularly those on age composition, be presented at the June 1991 meeting in order to facilitate a more thorough evaluation of this stock.

On catches exceeding TACS (Page 35)

It is therefore recommended that *initiatives should be taken to obtain more accurate catch and effort data as well as sampling data from the fisheries in the Regulatory Area in order to assess the stocks.*

STACFIS REPORT

Redfish in Division 3M (Pages 62 and 63)

Catch-at-age estimated from the USSR fisheries were available for 1978-89 (SCR Doc. 90/08). In 1989, the modal age was 8. STACFIS noted that data were available from 1968 to 1978 but were not presented. Also, the fish weight-at-age matrix was not available. STACFIS recommends that *catch-at-age and weight-at-age data from 1968 onward be provided for future assessments.*

As was the case in 1989 (NAFO Sci. Coun. Rep. 1989, page 65) however, STACFIS was unable to evaluate these analyses because details of the effort series used for calibration were not available, nor were sufficient details of the calibration process (e.g. regression plots) or partial recruitment. This is a recurring problem, and STACFIS recommends that *details of the calibration process in tuning SPA be provided in the future.* In addition, it was noted that the lack of data concerning the fishing activities of non-member non-reporting countries hampers the usefulness of SPA.

Redfish in Division 3L and 3M (Page 64)

Commercial catch-at-age data were available for the fishery from 1978 to 1989 (SCR Doc. 90/09). Age 7 dominated in the catch in 1989. It was noted that these data are actually available as far back as 1968. STACFIS recommends that *the entire time series of catch-at-age and weight-at-age be made available.*

In last year's assessment the USSR trawl-acoustic survey results were available for Div. 3LN and STACFIS recommends that *trawl-acoustic information be presented by Division, if possible, or at least by stock area as was done in 1989.*

American Plaice in Division 3M (Page 71)

STACFIS noted that there are now substantial survey data available on this stock at some national laboratories. STACFIS recommends that *survey data, particularly those on age composition, be presented at the June 1991 meeting in order to facilitate a more thorough evaluation of this stock.*

Witch Flounder in Divisions 3N and 3O (Page 82)

STACFIS reiterates its recommendation that *countries fishing the witch flounder stock in Div. 3NO should collect catch and effort information as well as length and age data and present them to NAFO to allow for a better evaluation of the status of this resource.* Of particular importance is information on precise locations of commercial activity in order to better interpret survey results.

Capelin in Divisions 3N and 3O (Page 95)

Results of a Soviet 0-group survey during 21 November-9 December 1988 indicated that the 1988 year-class was slightly stronger than the 1983 year-class which had been the strongest in the series. Results from a similar survey conducted during 19 November-9 December 1989 showed the 1989 year-class to be about 70% of the strength of the 1983 year-class. This 0-group survey has

been ongoing since 1983 and STACFIS recommends that *the USSR 0-group survey be continued to provide a database that can be evaluated as an indicator of recruitment.*

Catches in this stock are increasing with the entry of new fleets and STACFIS recommends that *sampling data for all components of the capelin fishery in Div. 3NO, including details on timing and location of the fishery, be collected.*

Shrimp in Subareas 0 and 1 (Page 99 and 100)

The reported catches in recent years have exceeded both the advised and the implemented TACs, and possible changes in discard practices may also have contributed to higher than advised removals from the stock. The data available are not sufficient to determine an appropriate lower catch level, but suggest caution in the short-term exploitation of this resource. Therefore, STACFIS advises that the TAC for 1991 not exceed 50,000 tons. STACFIS at the same time expresses great concern over the possibility of increasing discard rate and recommends that *direct observations on discard of shrimp in the shrimp fishery be made.*

Shrimp in Denmark Strait (Pages 101 and 103)

In response to a request from ICES (ACFM), STACFIS recommends that *experts having data on redfish by-catches and/or discards in the shrimp fishery forward such data to the Chairman of the ICES North-Western Working Group before the next meeting of that group.*

STACFIS at the same time expresses great concern over the possibility of increasing discard rate and STACFIS recommends that *direct observations on discard of shrimp in the shrimp fishery be made.*

On Catches Exceeding TACs (Page 105)

It is therefore recommended that *initiatives should be taken to obtain more accurate catch and effort data as well as sampling data from the fisheries in the Regulatory Area in order to assess the stocks.*

Reports on the Otolith Exchanges (Page 106 and 107)

STACFIS noted that ageing done by the Canadian and the USSR age readers were now in good agreement. Given the unavoidable within-reader variability, STACFIS considered that no further improvements were likely to be forthcoming from the exchanges nor were further improvements required for the assessment of the silver hake stock. STACFIS recommends that *a manual be issued documenting the established methods of ageing silver hake otoliths.* The STACFIS chairman thanked the Canadian and USSR laboratories for the effort put into solving the problems encountered in silver hake ageing.

Previous studies indicate better agreement in otolith reading of American plaice from Div. 3N, where most of the Spanish catch occurs. EEC-Portugal will participate in the exchange program in the future and STACFIS recommends that *further exchange of American plaice otoliths from Div. 3L and 3M be conducted.* Such exchanges should be accompanied with photographs showing the criteria used in the interpretation of the nucleus and the duplicated rings.

STACFIS was informed of problems with inter-reader variability between scales and otolith reading for Greenland halibut involving Canada, EEC-Portugal, EEC-Spain, Greenland, GDR and USSR. STACFIS recommends that *exchange of otoliths and scales accompanied with photograph showing criteria used in the interpretation of rings be conducted.*

STACREC REPORT

Acquisition of STATLANT 21A and 21B reports for recent years (Page 127)

STACREC recommends that *every effort be made by the statistics reporting offices to have the STATLANT 21A and 21B reports submitted on time.*

Fourteenth Session of CWP, February 1990 (Page 128).

A summary of the Report of the Fourteenth Session of the Coordinating Working Party on Atlantic Fishery Statistics CWP (NAFO SCS Doc. 90/19) was tabled. It was noted that the full report had not been incorporated in the submission at this meeting but would be presented in the SCS document to be circulated in the near future. The Committee's attention was drawn to matters of particular interest to NAFO, namely the near completion of the first part of the Handbook on Fishery Statistics (to be published by FAO) and proposed harmonization of STATLANT reports. As a result of one of the CWP agenda items, STACREC noted the need for more detailed reporting of the Elasmobranch catch in FAO Area 21 (the NAFO Convention Area). In agreement with discussions at CWP, STACREC recommended that *the Scientific Council extend an invitation to CWP to hold the Fifteenth Session of CWP at NAFO Headquarters in Dartmouth, Nova Scotia, Canada from 8 to 14 July 1992 and to prepare for that meeting that the Assistant Executive Secretary attend the Ad-hoc Inter-Agency Consultation which is to precede the 79th Statutory Meeting of ICES, in October 1991.*

Biological Surveys (Page 129)

Discussion on this suggestion resulted in designing a standardized format for tabulating surveys by stock area, giving a range of information including time series, depth, and survey design. Designated experts completed these tables with the available information at this meeting and they were incorporated into SCS Doc. 90/22. STACREC recommended that *the list of surveys on a stock-by-stock basis as detailed in SCS Doc. 90/22, be compiled by designated experts annually.*

PART B

Scientific Council Annual Meeting, September 1990

STACFIS REPORT

Special Session on Management Under Uncertainties (Page 146)

Many aspects of biological uncertainties had been discussed (see complete report in Annex 1) and STACFIS recognized the value of the contributions. STACFIS endorsed the convener's recommendation that *the papers presented to the Special Session should be published either in full , or as extended abstracts for papers to be published elsewhere (e.g. the J. Northw. Atl. Fish. Sci.), in a special volume of the NAFO Scientific Council Studies series,* and requested STACPUB to consider this recommendation and to consider an appropriate review procedure for such a volume.

Documentation of Assessments (Page 148)

In summary, it is difficult to achieve all goals in a single report. However, STACFIS recognized that the task of creating an alternative form for scientific/communication reports was not a trivial one and proposed to take a progressive approach. In particular, STACFIS recommends that: *the main research (SCR) document related to the assessment of a given stock serves as the focal point for integrating the scientific information pertinent to the assessment of that stock and that it be updated, as soon as possible after the scientific meeting, so as to reflect the analyses performed in support of the final assessment.* STACFIS noted that the tendency in recent years had been to update the SCR documents shortly after its meeting but recommends that:

a) the practice of updating the SCR document be generalized and streamlined to ensure that the final SCR document contains all data and analyses needed to substantiate the conclusions agreed upon by STACFIS, and

b) *the Summary Sheets be enhanced so as to provide a broader historical perspective with respect to catch trends and to the status of the resource (e.g. recruitment, spawning stock biomass, fishing mortalities).*

STACREC REPORT

Acquisition of STATLANT 21A and 21B Reports (Page 157)

STACREC reiterates its concern about the delays in the provision of these reports and recommends that *every effort be made by the statistics reporting offices to have the STATLANT 21A and 21B reports submitted on time.*

STACPUB REPORT

Review of Papers (Page 159)

STACPUB reviewed the papers of the Special Session held prior to the Annual Meeting. It was the collective opinion of STACPUB that the papers highlighted very important observations regarding uncertainties in fisheries management and is of significant interest to many people. It was however noted that many papers were not considered to be complete studies and were unlikely to be appropriate for the Journal. It was therefore recommended that *the proceedings be published (with the authors' permission) in a special issue of the NAFO Scientific Council Studies to allow for expedient circulation to interested parties.*