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SPECIAL MEETING OF SCIENTIFIC COUNCIL - FEBRUARY 1980

Provisional Report of the Scientific Council

Lisbon, Portugal, 5-13 February 1980

CONTENTS

NOTE: Please report any errors and omissions to the NAFO Secretariat.

PROVISIONAL REPORT OF SCIENTIFIC COUNCIL

Special Meeting, February 1980

Chairman: R. H. Letaconnoux   Rapporteur: V. M. Hodder

The Scientific Council met at Lisbon, Portugal, during 5-13 February 1980, at the invitation of the National Fisheries Research Institute of Portugal, to provide advice for 1980 on the conservation of certain stock for which management measures had been deferred from the 1979 Annual Meeting (*NAFO Proc.* 1979, pages 114-115), namely, the cod stocks in Divisions 3M and 3NO, the silver hake stock in Divisions 4VWX, the capelin stock in Subareas 2 and 3, and the squid-*Illex* stock in Subareas 3 and 4. Participants were welcomed to Portugal by the Director of the National Fisheries Research Institute.

The stock assessments were undertaken by the Standing Committee on Fisheries Science (STACFIS), whose report, as approved by the Council, is given in Appendix I. In considering the agenda for this meeting (Appendix II), it was agreed that Item 3 be deferred to the next meeting of the Council in June 1980. The list of participants is at Appendix III, and the list of research documents reviewed is at Appendix IV. Brief summaries of the stock assessments, together with other matters considered by the Council, are given below.

I. STOCK ASSESSMENTS (APP. I)

1. General Fishery Trends

For the stocks considered at this meeting of the Council, the nominal catches and total allowable catches (TACs) since 1972 were as follows:

Species	Stock area		TACs and Catches (000 tons)							
			1972	1973	1974	1975	1976	1977	1978	1979[1]
Cod	3M	TAC	-	-	40	40	40	25	40	40
		Catch	58	23	25	22	22	27	33	29
	3NO	TAC	-	103	101	88	43	30	15	25
		Catch	103	80	73	44	24	18	15	27
Silver hake	4VWX	TAC	-	-	100	120	100	70	81	70
		Catch	114	300	96	116	97	37	48	52
Capelin	2+3K	TAC	-	-	110[2]	160[2]	160[2]	212[2]	212	75
		Catch	46	136	127	199	216	152	55	11
	3LNOPs	TAC	-	-	148[3]	180[3]	180[3]	200[3]	200	10
		Catch	25	132	161	167	144	75	30	12
Squid-*Illex*	3+4	TAC	-	-	-	25[4]	25[4]	25[4]	100	120
		Catch	2	10	+	18	42	83	93	153

[1] Provisional data.
[2] Countries without specific allocations could each take up to 10,000 tons.
[3] Countries without specific allocations could each take up to 5,000 tons.
[4] Countries without specific allocations could each take up to 3,000 tons.

2. Cod in Division 3M

The provisional nominal catch in 1979 was 29,000 tons from a TAC of 40,000 tons. Except in 1977 when the TAC was reduced, the catches have been substantially less than the TACs since their introduction in 1974. Commercial catch rates in 1979 continued at the low level of recent years. An analysis of available length and age composition data indicates that the proportion of larger and older cod during the 1970's was much lower than in the 1960's, with 1979 catches composed almost entirely of ages 4 to 6.

A cohort analysis, with F = 0.64 for fully-recruited age-groups in 1979, yielded biomass estimates which were reasonably well correlated with research survey abundance indices for the 1972-76 period, resulting in 69,000 tons as the best estimate of the stock size in 1979. Projections of stock size and catch at $F_{0.1}$ = 0.20 implies a catch of about 8,000 tons in 1980 from a stock size (age 3+) of 75,000 tons and a spawning stock (age 6+) of 40,000 tons at the beginning of the year. Since extensive exploitation of cod less than age 6 implies a loss in yield-per-recruit, the Council was concerned that recent catches consisted almost entirely of ages 4-6 cod.

3. Cod in Divisions 3N and 30

The provisional nominal catch in 1979 was 27,000 tons against a TAC of 25,000 tons. Catches from this stock had declined from a high of 227,000 tons in 1967 to a low of 15,000 tons in 1978. Commercial catch rates have declined drastically from the mid-1960's to 1978, with some slight improvement indicated by preliminary data for 1979.

A review of two general production model analyses, utilizing catch and effort data for all of the major fleets fishing in the area up to 1979, indicated a yield at 2/3 F_{MSY} of about 100,000 tons for the 1960's and 1970's in one case, and yields at 2/3 F_{MSY} of 100,000 and 65,000 tons for the 1960's and 1970's respectively in the other case, under the assumption that an ecological change had occurred which may explain the lower level of recruitment in the 1970's. Both models were considered inadequate to represent the current status of the stock which is obviously not in equilibrium.

Two cohort analyses were examined, one based on $F = 0.60$ and the other based on $F = 0.25$ for fully-recruited age-groups in 1979. After discussion on the significance of various correlations between population numbers (and biomasses) from cohort analysis on the one hand and abundance indices from research surveys and commercial catch rates on the other, for the two different values of F assumed for 1979, the cohort analysis with $F = 0.25$ in 1979 was considered to best represent the current status of the stock. The assessment indicated that fishing at $F_{0.1} = 0.20$ in 1980 would yield a catch of 26,000 tons. Projections of stock size to the beginning of 1982 under average recruitment levels imply an increase in stock size (age 3+) from a low of 95,000 tons in 1976 to 284,000 tons in 1980 and an increase in spawning stock (age 6+) from 34,000 tons in 1976 to 197,000 tons in 1982.

The Council emphasizes that caution should be exercised in interpreting the results of the assessment because of uncertainty about the assumed level of fishing mortality in 1979. The stock is capable of yielding 70,000-80,000 tons or more at optimal biomass levels of 500,000-600,000 tons, but the projected catch for 1980 and biomass in 1982 are well below these levels. Furthermore, it is important to note that two year-classes (1974 and 1975) will constitute 70% of the spawning biomass in 1982, and that the next two year-classes (1976 and 1977) are estimated to be very weak. For these reasons, the Council advises that a cautious approach to the exploitation of the cod stock in Div. 3NO should be maintained until clear evidence of rebuilding the stock to the optimal level is indicated.

4. Silver Hake in Divisions 4V, 4W and 4X

The provisional nominal catch in 1979 was 52,000 tons from a TAC of 70,000 tons. The TAC was not fully utilized mainly due to Canadian and Cuban catches being substantially less than their allocations. Commercial catch rates were higher in 1979 than in 1978. The age composition of catches has confirmed a shift to older age-groups following the introduction of additional management measures in 1977, the fishery now being supported by age-groups 2 to 4.

The assessment indicated that fishing at $F_{0.1}$ in 1980 would yield a catch of 100,000 tons. If recruitment continues at presently estimated levels, a preliminary estimate of the catch at $F_{0.1}$ in 1981 is 85,000 tons, with a projected rapid return to the recent TAC level of 70,000 tons. The accuracy of this assessment is adversely affected by discontinuity in the estimates of catch rates and fishing effort, introduced as a result of recent changes in regulatory measures, thus creating uncertainty about the level of fishing mortality in 1979.

5. Capelin in Subareas 2 and 3

a) Overall fishery trends. Nominal catches have declined rapidly from 366,000 tons in 1975 to 85,000 tons in 1978, and to 23,000 tons in 1979 due partly to closure of the offshore fishery in the southern part of the area (Div. 3NO) during 1979. Commercial catch and effort statistics for Subarea 2 and Div. 3K indicate declines from 6.47 tons per hour in 1975 to 1.34 tons per hour in 1979 for USSR trawlers and from 5.01 tons per hour in 1977 to 1.00 tons per hour in 1979 for Romanian trawlers.

b) Subarea 2 and Division 3K. Biomass estimates from both Canadian and USSR acoustic surveys indicated a decline in capelin abundance in recent years. Estimates of the sizes of the 1975, 1976 and 1977 year-classes from sequential capelin abundance models indicate that these year-classes are very weak relative to the strong 1973 year-class which has now virtually disappeared from the population. Using the best estimates available for the sizes of the 1973 to 1977 year-classes and assuming average recruitment of the 1978 year-class at age 2, projections to 1980 indicate a low stock size relative to earlier levels. Since the stock size in 1980 and 1981 will be largely dependent on the sizes of the 1977 and 1978 year-classes and because of uncertainty about the strength of the 1978 year-class, the Council advises a closure of the autumn capelin fishery in this area or a small nominal TAC. A small fishery of 10,000-15,000 tons in 1980 would allow scientists to better assess the status of the stock in 1980 and to quantify the advice for 1981.

c) Divisions 3L, 3N and 3O. Biomass estimates from Canadian and USSR acoustic surveys in 1979 indicated that this stock is still substantially below historical levels of abundance. Projections for 1980 could not be made due to unresolved differences in age compositions of catches from Canadian and USSR surveys in 1979. However, the bulk of the spawning stock in 1980 will consist of the 1976 and 1977 year-classes which are known to be weak. Consequently, in order to allow for an increase in the spawning stock in Div. 3N and to protect the stock on its migration through Div. 3N and 3O, the Council advises that Div. 3N and 3O should be closed to a capelin fishery in 1980. Furthermore, the Council noted that, although capelin abundance in Div. 3L is still low, a small demonstrative fishery in 1980 would unlikely have a deleterious effect on the spawning stock but would provide quantitative data for use in providing better advice on the status of the stock in 1981, and therefore advises that the TAC for Div. 3L in 1980 should remain at the 1979 level of 16,000 tons.

6. Squid-*Illex* in Subareas 3 and 4

a) Fishery trends. The overall nominal catch in both subareas has increased rapidly from 14,000 tons in 1975 to about 153,000 tons in 1979 against a TAC of 120,000 tons. The excess of catch over TAC in 1979 was due largely to the high abundance of squid in inshore waters of Subarea 3 and the rapid expansion of inshore fishing effort. Preliminary statistics indicate that about 82,000 tons were taken in Subarea 3 mostly by the inshore fishery, and about 71,000 tons were taken in Subarea 4 mostly by the offshore fishery.

b) Biological studies. New data on the life cycle of *Illex* included observations on larval and juvenile stages from a spring survey seaward of the continental shelf in Gulf Stream waters, together with continuous observations during the fishing season on the progression of maturation from late juvenile to pre-spawning adult stages. Length frequency distributions were typically uni-modal and showed the progression of a single modal class throughout the season. Mean sizes for both sexes in Subareas 3 and 4 during the 1979 fishery were consistent with those reported for previous years. Research on age determination using statoliths showed that the number of "rings" and the statolith length both increased with mantle length. Seasonal fluctuations in food and feeding related to availability of prey species were noted in studies on *Illex* from the Scotian Shelf. The major components of *Illex* food were crustaceans, fish and squid, and the frequency of occurrence of these food types in relation to size of predator showed increased cannibalism in larger squid.

c) Environmental effects. Several sources of information indicated that environmental factors, especially temperature, may influence the migration and biomass of squid on the offshore and inshore fishing grounds. Squid were found to be abundant at temperatures greater than 6°C on the Scotian Shelf and were concentrated at temperatures between 6 and 8°C on the offshore grounds in Subarea 3. It was noted that the abundance of squid offshore in Subarea 3 in the spring is not a reliable index for forecasting the magnitude of the subsequent inshore migration, mainly due to fluctuations in the frontal zone between the cold Labrador Current and the North Atlantic Current.

d) Abundance estimates. Various biomass estimates and abundance indices for *Illex* in Subareas 3 and 4 in 1979 were considered and compared with the results of earlier studies. Biomass estimates from sequential population analyses were considered unreliable, while those based on data from stratified random bottom trawl surveys were considered to be underestimates due to systematic overestimation of catchability coefficients. Also, the estimates by the areal expansion method, based on untested assumptions for extrapolation which may lead to substantial bias, showed a wide range of values. However, it was concluded that *Illex* abundance was very high in Subareas 3 and 4 in 1979, the overall biomass probably being in the range of 500,000 to 3,000,000 tons in August.

e) Management regime. Since the inshore fishery is geographically restricted to a narrow band along the coast, fishing mortality is considered to affect a limited proportion of the stock. In years of high abundance, the inshore fishery could probably exceed its allowance without leading to excessive exploitation of the stock. The offshore fishery, on the other hand, takes place in areas where squid may be concentrated in years of low abundance, and it was considered that the most satisfactory means of preventing over-exploitation would be by controlled offshore catch allocations in conjunction with effort constraints, as currently practiced.

The council consequently agreed that the catch associated with a target exploitation rate of 0.4 would, under approximately average conditions of abundance, result in an overall catch of 150,000 tons, a level which would not be associated with a serious risk of excessive exploitation. Under such conditions, one would expect an inshore catch of about 50,000 tons. If the biomass of squid in 1980 is very high, as in 1979, the inshore allowance could be exceeded without causing excessive exploitation of the stock. If the biomass in 1980 is low, the offshore fishery will probably not be able to maintain a high catch-per-unit-effort. Limitation of offshore fishing effort by applying the 1978 catch rate to the 1980 TAC would ensure that fishing mortality would not increase greatly despite reduced abundance.

7. Future Research Requirements

The Council endorsed the requirements, listed in the Report of STACFIS (Appendix I), for intensified research on cod, capelin and squid, and, in addition, emphasized the need for intensified studies on the feeding of squid in inshore areas to elucidate the predator-prey relationships between squid and various fish species, especially juvenile cod.

II. OTHER MATTERS

1. Flemish Cap Project

The Convener of the *ad hoc* Working Group on the Flemish Cap Project (Mr R. Wells) reported that a meeting of Canadian, Polish and USSR scientists involved in this project was held at St. John's, Canada, during 18-22 January 1980, and that a report would be available in advance of the June 1980 Meeting of the Council.

2. Georges Bank-Gulf of Maine Larval Herring Program

The Council noted that the Task Force on the Larval Herring Program had been re-activated, as recommended at the 1979 Annual Meeting, and is scheduled to meet at Woods Hole, USA, during 28 April-2 May 1980. An outline of the matters to be considered is given in NAFO Circular Letter 80/3, issued on 8 January 1980.

3. Cooperative Research on Squid

The Council agreed that much had been accomplished from cooperative research projects in the past, and that arrangements for cooperative research on squid in 1980 be considered at the June 1980 Meeting of the Council.

III. FUTURE MEETINGS

1. Scientific Council Meeting in June 1980

The Scientific Council and its Standing Committees will meet at NAFO Headquarters, Dartmouth, Canada, during 3-13 June 1980. The Secretariat was requested to develop, for consideration by the Executive Committee of the Council, the agenda for this meeting, covering all of the major items normally considered previously by ICNAF's Standing Committee on Reserach and Statistics, and allocating them for consideration by the three Standing Committees of the Council, namely, the Committees on Fishery Science (STACFIS), Research Coordination (STACREC), and Publications (STACPUB).

2. Scientific Council Meeting in September 1980

The Scientific Council will meet at St. John's, Newfoundland, Canada, during 3-8 September 1980, to deal with any outstanding matters from the June 1980 Meeting and to provide a forum for discussion on general scientific matters related to the resources of the Convention Area (e.g. the Flemish Cap Project and the Georges Bank-Gulf of Maine Larval Herring Program). The suggested topics included the possibility that Canada could present a paper evaluating the effects on the stocks of reductions in fishing mortality levels in recent years. The Council agreed that the agenda for the September 1980 Meeting would be developed at the June Meeting on the basis of these topics and others that may be proposed at that time. Scientists were invited to suggest appropriate topics for consideration.

IV. ACKNOWLEDGEMENTS

The Chairman thanked the National Fisheries Research Institute for the excellent meeting facilities and the hospitality, the Chairman of STACFIS, Dr G. H. Winters, with the aid of Dr F. Nagasaki for ably dealing with the assessment matters, the participants for their interest and cooperation during the course of the meeting, and the Secretariat staff for their usual efficient work. The meeting was adjourned at 1100 hours on 13 February 1980.

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

Chairman: G. H. Winters

At the request of the Scientific Council, STACFIS met during 5-12 February 1980 to assess the status of the cod stocks in Divisions 3M and 3NO, the silver hake stock in Divisions 4VWX, the capelin stocks in Subareas 2 and 3, and the squid (*Illex*) stocks in Subareas 3 and 4. Conservation measures for these stocks in 1980 were deferred from the 1979 Annual Meeting (*NAFO Proc.* 1979, pages 114-115). Scientists attended from Bulgaria, Canada, European Economic Community (EEC), Faroe Islands, Japan, Poland, Portugal, Spain and Union of Soviet Socialist Republics (USSR).

In considering the relevant section of the Scientific Council agenda, STACFIS agreed that the assessments be carried out in two working groups which would meet concurrently. Consequently, meetings of the *ad hoc* Working Group on Squid (convened by F. Nagasaki) and the *ad hoc* Working Group on Cod, Silver hake and Capelin (convened by G. H. Winters) were held during 6-12 February and the results of the stock assessments, as approved by STACFIS, are given in Section I below. Future research requirements for the assessed stocks are outlined in Section II.

I. STOCK ASSESSMENTS

1. Cod in Division 3M (ICNAF Res. Doc. 79/VI/125; SCR Doc. 80/II/6, 25, 26, 27, 28, 41)

a) Fishery trends

Nominal catches from this stock were less than 10,000 tons prior to 1961. In the 1960-64, 1965-69 and 1970-74 periods, average annual catches were 26,000, 43,000 and 33,000 tons respectively. Total allowable catches (TACs) have been imposed since 1974, but actual catches have generally been less than the TACs. Recent catches and TACs were as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	40	40	40	25	40	40
Catch (000 tons)	23	25	22	22	27	33	29[1]

[1] Provisional data, with the assumption that Spain took its allocation of 4,590 tons.

b) Assessment parameters

Examination of age compositions from biological sampling of the commercial fishery during 1959-68 and 1972-79 indicated that the proportion of older and larger cod was much lower in the 1970's than in the 1960's (SCR Doc. 80/II/28). The 1972 and 1973 year-classes predominated in the catches during 1975-78. In the 1979 fishery, the 1973 and 1974 year-classes, which were about equal in numerical strength, comprised about 78% and the 1975 year-class about 18% of the catches.

The results of Canadian and USSR surveys conducted in recent years were reviewed. From the USSR survey in March 1979 (SCR Doc. 80/II/41), the 1977 year-class as 2-year-olds comprised about 11% of the catches. From the Canadian survey in January 1980 (SCR Doc. 80/II/27), the same year-class as 3-year-olds comprised about 60% of the catches.

Standardized catch rates derived from a multiplicative technique incorporating catch and effort data by country, gear and month (SCR Doc. 80/II/25) were quite similar to the annual catch rates of Portuguese trawlers. The standardized catch rate for 1979, based on limited catch and effort data, was about 0.40 tons per hour fished. From the asymmetrical yield curve of the multiplicative model and from a parabolic yield curve calculated at this meeting, with the assumption that the catch rate for 1980 would be the same as that estimated for 1979, the yield in 1980 at 2/3 F_{MSY} is projected to be in the range of 10,000-15,000 tons. However, since this stock is obviously not in equilibrium, predicted yields from such general production models are very questionable.

Cohort analyses were presented covering the 1959-68 and 1972-79 periods (SCR Doc. 80/II/28). There were no age composition data for the commercial fishery in 1969-71, and sampling was poor for some years during 1972-79. Partial recruitment factors for 1979 were derived from the relative comparison of age compositions from the commercial fishery and the Canadian survey in 1979, yielding a dome-shaped pattern with higher fishing mortality on age-groups 5 and 6 than on older age-groups, as follows:

Age (years)	3	4	5	6	7+
% selected	18	53	117	100	27

The average weight-at-age values used in the cohort analyses were derived from the annual sampling of commercial catches, and there was reasonably good agreement between the calculated catches and the reported nominal catches. The average weight-at-age values for 1979 were as follows:

Age (years)	3	4	5	6	7	8	9	10	11	12+
Av. weight (kg)	0.79	1.07	1.48	2.45	4.35	5.34	6.61	8.21	11.04	15.08

The correlations for the 1972-76 period between biomass estimates (age 3+) from cohort analyses at various terminal F-values in 1979 and both the standardized commercial catch rates and the Faroese longline catch rates were negative, implying that the catch rates were not reliable estimates of stock abundance. The correlations for the 1972-76 period between the biomass estimates (age 3+) from cohort analyses at terminal F-values of 0.64 and 1.30 in 1979 and the catch rates from USSR surveys were reasonably good, with $r^2 = 0.75$ and 0.68 respectively. The biomasses in 1979 implied by these regressions were 70,000 and 68,000 tons respectively. These estimates are similar to a total biomass estimate from the USSR survey in 1979 of 67,000 tons, which may be an underestimate due to the vertical distribution of the fish at the time of the survey, as previous USSR investigations have shown that the bias may be in the order of 30-40%. Since the cohort analysis at terminal F = 0.64 indicated a biomass (age 3+) of 69,000 tons in 1979, it was agreed to use this value in making the projections for 1980.

The biomasses of age 2+ cod were calculated for the 1972-79 period under the assumptions that there was insignificant fishing mortality on 2-year-olds and that natural mortality (M) was 0.20. The correlation between these biomass estimates and the USSR survey catch rates for 1972-78 (excluding 1977 as anomalous) was good ($r^2 = 0.79$). The biomass of age 2+ cod in 1979 estimated from this regression was 83,000 tons.

With estimates of 83,000 and 69,000 tons as the biomasses of age 2+ and age 3+ cod respectively, the biomass of age 2 cod in 1979 was therefore estimated to be 14,000 tons. With an average weight of 0.342 kg, the number of age 2 cod in 1979 was estimated to be 41 million. Taking M = 0.20 and considering fishing mortality to be insignificant on 2-year-olds, the recruitment of age 3 cod in 1980 was estimated to be 34 million fish.

c) Results of assessment

The partial recruitment pattern observed in recent years has been quite variable, and, since no methods of predicting the pattern for 1980 was available, it was agreed to use for the 1980 projections the average pattern adopted for assessing this stock in April 1979 (*ICNAF Redbook* 1979, page 71), namely

Age (years)	3	4	5	6+
% selected	4	17	90	100

Using these partial recruitment factors for 1980 and the other agreed parameters for 1979, projections of stock biomass at the beginning of 1980 and 1981 and catch in 1980 at $F_{0.1} = 0.20$ were determined as follows:

Year	Recruitment at age 3 (10^3)	F for fully recruited ages	Catch (tons)	Stock size (000 tons)		
				Age 3+	Age 4+	Age 6+
1979	1,436	0.64	28,000	69	68	43
1980	34,000	0.20	8,000	75	48	40
1981	-	-	-	-	75	44

Fishing at the level of $F_{0.1} = 0.20$, a catch of 8,000 tons is projected for 1980. The Committee noted that the instantaneous growth rate derived from the average weight-at-age data is about 0.5 up to age 6 and about 0.2 at age 7, the implication being that there would be a loss in yield-per-recruit if there is extensive exploitation of cod less that 6 years old.

2. Cod in Divisions 3N and 30 (SCR Doc. 80/II/10, 24, 41, 49)

a) Fishery trends

Catches from this stock have declined from a high of 227,000 tons in 1967 to 15,000 tons in 1978, the level of the TAC. Provisional statistics for 1979 indicate a catch of about 27,000 tons against a TAC of 25,000 tons, During 1973-77, the catches were substantially less than the corresponding TACs. Recent catches and TACs were as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	103	101	88	43	30	15	25
Catch (000 tons)	80	73	44	24	18	15	27[1]

[1] Provisional data

b) General production models

The Committee reviewed two general production model analyses which utilized catch and effort data for all of the major fleets fishing in the area up to 1978 with estimates for 1979 (SCR Doc. 80/II/10, 24). The authors of SCR Doc. 80/II/10 proposed that the low level of recruitment in recent years in Div. 3N and 30 has resulted from an ecological change rather than from high fishing mortality. Consequently, equilibrium yield curves based on two different levels of recruitment were calculated, one for the 1960's and the other for the 1970's, the estimated yield at 2/3 F_{MSY} being about 100,000 and 65,000 tons respectively. In SCR Doc. 80/II/24, the estimated biomass was shown to have declined from a peak of more than 600,000 tons in the mid-1960's to a low of less than 300,000 tons in the mid-1970's with some slight recovery since then. The single equilibrium yield curve indicated a yield of about 100,000 tons at 2/3 F_{MSY}, but the right-hand limb of the curve is very steep with stock collapse predicted at sustained effort close to 70,000 hours fished. Both analyses show a decline in catch-per-unit-effort (CPUE) from the mid-1960's to 1978 with some improvement in 1979.

The Committee considered that both general production model analyses suffer from the same inadequacies, their use being questionable for a stock that is obviously not in equilibrium. In any case, it was considered that the critical CPUE point is that for 1979. In SCR Doc. 80/II/24, the CPUE value for 1979 is based almost solely on data for Canada (N) tonnage class 5 trawlers and is not considered representative of the fishery on the stock over its entire range in Div. 3N and 30 during the year, mainly because the majority of the catch and effort data pertain to the Canadian fishery in January-March in a small part of Div. 30 adjacent to Subdiv. 3Ps where catch rates were very high. Also, in SCR Doc. 80/II/10, the catch rates for 1977 and 1978 are considered to be low in relation to stock abundance in these years and the 1979 catch rate is based on very preliminary data. For these reasons, the Committee could not consider the projections from either of these models as accurately reflecting the status of the stock in the late 1970's, and therefore agreed to use the cohort analysis as a better estimator of current stock status.

c) Cohort assessment parameters

Catch-at-age data for 1972-79 were used in the cohort analysis (SCR Doc. 80/II/49) to determine fishing mortalities and stock sizes. However, the estimation of fishing mortality for 1979 was subject to some uncertainty.

Using $F = 0.25$ for fully-recruited age-groups in 1979 resulted in population numbers (age 3+) from the cohort analysis which were well correlated with numbers per standard set (age 3+) from the Canadian surveys in 1972-79 ($r^2 = 0.80$, excluding the anamolous 1973 point). Also, for 3-year-olds, the numbers from the cohort analysis and the numbers per standard set from the Canadian surveys in 1972-79 were well correlated ($r^2 = 0.84$), and the numbers of 3-year-olds from the cohort analysis were reasonably well correlated ($r^2 = 0.60$) with the numbers of 2-year-olds (for the corresponding year-classes) per standard set from the Canadian surveys. However, there was no significant correlation between the biomass estimates (age 3+) from the cohort analysis and the commercial catch rates using the standardized CPUE values from SCR Doc. 80/II/24 on the one hand and those from SCR Doc. 80/II/10 on the other. Also, there was no correlation between population numbers (age 3+) from the cohort analysis and catches per hour (age 3+) from the USSR surveys in 1972-79.

Using F = 0.60 for fully-recruited age-groups in 1979 resulted in biomass estimates (age 3+) from the cohort analysis which appeared to be well correlated (r^2 = 0.92) with the standardized commercial catch rates for 1972-78 from SCR Doc. 80/II/24, but the 1976 estimate and more importantly the 1979 estimate were completely outside the range of the correlation and were thus excluded from the calculation of r^2. Also, the resultant population numbers (age 3+) from the cohort analysis were not significantly correlated with either the numbers per standard set (age 3+) from the Canadian surveys or the numbers per hour fished (age 3+) from the USSR surveys.

After discussing the problems associated with determining realistic estimates of fishing mortality and stock size in 1979, the Committee agreed to accept the results of the cohort analysis which correlated well with the Canadian survey data (i.e. F = 0.25 for 1979) as best representing the current status of the stock, but at the same time recognizing the uncertainties associated with the parameter estimates.

For use in the cohort analysis, the partial recruitment factors for 1979, derived from the relative comparison of age compositions from the commercial fishery and the Canadian surveys in 1979, are as follows:

Age (years)	3	4	5	6	7	8	9	10	11+
Part. recruitment	0.03	0.36	0.76	1.00	1.00	1.00	0.91	0.76	0.30

Recruitment estimates at age 3 by year-class were obtained from (i) the correlation of numbers at age 3 from the cohort analysis and from the Canadian surveys, and (ii) the correlation of numbers at age 3 from the cohort analysis and numbers at age 2 for the same year-classes from the Canadian surveys. These, together with the actual estimates for 3-year-olds from the cohort analysis, are as follows:

Year-class	Estimated recruitment at age 3 (millions)		
	Cohort age 3 *vs* surveys age 3	Cohort age 3 *vs* surveys age 2	Actual cohort estimates
1975	53	40	62
1976	24	20	18
1977	-	22	-

For the assessment, the Committee agreed to use the numbers at age 3 from the cohort analysis as estimates of the sizes of the 1975 and 1976 year-classes, namely, 62 million and 18 million fish respectively. In addition, 25 million fish at age 3 was accepted as the size of the 1977 year-class.

d) Results of cohort analysis

The stock sizes for 1979 and 1980 were calculated by cohort analysis as outlined above, and a catch projection was made for 1980 at $F_{0.1}$ = 0.18. In addition, stock sizes at the beginning of 1981 and 1982 were projected by assuming that the size of the 1978 and 1979 year-classes at age 3 is equal to the geometric mean of the sizes of the 1969-76 year-classes (i.e. 40 million fish) and that fishing occurred at the $F_{0.1}$ level in 1981. The results of the analysis and projections are as follows:

Year	Recruitment at age 3 (10^6)	F for fully-recruited ages	Catch (tons)	Stock size (000 tons)		
				Age 3+	Age 4+	Age 6+
1979	18	0.25	27,000	204	191	67
1980	25	0.18	26,000	223	205	132
1981	40	0.18	-	257	228	189
1982	40	-	-	284	255	197

e) Conclusions

The catch at $F_{0.1}$ implied for 1980 from the cohort analysis is about 26,000 tons. Stock size projections to the beginning of 1982, under the assumptions of fishing at $F_{0.1}$ in 1980 and 1981 and of recruitment at age 3 in 1981 and 1980 being equal to the average level for 1969-76, indicate an increase in biomass of age 3+ fish to 284,000 tons in 1982 from a low of 95,000 tons in 1976. The spawning biomass (age 6+) is also projected to increase to 197,000 tons by 1980 from a low of 34,000 tons in 1976.

The Committee emphasized that caution should be exercised in interpreting the results of the cohort analysis and the projections for several reasons. Firstly, the results of the analysis with F = 0.25 for 1979 is the most optimistic assessment of the status of the stock in the late 1970's. If F in 1979 was as high as 0.60, as indicated by one analysis, the total biomass during the late 1970's is estimated to have remained stable at the low level of 60,000-70,000 tons. Secondly, the stock, if rebuilt to its optimal level, could yield about 70,000-80,000 tons and possibly up to 100,000 tons. The total biomass necessary to produce this yield is in the order of 500,000-600,000 tons, compared with the projected level of about 300,000 tons by 1982 under the most optimistic assessment of the stock status in 1979. Thirdly, about 50% of the total biomass and about 70% of the spawning biomass in 1982 will consist of two age-groups (ages 7 and 8), and the two immediately following year-classes (1976 and 1977) are estimated to be poor. In fact, the two dominant year-classes (those of 1974 and 1975), which will contribute to most of the increase in projected biomass by 1982, average about 68 million fish, whereas the recruiting year-classes in the 1960's averaged about 100 million fish. The total biomass in the mid 1960's was in the order of 400,000-500,000 tons, much higher than the present biomass and also significantly higher than the biomass projected for 1982. Therefore, the Committee advises that a cautious approach to exploitation of the cod stock in Div. 3N and 3O should be maintained until clear evidence of rebuilding of the stock to the optimal level is indicated.

3. Silver hake in Divisions 4V, 4W and 4X (SCR Doc. 80/II/18, 19, 20, 21, 46, 48)

a) Fishery trends

Provisional statistics indicate an increase in catch to 52,000 tons in 1979 from 48,000 tons in 1978 and 37,000 tons in 1977. The 1979 TAC of 70,000 tons was not fully utilized, due mainly to Canadian and Cuban catches being substantially less than their allocations. Recent catches and TACs were as follows:

	1973	1974	1975	1976	1977	1978	1979
TAC (000 tons)	-	100	120	100	70	81	70
Catch (000 tons)	300	96	116	97	37	48	52

Commercial catch rates for both the Cuban and USSR fleets increased in 1979 over those of 1978, but the extent of the increase could not be determined due to the preliminary nature of the 1979 data.

b) Assessment parameters

The 1979 catch consisted predominately of age-groups 2, 3 and 4, and it was confirmed that the changes in management measures instituted in 1977 have changed the recruitment pattern to the fishery, with less dependence of recent catches on ages 1 and 2 fish. The partial recruitment factors used in the assessment, representing the means of the 1977 and 1978 values, are as follows:

Age (years)	1	2	3	4	5	6+
Part. recruitment	0.05	0.52	1.00	0.97	0.75	0.65

The average weight-at-age values also appear to have changed in the most recent years, and the values used in this assessment are the means of weight-at-age data for 1976-79, as follows:

Age (years)	1	2	3	4	5	6+
Mean weight (g)	50	130	200	250	315	500

The above changes in parameters required the recalculation of the yield-per-recruit curve, giving $F_{0.1} = 0.67$. The natural mortality (M) was taken to be 0.40, a value estimated several years ago and used in previous assessments.

A fishing mortality rate of 0.33 for fully-recruited age-groups was used for 1979, and the results of the virtual population analysis were fairly consistent with the historical data on commercial catch rates and fishing effort. However, these latter data have certain deficiencies. In particular, the catch and effort data for 1977-79 which were collected by observers are not directly comparable with data prior to 1977 from ICNAF Statistical Bulletins. Consequently, there is some uncertainty as to the precise status of the stock in 1979.

The change in partial recruitment factors makes recruitment estimates at age 1 for 1980 of less importance to the calculation of yield for 1980 than in previous assessments. It was noted that the inverse relationship between survey estimates of squid population numbers in one year and year-class strength of age 1 silver hake in the next (ICNAF Res. Doc. 79/VI/48) still holds with the addition of data for 1978 (SCR Doc. 80/II/21), giving an estimate of 1.06×10^6 fish as the size of the 1979 year-class at age 1.

c) Assessment results

The calculations indicate a yield in 1980 of 100,000 tons at $F_{0.1} = 0.67$. If the size of the 1980 year-class is assumed to be the same as that of the 1979 year-class, provisional calculations imply a catch of 85,000 tons at $F_{0.1}$ in 1981. In general terms, the stock is estimated to have experienced fishing mortalities below $F_{0.1}$ in recent years, due to the catches being substantially less than the TACs. Although a large increase in yield is indicated for 1980, the projections suggest that the yield will quickly return to the recent TAC level of 70,000 tons. These projections depend largely on future recruitment levels which cannot be predicted at this time.

4. Capelin in Subareas 2 and 3 (SCR Doc. 80/II/4, 13, 14, 15, 16, 42, 43, 44, 45)

a) Fishery trends

The nominal catch of capelin in Subareas 2 and 3 increased from 2,800 tons in 1971 to 366,000 tons in 1975 and declined to 85,000 tons in 1978. Preliminary statistics indicate a catch of 23,000 tons in 1979, due in part to the prohibition of an offshore fishery in Div. 3LNO. Recent catches and TACs were as follows:

Area		1973	1974	1975	1976	1977	1978	1979
2+3K	TAC (000 tons)	-	110[1]	160[1]	160[1]	212[1]	212	75
	Catch (000 tons)	136	127	199	216	152	55	11
3LNOPs	TAC (000 tons)	-	148[2]	180[2]	180[2]	200[2]	200	10
	Catch (000 tons)	132	161	167	144	75	30	12

[1] Countries without allocations could each take up to 10,000 tons.
[2] Countries without allocations could each take up to 5,000 tons.

b) Biological studies

The Committee recognized that there were two sources of bias associated with acoustic surveys: one associated with survey design and the other with calibration parameters, especially the target strength. Statistical methodology is presently available to estimate the variance associated with survey design, but, although it is known that the variance associated with target strength can be large, basic research on estimating this parameter and applying it to biomass estimates has been limited. In this regard, the Committee complimented USSR scientists on their attempts to provide an absolute calibration of their echo-integration system (SCR Doc. 80/II/44) by modelling fish schools. Various improvements in the experiment were suggested such as using a wider range of school density and attempting the experiment with living fish.

In a discussion on estimation of natural mortality of capelin, it was noted that the method used by Icelandic scientists (ICES CM 1979/11:27) can be highly biased by the sampling data, especially the age composition and the sex ratio. Because there is always some bias involved in sampling capelin and because the method is very sensitive to such bias, an estimate of natural mortality by this method should be treated with caution.

A method to estimate the maturation rates of capelin using catch-per-unit-effort data was presented by Canadian scientists (SCR Doc. 80/II/16). The analysis revealed that there is annual variation in maturation rates and that there is an increase in these rates with age. Because sequential capelin abundance models (SCAM) are very sensitive to this parameter, reliable estimates of the proportion mature at age are necessary to produce unbiased estimates of biomass and year-class strength using these models.

c) Subarea 2 and Division 3K

i) Commercial catch-effort analysis

Catch rates of USSR BMRT-type trawlers, considered at the April 1979 Meeting as a useful index of abundance (*ICNAF Redbook* 1979, page 34), has declined from 6.47 tons per hour in 1975 to 1.34 tons per hour in 1979 (SCR Doc. 80/II/13). Catch rates of Romanian trawlers in Div. 2J declined from 5.01 tons per hour in 1977 to 2.02 tons per hour in 1978 and to 1.00 tons per hour in 1979 (SCR Doc. 80/II/4).

ii) Research surveys

A USSR acoustic survey in Div. 2J during November 1979 provided a biomass estimate of 14,500 tons (SCR Doc. 80/II/43), which represent a decline in abundance by a factor of 4 from the estimate in 1978 and by a factor of 100 from the estimate in 1974. A Canadian acoustic survey during October-November 1979 provided biomass estimates of about 6,300 tons in Div. 2J and 39,500 tons in Div. 3K (SCR Doc. 80/II/13), which represent for the area as a whole a decline in abundance by a factor of 5 from the 1977 level.

The age composition of samples taken during the USSR survey indicated that the 1975 and 1976 year-classes predominated, whereas samples taken during the Canadian survey indicated that the 1977 and 1978 year-classes predominated. This is in contrast to the age composition of samples from the 1979 commercial fishery where only the 1977 year-class was dominant.

iii) Numerical population models

A sequential capelin abundance model (SCAM) was used to estimate the biomass of capelin on 1 September 1979 (SCR Doc. 80/II/13). This model used new estimates of spawning mortality and the proportions mature at age, derived from a comparison of mean length-at-age data and a maturity ogive. Because few research samples were available, estimates of partial recruitment for age 2 were not considered reliable, and thus the projections of population numbers at age 2 from the two SCAM analyses with terminal F's at 0.010 and 0.012 were not very realistic. Using the 1979 catch rate of 1.34 tons per hour for USSR BMRT-type trawlers in the regressions of total biomass estimates on 1 September from SCAM (with terminal F = 0.012 and 0.010) against catch rates of USSR BMRT-type trawlers in 1973-78 yielded total biomass estimates for 1979 from which the biomass estimates of age 3 and older capelin were subtracted, giving estimates of 15.0×10^9 and 42.3×10^9 fish respectively as the size of the 1977 year-class at age 2. The general trend in total biomass from these analyses indicate a decline over the last four years such that the biomass in 1979 was only about 7% of the peak biomass in 1976. The three strongest year-classes were indicated to be those of 1973, 1974 and 1969.

A second method using SCAM to predict the sizes of recent year-classes was presented (SCR Doc. 80/II/15). This model used the same estimates for such parameters as catch-at-age, mean weight-at-age and spawning mortalities, but the values for the proportions mature-at-age were derived using catch-per-unit-effort data (SCR Doc. 80/II/16). Estimates of the sizes of the 1975, 1976 and 1977 year-classes at age 2 were obtained from regressions relating numbers-at-age from the model to catch-per-unit effort for the corresponding year-classes, these estimates being 9.6×10^9 for the 1975 year-class, 8.3×10^9 for the 1976 year-class, and 25.0×10^9 for the 1977 year class. A further estimate of the strength of the 1977 year-class at age 2 (8.9×10^9 fish) was derived from the regression of biomass estimates on 1 September from the model against catch rates of USSR BMRT-type trawlers in 1978, using a catch rate of 1.34 tons per hour in 1979 to obtain a biomass estimate for 1979. These analyses showed that the 1973 and 1969 year-classes were the strongest in recent years with those of 1974, 1975 and 1976 being the weakest year-classes.

iv) Recruitment estimation and prognosis for 1980

The four estimates of the size of the 1977 year-class at age 2 ranged from 8.9×10^9 to 42.3×10^9 fish, the average being 22.8×10^9 . These estimates were all lower than the value used in the prognosis for 1979 (*ICNAF Redbook* 1979, page 36) and substantially lower than that estimated for the strong 1973 year-class, as indicated below:

Year-class	1970	1971	1972	1973	1974	1975	1976	1977
Estimated numbers (10^6) at age 2 on September 1	15,160	22,210	19,612	57,739	14,564	9,608	8,130	22,800[1]

[1] Mean of four estimates.

The biomass of the stock on 1 January 1980 and 1 September 1980 were calculated using the average of the four estimates as the size of the 1977 year-class at age 2 (22.8 × 10^9) and the geometric mean of the 1969-76 year-class sizes at age 2 as an estimate of the 1978 year-class (Table 1, Option 1). The biomasses of the stock on 1 January 1980 and 1 September 1980 were also calculated using the average of the two lowest estimates of the size of the 1977 year-class at age 2 (11.95 × 10^9) and the geometric mean of the 1969-76 year-class sizes at age 2 as an estimate of the 1978 year-class (Table 1, Option 2). This latter value for the size of the 1977 year-class was chosen for this projection because the total biomass on 1 September showed a decline from 1978 to 1979, which agrees with declines in abundance from commercial catch rates and acoustic surveys.

Table 1. Capelin in Subarea 2 and Div. 3K: estimates of stock size on 1 September 1979 and projected estimates of stock size on 1 January and 1 September 1980.

Age	Stock size numbers (000) 1 Sep 1979	1 Jan 1980	1 Sep 1980
Option 1			
2	22,800,000	27,275,180	22,331,030
3	3,575,340	20,292,150	13,619,630
4	777,860	3,190,100	1,142,230
5	170,440	693,350	147,170
6	28,440	139,530	22,480
Biomass (tons)	505,190	693,010	776,180
Option 2			
2	11,950,000	27,275,180	22,331,030
3	3,575,340	10,474,660	7,030,360
4	777,860	3,190,100	1,142,230
5	170,440	693,350	147,170
6	28,440	139,530	22,480
Biomass (tons)	355,510	525,160	610,770

The Committee concluded that the stock sizes provided in Option 2 (Table 1) were more realistic because the trends in biomass agree with trends in commercial catch rates from 1976 to 1979 and acoustic survey estimates of abundance from 1977 to 1979. Since the 1978 year-class, for which no quantitative information is available, comprises a substantial proportion of the projected stock size estimates in 1980, these estimates could be subject to substantial error. Because the 1975 to 1977 year-classes are very weak, the spawning stock in 1980 will be low and it will depend in 1981 to some extent on the 1978 year-class for which there is no quantitative estimate. The Committee therefore advises a closure of the autumn fishery for capelin in Div. 2J+3K or a small nominal TAC. A small fishery of 10,000-15,000 tons in 1980 would allow scientists to better assess the status of the stock in 1980 and to quantify their advice for 1981.

d) Divisions 3L, 3N and 3O

i) Commercial catch-effort analysis

No offshore commercial fishery occurred in these divisions in 1979.

ii) Research surveys

USSR acoustic surveys in May-June 1979 provided biomass estimates of 483,000 tons of mature capelin and 246,000 tons of immature capelin in Div. 3L, and 2,730 tons of mature capelin in Div. 3O (SCR Doc. 80/II/42). These estimates for Div. 3L represent an increase over 1978 levels, but information available for Div. 3NO indicates that the spawning population was substantially lower than historical values which ranged from 685,000 to 1,050,000 tons. Acoustic surveys by Canada in June-July 1979 resulted in a biomass estimate of 185,000 tons in Div. 3LNO and two estimates of 3,300 and 20,250 tons of spawning capelin in Div. 3N. No previous acoustic estimates by Canada were available for comparison.

Age compositions of capelin samples from the Canadian and USSR surveys in Div. 3LNO were different. In the Canadian samples, the 1976 and 1977 year-classes dominated in Div. 3L and examination of the mean length indicated that many of these fish were immature, whereas the 1975 and 1976 year-classes dominated the mature population in Div. 3NO. In the USSR samples, the 1977 year-class was not strongly represented in Div. 3L and 3N, most of the fish being mature and belonging to the 1975 and 1976 year-classes. No reasons for these differences were apparent, but it was suggested that the USSR samples, being relatively few in number, may not be truly representative of the age structure of the population.

iii) Numerical population analyses

No numerical analyses were available for the populations in Div. 3LNO.

iv) Recruitment estimation and prognosis for 1980

Stock size projections for 1980 were not made because the differences between the Canadian and USSR estimates of the age composition of the stock could not be resolved. However, it is known that the 1975 and 1976 year-classes are very weak and the 1977 year-class appears to be only slightly stronger. These year-classes, especially those of 1976 and 1977, will comprise the bulk of the spawning stock in 1980. Consequently, in order to allow further increase in the spawning stock in Div. 3N and to protect this stock during its migration through Div. 3O to Div. 3N, the Committee advises that there should be no fishery for capelin in Div. 3N and 3O during 1980.

The Committee noted that, although stock abundance is still low in Div. 3L, a small demonstrative fishery in Div. 3L in 1980 would not likely have a deleterious effect on the spawning stock but would yield quantitative data in 1980 for use in providing better advice for 1981, and therefore advises that the 1980 TAC for Div. 3L remain at the level of 16,000 tons as in 1979.

5. Short-finned squid (*Illex illecebrosus*) in Subareas 2 to 4

a) Fishery trends

The nominal catch of *Illex* in Subareas 2 to 4 increased rapidly from an annual average of about 4,500 tons during 1970-74 to 92,700 tons in 1978. Preliminary data indicate that the 1979 catch was about 153,000 tons, an increase of 65% over that of 1978. Recent catches and TACs were as follows:

Year	Nominal catches (tons) by subarea 2	3	4	Total SA 2-4	TAC (tons)
1972	-	26	1,842	1,868	-
1973	2	620	9,255	9,877	-
1974	31	17	389	437	-
1975	-	3,751	13,993	17,744	25,000[1]
1976	-	11,257	30,510	41,767	25,000[1]
1977	6	32,748	50,726	83,480	25,000[1]
1978	-	40,697	51,987	92,684	100,000
1979	-	81,820	71,279	153,099	120,000

[1] Countries without specific allocations could each take up to 3,000 tons.

Catches in Subarea 3 have shown a steady and rapid increase from 1972-74 to 1979, the catch of 81,800 tons in 1979 being double that of 1978. Increased catches in Subarea 3 have resulted from an apparent increase in the abundance of *Illex* in coastal waters and the expansion of effort in the inshore fishery, as the offshore fishery accounted for only 2,400 tons or about 3% of the catch in 1979 (SCR Doc. 80/II/32). Catches in Subarea 4, after increasing rapidly during 1975-77 from 14,000 to 50,700 tons, increased only slightly to 52,000 tons in 1978 and more rapidly to 71,000 tons in 1979. These increases in Subarea 4 were the result of increased offshore fishing effort under established TACs. Although inshore catches increased from about 1,100 tons in 1978 to roughly 6,400 tons in 1979, they have comprised a relatively small proportion of the total catch in Subarea 4. There are indications that the inshore component of the catch in both Subareas 3 and 4 would have been higher if market prospects and onshore freezing capacity had been greater.

The seasonal pattern of the fishery in Subareas 3 and 4 in 1979 shows catches increasing rapidly following the commencement of the directed fishery in July to a peak in September and then decreasing rapidly during the autumn, as follows:

Month	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Catch (000 tons)	+	1.7	21.3	36.8	51.1	32.8	9.2	0.2	153.1

In Subarea 3, inshore jigging continued to be the dominant method of fishing while offshore trawl catches remained low (SCR Doc. 80/II/12, 34). Significant changes in the Subarea 4 fishery included expansion of inshore jigging and the introduction by Japan, through cooperative arrangements with Canada, of an offshore jigger fishery in which seven vessels of the 100-499 tonnage class took more than 6,000 tons.

Preliminary catch and effort data for the directed squid fishery on the offshore grounds by vessels operating under their national allocations indicated an increase from 7.5 tons per day in 1978 to 12.7 tons per day in 1979 for Subarea 3 and an increase from 9.3 tons per day in 1978 to 16.9 tons per day in 1979 for Subarea 4. However, data for vessels operating under cooperative arrangements with Canada in 1979 resulted in values of 28.1 and 22.9 tons per day for Subareas 3 and 4 respectively (SCR Doc. 80/II/32). Consequently, because of the apparent differences in catch rates, no directed comparison was possible with data presented previously for 1978 (*ICNAF Redbook* 1979, page 40).

b) By-catches

By-catches in the directed trawl fishery for squid on the Scotian Shelf in 1979 (SCR Doc. 80/II/8, 12, 18) did not change greatly from the situation in previous years. Silver hake and argentine were the dominant by-catch species. Cod, pollock, haddock and redfish were also caught but in very small quantities, usually comprising less than 1% of the catch in the directed squid fishery. There was no by-catch in the experimental squid-jigging operations. Preliminary analysis of data for the area eastward of the "small-mesh gear" line along the edge of the Scotian Shelf indicated that by-catches were negligible, but this may have been due to the fact that only off-bottom trawls could be used in the area. By-catches of haddock and pollock were higher westward of the "small-mesh gear" line, but experimental fishing in this area was very limited in 1979. Observations on by-catch in other areas were limited to those on one trawler fishing for squid on St. Pierre Bank with a 10% by-catch consisting mainly of pollock. The by-catch of squid in the directed fishery for silver hake on the Scotian Shelf was about 10% in 1979, substantially higher than in 1978 (2.4%) but slightly lower than in 1977 (12%).

c) Biological characteristics

i) Distribution

During a plankton survey in March-May 1979, *Illex* larvae and juveniles were recorded for the first time in the Gulf Stream seaward of the Scotian Shelf (SCR Doc. 80/II/38). In 1979, the period of occurrence on the continental shelf and in coastal waters was from May to late December in Subarea 4 (SCR Doc. 80/II/30, 32) and from June to early December in Subarea 3 (SCR Doc. 80/II/34). The extension of *Illex* distribution into the southern Gulf of St. Lawrence, which was reported for 1978 (*ICNAF Redbook* 1979, page 27), was again reported in 1979, apparently in greater abundance. Squid were abundant in many localities along the coastlines of Newfoundland and Nova Scotia, and large quantities were reported to have been washed ashore in the Bay of Fundy and at many localities in Newfoundland.

ii) Life cycle

Length frequency distributions of *Illex* in 1979, reported from inshore and offshore surveys in Subarea 3, extended from July to November, while those from offshore surveys in Subarea 4 extended from February to December (SCR Doc. 80/II/2, 11, 12, 30, 34). The length frequencies were typically unimodal with a consistent single modal class progressing through the season for both sexes. However, inconsistent modes were apparent in some samples and these were attributed to insensitivity of sampling methods to determining size variation which may exist between components of the stock (SCR Doc. 80/II/12, 30). Length frequency distributions of males and females from a survey in Subdiv. 3Ps showed no marked variation with depth (SCR Doc. 80/II/11). Weekly length compositions from samples taken during May to December in Subarea 4 were used to construct Bertalanffy growth curves for 1977 to 1979, which indicated that, although growth in May appeared to be slower in 1977 and 1979 than in 1978, mean sizes by the end of August were similar in all three years (SCR Doc. 80/II/30). The L_∞ values ranged from 293 to 347 mm (mantle length) in females and from 232 to 278 mm in males.

Using the 1978 and 1979 growth curves to trace the progression of maturation through the season showed that males became mature at the same mantle length (228 mm) in late November 1978 and in late October 1979, whereas females at approximately the same sizes (250 mm in 1978 and 258 mm in 1979) became mature in early and late December of 1978 and 1979 respectively. It was suggested that these stages and dates relate to the imminant emigration phase, when *Illex* leave their summer residency on the continental shelf for their spawning areas. An offshore survey in Subarea 4 during October-November 1979 showed a definite trend toward larger and more mature squid being located at greater depths (SCR Doc. 80/II/40). Studies in Subarea 3 did not cover sufficient periods of time to allow the tracing of maturation patterns to the same extent as in Subarea 4. However, a study of *Illex* from a survey in Subdiv. 3Ps during October 1979 (SCR Doc. 80/II/11), using the same maturation criteria as used for Subarea 4, indicated that the majority of males were mature (56-69%) whereas less than 1% of the females had entered the late stage of maturity (vitellogenesis); but a study from inshore Newfoundland samples (SCR Doc. 80/II/34), using different maturation criteria (ICNAF Res. Doc. 73/71), indicated that very few males (less than 5%) had become mature in November and all females observed were immature.

Information on the sex ratio of *Illex* in Subarea 4 during July-August showed males at about 59% (SCR Doc. 80/II/2). Similar percentages were reported for samples taken at Holyrood, Newfoundland, until the end of August (SCR Doc. 80/II/34). The percentages of males were noted to decline during the latter part of the season, the most rapid decline occurring during the last month (SCR Doc. 80/II/12, 30, 36). Although no conclusive evidence was presented, it was suggested, among other factors, that these changes might be the result of larger females cannibalizing on smaller males and/or emigration of the earlier maturing males.

The Committee noted that a better understanding of the life cycle of *Illex* has been achieved through the accumulation of information, presented at this and previous meetings, from observations on egg and larval stages in the laboratory, on larval and early juvenile stages found in Gulf Stream waters of Subareas 3 and 4 in the spring, and on the progression of maturation in juvenile to mature adult stages during the summer and autumn on the continental shelf.

iii) Spawning

Observations on maturity and spawning were again made on *Illex* in captivity (SCR Doc. 80/II/39), indicating that the egg masses were extruded by mantle contraction as the females "rested" on the bottom of the pool and became neutrally or positively bouyant with the influx of colder, more saline water into the pool. The Committee agreed that there was insufficient evidence to relate these observations to natural conditions. Specifically, concern was expressed with regard to the suggestion of bottom spawning and the bouyancy of egg masses, as in nature larvae have been found in the upper 500 m of the water column (SCR Doc. 80/II/38).

iv) Age determination

The Committee recognized that research into age determination of *Illex* from statoliths had progressed. One study (SCR Doc. 80/II/1) found that the number of "rings" increased with mantle length, but that they did not appear to represent chronological marks based on a cohort analysis of samples from inshore Newfoundland waters. However, age validation may have been complicated by the presence of mixed age-groups in the samples. Another study (SCR Doc. 80/II/22) pointed out some characteristic views on ageing methodology from a literature review of the subject on various squid species, and suggested for *Illex* a relationship between mantle length and statolith length and between mantle length and the number of growth "rings".

v) Food and feeding patterns

The majority of the *Illex* stomachs examined from Subarea 3 were empty or less than half full and no specific feeding pattern was discernable (SCR Doc. 80/II/12). In Subarea 4, however, studies undertaken in 1978 and 1979 (SCR Doc. 80/II/31) indicated that feeding activity was at a high level in May, decreased during the summer and increased again by

September, corresponding with fluctuations in the apparent abundance of euphausiids which represent the most common prey species. It is likely that *Illex* feeds on euphausiids in the upper regions of the water column at night and returns to the bottom to digest their meal during daylight hours, but the occurrence of fish in the stomachs also indicates demersal predation. Experiments in the laboratory indicated that it took 14-16 hours for *Illex* to fully digest a meal of macerated or chunky food (SCR Doc. 80/II/29).

Three major types of *Illex* food (crustaceans, fish and squid) were identified (SCR Doc. 80/II/31). The crustaceans were mainly euphausiids and the squid were mainly *Illex illecebrosus* but the fish species were less readily identifiable. A study of the frequency of occurrence of these prey groups in relation to size of *Illex* indicated that the importance of crustaceans as food decreased from more than 80% in juvenile squid of 145 mm (at the time of immigration) to less than 50% in squid of 200-225 mm mantle length. Cannibalism consistently increased from about 40% in squid of 200-225 mm to more than 80% in the 1978 and about 60% in the 1979 samples for the largest sizes of *Illex*. The occurrence of fish as food was about 10% for all size groups of *Illex* greater than 200-225 mm. The progression of predation from feeding on crustaceans to fish and squid was attributed to availability and size-relative preference of prey (SCR Doc. 80/II/31). Mysids, copepods and amphipods and eggs of this crustacean constituted the stomach contents of the few juvenile *Illex* (10-70 mm) with sufficient food to quantify.

vi) Tagging

Tagging studies on squid conducted in Newfoundland waters since 1965 (SCR Doc. 80/II/33) indicated very few tag returns up to 1977. However, tagging studies in 1978 and 1979, with improved tagging techniques, higher rewards for tag returns and greater publicity about the experiments, demonstrated that such studies are useful in elucidating inshore migration patterns. Preliminary results indicate both small-scale and large-scale movements in coastal waters, but increased offshore tagging effort is needed in order to understand the shoreward migration pattern.

d) Environmental influence on distribution and abundance

i) Scotian Shelf

Data from a Canadian survey in 1979 (SCR Doc. 80/II/17) confirmed the general trend of high abundance being connected with high mean bottom temperatures. Although no linear relationship is obvious between temperature and abundance, there is the tendency for the abundance to be high at bottom temperatures greater than 6°C and for large squid catches to occur in areas where the temperature ranged from 8 to 10°C. The results of a joint Canada/USSR survey in March-April 1979 (SCR Doc. 80/II/38) indicate that most of the catches of juvenile *Illex* occurred in waters influenced by the Gulf Stream system at temperatures ranging from 15 to 20°C and salinities between 35.4 and 36.6‰. These results indicate that temperature may indirectly influence squid abundance through larval and juvenile survival and distribution.

ii) Gulf of St. Lawrence

Although no apparent relationship was obvious between temperature and *Illex* abundance from data available for 1970-78, it was noted that both the mean bottom temperature and squid abundance were high in 1978 (SCR Doc. 80/II/17).

iii) Newfoundland area

Data from a French survey on St. Pierre Bank (Subdiv. 3Ps) in October 1979 (SCR Doc. 80/II/11) indicated that 90% of the catches containing squid were made at temperatures between 6 and 8°C along the slope of the bank. Temperatures (-1 to 3°C) on shallower parts of the bank, influenced by the Labrador Current system, appeared to be unsuitable for squid and probably formed a thermal barrier to their migration. Data for the coastal waters around St. Pierre and Miquelon islands indicate that the inshore migration of squid begins when the temperature reaches 7°C at the end of June and that the offshore migration occurs in early November when the temperature falls below this value. These observations, together with those for inshore Newfoundland waters indicate that the squid-jigging fishery usually occurs at temperatures from 7 to 15°C. However, it was noted that high catch rates in southeastern Newfoundland localities (Div. 3L) in 1979 were associated with low water temperatures (< 5°C), and it was suggested that other environmental factors, such as wind direction, may influence the inshore distribution of squid.

An updated study, based on observations during 1966-79 (SCR Doc. 80/II/5), indicated that the offshore abundance of *Illex* observed in trawl surveys on the Grand Bank in the spring is not a reliable index to forecast the magnitude of the subsequent inshore migration. The forecast index does not seem to be correlated with either yearly sea-surface temperature anomalies or iceberg numbers, but the observations suggest that the fluctuation of the frontal zone between the cold Labrador Current and the warmer North Atlantic Current may play a determining role in the distribution of squid not only because of temperature preference but also because of food availability.

e) <u>Abundance indices</u>

Various estimates and indices of *Illex* abundance in Subareas 3 and 4 for 1979 were considered and compared with the results of earlier studies. The estimates, summarized in Tables 2 and 3, were classified as (i) sequential abundance estimates, (ii) stratified random groundfish survey estimates, (iii) areal expansion of commercial fishery catch rates, and (iv) others.

Table 2. Summary of abundance estimates for *Illex illecebrosus* in Subareas 3 and 4 in 1979, based on research documents and other information considered by STACFIS.

Country	Area	Source	Time period	Population (10^6)	Biomass (tons)	Survey area	Comments
Canada	3N	SCR 80/II/35	Jun	193.3	21,410		Strat. random trawl survey
	3O	"	"	333.0	29,030		" " " "
	3Ps	"	"	44.2	3,600		" " " "
	3	"	Sep 1-15	6,548.0	1,763,370		Sequential abundance analysis
	4T	SCR 80/II/17	Sep		13,320		Strat. random trawl survey
	4VWX	"	Jul		70,300		" " " "
	4VWX	Unpubl. data	Sep 2		44,520		Sequential abundance analysis
	4VWX	SCR 80/II/37	Oct-Nov	135.0	45,000		Areal expansion, research survey
	4	SCR 80/II/32	Jul 8		62,000		Catch/effort *vs* cumulative catch
	4	"	Sep 2		132,000		" " " "
Cuba	4VW	SCR 80/II/7	Jul		85,570	1.7×10^6 ha	Areal expansion - Cuban fishery
		"	Aug		102,420	1.5×10^6 ha	" " " "
		"	Sep		96,840	2.4×10^6 ha	" " " "
France	3Ps	SCR 80/II/11	Oct 12-31	262.5	70,000		Strat. random trawl survey
Japan	4VWX	SCR 80/II/9	Sep		692,000	4,769 mi^2	Areal expansion - Japanese catch from Canadian allocation
Poland	4W	SCR 80/II/23[a]	Jul	564.6	107,030	17,050 km^2	Areal expansion - Polish fishery
Romania	4W	SCR 80/II/3	Aug	635.0	98,781	9,988 km^2	Areal expansion - Romanian fishery
USSR	3+4	SCR 80/II/36[a]	Aug		$1.5\text{-}3.0 \times 10^6$		Areal expansion, March research vessel survey

[a] Estimates revised by STACFIS from documented values.

Table 3. Relative biomass density estimates for *Illex illecebrosus* in Subareas 3 and 4, based on (A) stratified random trawl surveys, and (B) areal expansion of commercial fishery data.

			1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	
A.	3NOP	May-Jun	1.0	0.15	0	0.04	0.001	0.002	0.01	0.13	0.09	0.02	SCR 80/II/5
	3Ps	Oct	1.0		0.96								SCR 80/II/11
	4T	Sep	1.0	2.32	1.15	1.27	0.08	0	0.004	0.002	0.03	0	SCR 80/II/17
	4VWX	Jul	1.0	0.16	0.66	2.90	0.35	0.14	0.13	0.05	0.21	0.03	"
B.	4VW	Jul	1.0	0.29	1.78								SCR 80/II/7
		Aug	1.0	1.05	0.86								"
		Sep	1.0	0.92									"
	4VWX	Sep	1.0	0.36									SCR 80/II/9
	4W	Jul-Oct	1.0	0.83	1.34[a]								SCR 80/II/23

[a] Not adjusted for area.

i) Sequential abundance estimates

Sequential abundance estimates based on bi-weekly commercial catch reports were presented for Subareas 3 (SCR Doc. 80/II/35) and Subarea 4 (unpublished data). Such estimates rely on assumed natural mortality and end-of-season fishing mortality rates, as well as data chosen for the application of "terminal F", and the resulting estimates are sensitive to these parameters. The terminal F-value for the Subarea 3 estimate was obtained by maximizing the correlation between calculated bi-weekly fishing mortality rates and "fishing effort" obtained by dividing the bi-weekly catch by catch rates at Holyrood, Newfoundland. The Committee noted that a decline of 76% in the Holyrood catch rates from 1 July to 30 September did not correspond to the calculated 28% decline in population numbers during this period. It was concluded that the catch rates at Holyrood indicated a high local exploitation rate and did not measure the overall abundance of *Illex* in Subarea 3. Since no other index was available to calibrate the sequential abundance estimate, the Committee considered the estimate for Subarea 3 to be unreliable. The Committee was also unable to achieve a satisfactory calibration of the sequential abundance estimate for Subarea 4, because the catch-per-unit-effort series showed no decline over time when the rates were expressed in terms of numbers.

ii) Stratified random trawl survey estimates

Biomass estimates based on stratified random bottom trawl surveys were available for Div. 3NOP in June 1979 (SCR Doc. 80/II/36), Subdiv. 3Ps in October (SCR Doc. 80/II/11), Div. 4T in September (SCR Doc. 80/II/17), and Div. 4VWX in July (SCR Doc. 80/II/17). These estimates were considered to be underestimates due to systematic overestimation of catchability coefficients, but it was concluded that they can be used in year to year comparisons to indicate relative changes in *Illex* abundance.

The geographical distribution of research vessel catches on the Scotian Shelf in 1979 was unusual, with several large catches being made northeast of Sable Island. The disproportionate influence of small numbers of large catches in determining the mean catch per tow and the abundance estimates was noted. Diel effects were not allowed for in the calculation of the abundance estimates on the Scotian Shelf.

iii) Areal expansion of commercial fishery catch rates

Areal-expansion estimates of the squid biomass in the areas of commercial fishing were presented in SCR Doc. 80/II/3, 7, 9 and 23. It was noted that these estimates depend on the untested assumptions that squid density is uniform over large areas and that commercial fishing operations do not concentrate on local areas of high relative density. Any tendency of the commercial fleet to locate and exploit areas of high local abundance would cause the density to be overestimated. This overestimation is compensated in some degree by overestimation of the catchability coefficient and limiting the area for which the calculated densities are extrapolated. It was noted that detailed analysis of commercial catch, effort and location of capture data from logbook records could lead to estimates of the biases involved.

Systematic differences in catch rates were noted between Japanese vessels fishing from the Canadian allocation and those fishing from the Japanese allocation for squid, the factor being 2 in the case of catch per hour fished and 4 for catch per day fished. Because such large differences have a substantial impact on the analysis of commercial fishery data, the Committee

recommends

that commercial catch and effort statistics of national fleets, classified by tonnage class, gear type and NAFO division (and subdivision, where applicable), be reported in provisional and final form to the NAFO Secretariat, distinguishing statistics relating to catches from national quotas and those suballocated from the Canadian quota.

iv) Other estimates

Illex abundance estimates were also presented in SCR Doc. 80/II/32, 36, 37. A regression of catch rate on cumulative catch for the offshore fishery in Subarea 4 led to rough estimates of 60,000-130,000 tons for the area fished. Areal expansion and projection to August of USSR survey catches of larval and juvenile squid in March 1979 led to biomass estimates of 1.5-3.0 million tons for Subareas 3 and 4. The Committee noted that the assumed survival rate was arbitrary so that the absolute magnitude of the biomass in August was not reliably estimated. The potential value of such pre-season surveys in providing an index of abundance of young *Illex* was stressed, and the Committee emphasized the value of repeating such surveys and of refining the estimation technique. A research vessel survey in October-November 1979 led to a biomass estimate of 45,000 tons of *Illex* in a band along the edge of the Scotian Shelf.

The Committee, being fully aware of the sources of bias and uncertainty in the various abundance estimates, noted that (i) the reported preliminary catch of *Illex* in Subareas 3 and 4 was 153,000 tons, (ii) an estimate biomass of about 70,000 tons remained along the slope of St. Pierre Bank and 45,000 tons in a narrow band along the edge of the Scotian Shelf near the end of the fishing season, (iii) commercial catch rates in Subarea 4 remained high throughout the fishing season, and (iv) commercial catch rates and research vessel surveys indicated a greater abundance of *Illex* in Subareas 3 and 4 in 1979 than in 1978. Consequently, the Committee concluded that the biomass of *Illex* was quite high in Subareas 3 and 4 in 1979, probably between 500,000 and 3,000,000 tons in August (SCR Doc. 80/II/36).

The ratio of stratified random trawl survey abundance indices for 1979 in Subarea 3 (Div. 3NOPs in June) and in Subarea 4 (Div. 4VWX in July) was 54:70 (Table 2), approximately the same (5:7) as the estimated biomass ratio for these subareas in 1978 (*ICNAF Redbook* 1979, page 45). The Committee recognized that the relative proportions of the biomass in Subareas 3 and 4 may vary substantially from year to year due to oceanographic and other factors. The research vessel survey data indicate that the abundance of *Illex* was much greater during the 1975-79 period than during 1970-74 (Table 2), the ratio of averaged indices for these periods being 5:1 for Div. 3NOPs and 10:1 for Div. 4VWX.

f) Management regime

Due to high inshore abundance of *Illex*, the preliminary total catch of 153,000 tons in Subareas 3 and 4 exceeded the recommended 1979 TAC of 120,000 tons by 27%. The larger-than-expected catch does not appear to have increased the exploitation rate for *Illex* beyond the target level adopted by ICNAF's Standing Committee on Research and Statistics (*ICNAF Redbook* 1978, page 28) because abundance in 1979 was high. The 1979 TAC was divided into an inshore allowance of 35,000 tons and offshore allocations of 85,000 tons. The offshore fishery was controlled by licence limitation on the area fished and by enforcement of catch allocations, but the inshore fishery was not controlled. In view of the unexpected excess (by a factor of 2.4) of the inshore catch over the allowance, the Committee examined the consequences of not regulating the inshore fishery.

Although offshore surveys do not appear to provide a predictive index, there is the tendency for Newfoundland inshore catches to be high when trawl survey estimates in Div. 3NOPs are high (SCR Doc. 80/II/5). Similarly, abundance indices for Subareas 3 and 4 show roughly parallel trends. Thus, it is possible that inshore availability of large quantities of *Illex* occurs only in years of high abundance over much of Subareas 3 and 4. If this is so, fishing mortality in the inshore fishery, which is geographically restricted to a narrow band along the coast, would affect a limited proportion of the stock. Therefore, it appears that, in years of high squid abundance, the inshore fishery could exceed its allowance without leading to excessive exploitation of the stock. However, this conclusion remains speculative, and, until there is firm evidence to support this view, potential inshore catches should continue to be allowed for within an overall TAC.

The offshore fishery, however, takes place in areas where squid may be concentrated in years of low abundance. The offshore fleet is highly mobile and can locate the squid concentrations when abundance is low. Also, information from the offshore fishery in 1979 indicates that the catch rates of some vessles may vary by as much as a factor of 4 by changes in fishing tactics. The Committee considers that the use of some measure of fishing effort, such as "days on grounds", as the basis for regulation of the offshore squid fishery with no catch limitation could lead to unforeseen large changes in the catchability coefficients of the commercial fleets. For these and other reasons outlined in previous reports (*ICNAF Redbook* 1978, page 23, and *ICNAF Redbook* 1979, page 29), the Committee considers that controlled offshore catch allocations in conjunction with effort constraints, as currently practised, remain the most satisfactory means of preventing biological over-exploitation and a low spawning stock size.

The Committee had no new information that would justify changing previous advice on the opening date of the offshore squid fishery (currently 1 July) in Subareas 3 and 4.

g) Total allowable catch in 1980

Previous advice on appropriate catch levels in 1978 and 1979 was based on estimating stock abundance in the previous year and applying a target exploitation rate of 0.40, under the assumption that there would be no significant change in the biomass. This approach was adopted because it was not possible, due to its one-year life cycle, to forecast the abundance of *Illex* for the ensuing year. Although abundance estimates for larval and juvenile *Illex* were available for the first time from a winter-spring survey in 1979, there is still no reliable means of predicting the biomass in 1980. Furthermore, 1979 was a year of very high abundance, such that catches in the range of 200,000 to 1,200,000 tons might have corresponded to the exploitation rate of 0.40.

The possible consequences of applying various TACs to estimated stock biomasses in 1968-79 were examined. Using the 10-year series of biomass estimates of *Illex* from the Canada (M) bottom trawl surveys in Div. 4VWX (SCR Doc. 80/II/17) as relative abundance indices, *Illex* biomasses were calculated for Subareas 3 and 4 by assuming research vessel catchability to be 10% and equal abundance of squid in the two subareas (Table 4). TAC levels of 100,000, 150,000 and 200,000 tons are expressed as percentages of the calculated biomasses. These estimates are crude and are intended only to indicate in a general way what might have happened if a constant TAC had been in effect from 1968 onwards. Also, it must be emphasized that the catchability factor of 10% has not been experimentally measured and that it may differ substantially from the assumed value as well as varying from year to year. With these limitations, Table 4 shows that closure of the fishery would have been necessary in years of low abundance when a TAC of 100,000 tons exceeded the calculated biomass, whereas in years of high abundance a TAC of 200,000 tons represents a calculated exploitation rate less than half of the target value of 0.40 used in previous assessments. Thus, no single TAC is appropriate for all years, and the need for a means of forecasting squid abundance is underlined.

In evaluating the likely consequences of alternative TACs, it was assumed that offshore allocations would be taken unless the fishery was closed and that inshore catches would be proportionate to squid abundance. In 1976-79, inshore catches represented 27-57% of the total catches and averaged 45%. If this relative proportion continues and if a TAC of 150,000 tons were chosen, serious over-exploitation would not likely occur except in years of low abundance. The squid fishery would be expected to fail in these years under almost any circumstances, and it would be necessary for managers to detect and deal with situations of very low abundance. In years of exceptionally high abundance, catches would be less than those corresponding to the target exploitation rate (0.40), but this is also considered inevitable until some means of predicting squid abundance is developed. Although tentative, the above analysis indicates a range of situations that might arise in 1980. On the basis of relative abundance indices for the last 12 years, the Committee <u>advises</u> that a TAC of 150,000 tons would not be associated with a serious risk of excessive exploitation.

Table 4. Possible historical impact of various TAC levels on squid (*Illex*) in Subareas 3 and 4.

Year	Calculated biomass 3+4 (000 t)	% TAC is of calculated biomass		
		TAC 100,000 tons	TAC 150,000 tons	TAC 200,000 tons
1968	100[1]	100**	150**	200**
1969	22[1]	493**	680**	907**
1970	38	260**	390**	520**
1971	294	34	51*	68*
1972	64	157**	235**	313**
1973	178	56*	84*	112**
1974	190	53*	79*	105**
1975	496	20	30	40
1976	5,250	2	3	4
1977	1,010	10	15	20
1978	220	45	68*	91**
1979	1,406	7	11	15
No. of years when more than 50% of TAC would have been taken (*+**)		6	8	8
No. of years when more than 90% of TAC would have been taken (**)		4	4	7

[1] Estimated from overall ratio of Canadian and USA survey indices in 1970-77, excluding 1976.

h) Conclusions

Having considered the various biomass estimates and indices of abundance of *Illex* in Subareas 3 and 4 in 1979, the Committee observed that:

i) The biomass in 1979 was very large, greater than that of 1978.

ii) The biomass in 1979 was not precisely estimated but it was considered to be in the range of 500,000-3,000,000 tons.

iii) The estimated biomass in 1979 could not be used to project the stock size in 1980, due to the very short life cycle of *Illex*.

iv) Various approaches, using estimated relative values of successive annual generations were discussed to assess the possible biomass and the level of exploitation in 1980.

v) The catch associated with a target exploitation rate of 0.40 could be in the range of 100,000 to 200,000 tons, and a 1980 TAC of 150,000 tons would not be associated with a serious risk of excessive exploitation.

vi) If the squid biomass in 1980 is very high, as in 1979, the inshore allowance could be exceeded without causing excessive exploitation of the stock.

vii) If the biomass in 1980 is low, the offshore fishery will probably not be able to maintain high catch rates, and the limitation of offshore fishing effort by applying the 1978 catch rate to the 1980 TAC would ensure that fishing mortality would not increase greatly despite reduced abundance.

II. FUTURE RESEARCH REQUIREMENTS

1. Cod in Divisions 3M and 3NO

The Committee noted with concern that commercial catch rate data for recent years are not very well correlated with biomass estimates from cohort analysis. The value of research vessel surveys was stressed, and it was agreed that efforts should be intensified in that direction.

2. Capelin in Subareas 2 and 3

In view of the importance of acoustic techniques in detecting trends in capelin abundance, the Committee agreed that high priority should be placed on experiments to estimate the variance associated with the calibration parameters, especially target strength which is known to be highly variable. Also, attempts to calculate the variance associated with survey design should be started immediately.

3. Squid in Subareas 3 and 4

a) The Committee noted the progress being made in studies on the use of statoliths as indicators of age in *Illex* and urged that such studies be continued.

b) The Committee noted the success of recent inshore tagging experiments and suggested that future research be directed toward the development of offshore tagging techniques, as it was considered that offshore tagging would be significant in determining migratory patterns, stock discrimination and the estimation of population parameters.

c) The Committee noted the very significant progress in 1979 toward understanding the larval and juvenile distribution of *Illex* and the influence of environmental factors, and strongly urges the continuation and expansion of such studies, including increased emphasis on the determination of oceanographic processes and environmental factors which may influence growth, distribution and mortality of larvae and juvenile *Illex* prior to their appearance on the continental shelf.

d) The Committee agreed that increased emphasis should be placed on studies relating to the influence of environmental conditions on the distribution and abundance of *Illex* during their occurrence on the continental shelf.

III. ACKNOWLEDGEMENT

There being no further business, the Chairman expressed his thanks to all participants for their interest and cooperation during the course of the meeting, especially to the rapporteurs who summarized the results of the discussions on their assigned topics and to Dr F. Nagasaki who agreed on short notice to be Convener of the *ad hoc* Working Group on Squid, and to the Secretariat for their usual efficient work.

APPENDIX II. AGENDA

Special Meeting of Scientific Council - February 1980

1. Opening (Chairman: R. H. Letaconnoux)

   a) Rapporteur
   b) Adoption of agenda
   c) Plan of work

2. Consideration of Report of STACFIS (Chairman: G. H. Winters)

   a) Stock assessments
      i) Cod (3M, 3NO)
      ii) Capelin (2+3K, 3LNO)
      iii) Silver hake (4VWX)
      iv) Squid-*Illex* (SA 3 and 4)

   b) Future research requirements

   c) Other matters

3. *Ad hoc* Working Group on International Scientific Observer Scheme (Convener: J. S. Beckett)

4. Future Meetings

   a) Agenda and timetable for June 1980 Meeting of Scientific Council

5. Other Matters

6. Adjournment

NOTE: Item 3 was deferred for consideration at the June 1980 Meeting of the Council.

APPENDIX III. LIST OF PARTICIPANTS

Special Meeting of Scientific Council - February 1980

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APPENDIX IV. LIST OF DOCUMENTS

Special Meeting of Scientific Council - February 1980

RESEARCH DOCUMENTS

SCR Doc. No.	Serial No.	
80/II/1	N027	HURLEY, G. V., and P. BECK. The observation of growth rings in statoliths from the ommastrephid squid, *Illex illecebrosus*
80/II/2	N028	MAXIM, C. Population structure of *Illex illecebrosus* on the Scotian Shelf in the summer of 1979
80/II/3	N029	MAXIM, C. Stock assessment of *Illex illecebrosus* in Division 4W based on the area density method
80/II/4	N030	MAXIM, C. Capelin (*Mallotus villosus*) catch, effort, and biological characteristics in the Romanian fishery in Division 2J, September-October 1979
80/II/5	N031	HURLEY, G. V. An examination of criteria for the short-term forecasting of inshore abundance of squid (*Illex illecebrosus*) at Newfoundland
80/II/6	N032	HOYDAL, K. The Faroese longline fishery on the Flemish Cap cod in 1979
80/II/7	N034	MARI, A., and R. DOMINGUEZ. Biomass estimates of squid (*Illex illecebrosus*) in Divisions 4VW, 1979
80/II/8	N040	HATANAKA, H., and T. SATO. Outline of Japanese squid fishery in Subareas 3 and 4 in 1979
80/II/9	N041	NAGAI, R., and Y. UOZUMI. Estimation of the abundance index for *Illex* based on Japanese fishery operations along the edge of the Scotian Shelf, 1979
80/II/10	N042	VAZQUEZ, A., and M. G. LARRANETA. Assessment of the cod stock in Divisions 3NO
80/II/11	N043	DUPOUY, H., and J. C. POULARD. Biomass estimate and biological characteristics of the squid (*Illex illecebrosus*) on St. Pierre and Burgeo Banks (Subdivision 3Ps) in the autumn of 1979
80/II/12	N044	MINET, J. P., and H. DUPOUY. Catch, effort and biological characteristics of squid (*Illex illecebrosus*) in the French fishery in Subareas 3 and 4, 1979
80/II/13	N045	CARSCADDEN, J. E., and D. S. MILLER. Analytical and acoustic assessments of the capelin stock in Subarea 2 and Division 3K, 1979
80/II/14	N046	MILLER, D. S., and J. E. CARSCADDEN. An acoustic survey of capelin (*Mallotus villosus*) in Divisions 3LNO, 1979
80/II/15	N047	CARSCADDEN, J. E., and G. H. WINTERS. An alternate method of assessing the capelin stock in Divisions 2J+3K, using SCAM and catch-per-unit effort
80/II/16	N048	WINTERS, G. H., J. E. CARSCADDEN, and D. S. MILLER. An indirect method of estimating maturation rates of cohorts of capelin
80/II/17	N049	KOELLER, P. A. Distribution, biomass and length frequencies of squid (*Illex illecebrosus*) in Divisions 4TVWX from Canadian research vessel surveys: an update for 1979
80/II/18	N050	WALDRON, D. E., and A. SINCLAIR. Observations on the squid (*Illex illecebrosus*) and silver hake (*Merluccius bilinearis*) fisheries on the Scotian Shelf in 1979
80/II/19	N051	SCOTT, J. S. Winter distribution of juvenile silver hake from research cruises on the Scotian Shelf, 1966-1974
80/II/20	N052	HUNT, J. J. Age validation of silver hake, *Merluccius bilinearis*

80/II/21	N053	CLAY, D. Assessment of the silver hake (*Merluccius bilinearis*) stock in Divisions 4VWX, using provisional 1979 data
80/II/22	N054	LIPINSKI, M. A preliminary study of the age of squids from their statoliths
80/II/23	N055	LIPINSKI, M. Assessment of the squid (*Illex illecebrosus*) stock in Division 4W by area-density method
80/II/24	N056	GAVARIS, S. Assessment of the cod stock in Divisions 3NO
80/II/25	N057	GAVARIS, S. Assessment of the cod stock in Division 3M
80/II/26	N058	WELLS, R. Estimation of total mortality of cod on the Flemish Cap in 1978 and 1979 from Canadian research vessel survey data
80/II/27	N059	WELLS, R. Distribution and abundance of cod on the Flemish Cap, January 1980
80/II/28	N060	WELLS, R. Changes in the size and age composition of the cod stock in Division 3M during 1959-79
80/II/29	N061	WALLACE, I. C., R. K. O'DOR, and T. AMARATUNGA. Sequential observations on gross digestive processes of *Illex illecebrosus*
80/II/30	N062	AMARATUNGA, T. Growth and maturation patterns of the short-finned squid (*Illex illecebrosus*) on the Scotian Shelf
80/II/31	N063	AMARATUNGA, T. Preliminary estimates of predation by the short-finned squid (*Illex illecebrosus*) on the Scotian Shelf
80/II/32	N064	ROBERGE, M., and T. AMARATUNGA. A review of the *Illex* fishery in Subareas 3 and 4, with special reference to 1978 and 1979 data reported to Canada
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