Northwest Atlantic Fisheries Organization

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SPECIAL MEETING OF SCIENTIFIC COUNCIL - NOVEMBER 1980

Report of Scientific Council, Dartmouth, Canada 18-22 November 1980

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REPORT OF SCIENTIFIC COUNCIL

Special Meeting on Shrimp and Seals, November 1980

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

The Scientific Council met at NAFO Headquarters, Dartmouth, Canada, during 18-22 November 1980 to provide advice for 1981 on the conservation of the harp and hooded seal stocks in the Northwest Atlantic as requested by Canada and the shrimp stocks in Subareas 0 and 1 as requested by Canada and the European Economic Community (SCS Doc. 80/IX/32, page 5). In addition, at the request of ICES (International Council for the Exploration of the Sea) and agreed by the Executive Committee of the Scientific Council, a review of the status of the shrimp stocks and fishery at East Greenland was included in the agenda for this meeting (Appendix II). Representatives attended from Canada, European Economic Community (EEC), Faroe Islands, Iceland and Norway (Appendix III).

The stock assessments were undertaken by the Standing Committee on Fishery Science (STACFIS), whose report as approved by the Council, is given in Apprendix I. The list of research and summary documents reviewed is given in 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. Assessment of Seal Stocks

a) Harp seals

Provisional statistics indicate that the 1980 catch of harp seals in the "Gulf" and "Front" areas was 171,929 and that the catch at Greenland could amount to more than 10,000 and possibly as many as 12,000-13,000.

An independent review of the status and management of harp seals in the Northwest Atlantic, by J. R. Beddington and H. A. Williams (1980, US Dept. Commerce, Tech. Info. Serv. Doc. No. PB80-206105, 127 p.), was assessed. These authors used the detailed catch-at-age data derived by P. F. Lett and T. Benjaminsen (1977, J. Fish. Res. Bd. Canada, 34: 1155-1187) and data from a specific population model to form a cumulative χ^2. Parameters of the model are then manipulated until a minimum χ^2 value is obtained which corresponds to the best fit. This results in a high point estimate for natural mortality (M = 0.14) and indicates a substantial decline in the population since 1952 which has only been slowed by recent quotas. In examining their method, it was found that incorrect assumptions about selectivities of landsmen and large vessel hunts, inaccurate age determinations (especially of older animals), and inappropriate weighting of samples biased their results. Their derived vital rates were used to calculate 1952 replacement yields of the order of 10,000 animals, implying that, unless the mortality rate was less, the harp seal population must have been in continuous decline since 1800 from a level of tens of millions of seals. In view of the unlikeliness of this having occurred and for other reasons, the estimates of Beddington and Williams were considered to be unrealistic.

A value of M = 0.10 was adopted for the assessment, although it was recognized that values from 0.08 to 0.12 could not be ruled out by existing analyses. New estimates of pregnancy rates were tabled and adopted for calculation of yields and projections of catch and population size. Mark-recapture experiments in 1978-80 and an aerial survey in 1977 gave a mean estimate of pup production in 1977-80 of 410,000 with a nominal standard error of 46,000. Survival index calculations gave an estimated pup production of 342,000 in 1973 with 95% confidence limits of 267,000-625,000. These two estimates were considered to be equally reliable and were used to provide a best estimate of 375,000 for pup production in 1980. In the absence of a moulting sample of seals in 1980, the 1979 age composition was used to project catch and stock size to 1985 and to calculate replacement yields.

With M = 0.10 and 1980 pup production of 375,000, replacement yield was estimated to be 210,000 animals, with an age 1+ population of 1.57 million animals, and the sustainable yield was estimated to be 234,000 animals. This latter value is lower than would be expected in a population with a stable age distribution, due to the present large proportion of immature animals resulting from the reduced pup catches from 1972 onwards.

The population in 1985, with a continued annual catch of 180,000 (80% pups and 20% age 1+ animals) is projected to consist of 425,000 pups and 1.70 million age 1+ animals, representing an annual growth rate of 1.7%. An annual catch of 210,000 seals, with the same proportions of pups and adults, is projected to result in a stable population for the 5-year period. The projected increase of the harp seal population noted above should not be interpreted as a firm prediction because natural mortality rates from 0.08 to 0.12 and pup productions from 300,000 to

500,000 are possible. Although the available information best corresponds to an expanding population if the annual kill is 180,000 seals, the rate of expansion could be larger or smaller than the 1.7% given above.

b) Hooded seals

No new analyses of age and reproductive data were available, the most recent being those presented at the November 1978 Meeting (ICNAF Redbook 1979, pages 11-14). Consequently, there was no basis for revising the assessment of hooded seals made at that meeting, and the Council reiterates the previous advice that a kill of 15,000 hooded seals at the Front under the present management regime is likely to permit the population to increase. The Council also advises that the upper limit of 5% females in the kill be retained as a conservation measure for 1981.

2. Assessment of Shrimp in Subareas 0 and 1

The 1979 offshore shrimp fishery in Subareas 0 and 1 was regulated by an overall total allowable catch (TAC) of 29,500 tons, of which about 26,000 tons were taken. The same TAC was continued in 1980, and preliminary statistics for January-October indicate an offshore catch of about 30,000 tons. The major fishing areas were the northern parts of Store Hellefiske Bank (Div. 0A and 1B) with an extension of the fishery northward to Div. 1A. Available information on shrimp biology included depth relationships, diurnal variation and age interpretation.

All available information on biomass, trends in catch rates and composition of the stock were considered in advising on a TAC for 1981. It was noted that the decline in abundance, evident during 1976-78 from catch-per-unit-effort indices and biomass estimates, had levelled off with some increase indicated in 1980. However, there was uncertainty as to whether the increase indicated by the catch rates and by the photographic biomass estimates represented a real increase in stock abundance or resulted from changing fishing patterns or environmental conditions. The Council therefore advises that the overall TAC for the offshore grounds in Subarea 1 and adjacent parts of Subarea 0 in 1981 should remain at the same level as in 1980 (29,500 tons). In order to improve the basis for assessing the shrimp stocks, the Council endorsed the recommendations of STACFIS regarding future research requirements.

3. Assessment of Shrimp off East Greenland

The shrimp fishery off East Greenland began in 1978 and by 1980 vessels from Denmark, Faroe Islands, France, Greenland, Iceland and Norway fished in the area of Strede and Dohrn banks between Iceland and Greenland (around 66°N and 28-30°W). Catch rates were high in the early months of the year and declined sharply in June, indicating a shift in the concentrations due possibly to changes in hydrographic conditions. The available biological data indicate that the fishery in April-May exploits large berried females and that the shrimp are larger than those off West Greenland. Also, there are indications that as many as 25% of the females do not mature. By-catches occasionally consisted of large quantities of capelin, Atlantic cod, and Greenland halibut but generally comprised smaller amounts of redfish, wolffishes and some other species.

A single biomass estimate was presented but it was not considered reliable because of data limitations. Environmental factors and fishing patterns were discussed in relation to the variable catch rates, but no firm conclusions could be reached. Although it was not possible to provide an estimate of potential yield from this stock, a cautious approach to exploitation is suggested. The need for greatly expanded research activity was emphasized.

II. COLLABORATION WITH OTHER ORGANIZATIONS

1. ICES Request for Assessment of Shrimp at East Greenland

In a telegram to the Executive Secretary of NAFO on 20 October 1980, the General Secretary of ICES on behalf of its Advisory Committee on Fishery Management (ACFM) expressed the desire that assessment of the shrimp stocks at East Greenland be considered at the November 1980 Meeting of the Scientific Council when the shrimp stocks at West Greenland are assessed, since most of the scientists involved would be the same. Telephone contact with the majority of the members of the Executive Committee of the Scientific Council indicated general agreement with the proposal, and this was communicated to Scientific Council members on 23 October 1980 (NAFO Circ. Letter 80/75). Consequently, the report of STACFIS (Appendix I) contains a section entitled "Shrimp at East Greenland".

III. FUTURE SCIENTIFIC MEETINGS

1. Special Meeting for Assessment of Capelin and Cod

The Council confirmed that its next meeting would be held at NAFO Headquarters, Dartmouth, Canada,

during 17-21 February 1981 to review the status of and provide advice for management in 1981 of the capelin stocks in Div. 2+3K and 3LNO, and the cod stocks in Div. 3M and 3NO.

2. Regular Meeting in June 1981

The Council confirmed that its regular meeting will be held at NAFO Headquarters, Dartmouth, Canada, during 9-20 June 1981, preceded by a special session on "squid biology and distribution" during 3-6 June and a meeting of the *ad hoc* Working Group on the Flemish Cap Project on 8 June.

IV. OTHER MATTERS

1. Recommendations for Future Research

The Council noted that the Secretariat has compiled and circulated a list of research requirements recommended at its meetings held in February, June and September 1980, and urged scientists to take particular note of these, since many of them relate to requirements and/or commitments, on which reports are expected to be presented at forthcoming meetings of the Council in 1981.

2. Progress Report on Publication of the New Journal

The Assistant Executive Secretary informed the Council that the Secretariat, in collaboration with members of the Standing Committee on Publications (STACPUB), had completed the new cover design for the Journal of Northwest Atlantic Fishery Science and that Volume 1, containing 10 refereed papers, should be ready for distribution about mid-December.

V. APPROVAL OF REPORTS

1. Provisional Report of the September 1980 Meeting

The Council reviewed and formally approved without amendment the report of its meeting at St. John's, Newfoundland, Canada, during 3-8 September 1980.

2. Report of the November 1980 Meeting

The Council noted that its report of the present meeting is scheduled for inclusion in the first issue of "Scientific Council Reports" to be published in December 1980. The Council agreed to formally adopt the report, subject to minor editorial amendment, where necessary, by the rapporteur.

VI. ADJOURNMENT

The Chairman expressed his thanks to the Bedford Institute Administration for the use of conference rooms, to the NAFO Secretariat for their usual efficiency in preparing for and servicing this meeting, to the Chairman of STACFIS and the conveners and rapporteurs of working groups, and to all participants for their cooperation and contributions. The meeting adjourned at 1300 hours on 22 November 1980.

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

Special Meeting of Shrimp and Seals, November 1980

Chairman: G. H. Winters

At the request of the Scientific Council, STACFIS met during 18-22 November 1980 to review (a) the status of the harp and hooded seal stocks in the Northwest Atlantic at the request of Canada (SCS Doc. 80/IX/32, page 34) and (b) the shrimp stocks in Subareas 0 and 1 at the request of Canada and the European Economic Community (SCS Doc. 80/VI/25, pages 57-58). In addition, as requested by ICES on 20 October 1980 and agreed by the Executive Committee of the Scientific Council, the Committee reviewed the status of the shrimp stocks off East Greenland (Appendix II). Scientists attended from Canada, European Economic Community, Faroe Islands, Iceland, and Norway (Appendix III).

In considering the agenda of the Scientific Council, STACFIS agreed that the assessments of shrimp and seals be carried out in two working groups which would meet concurrently. Consequently, the *ad hoc* Working Group on Seals (convened by Dr A. W. Mansfield with Dr W. G. Doubleday as rapporteur) and the *ad hoc* Working Group on Shrimp (convened by Mr P. Kanneworff with Mr D. G. Parsons and Mr K. Hoydal as rapporteurs) were held during 18-21 November 1980, and their reports as approved by STACFIS are given in Sections I, II and III below.

I. HARP AND HOODED SEALS

1. Harp Seals (SCS Doc. 80/VI/4, 80/XI/33; SCR Doc. 80/XI/160, 161, 162, 168, 171)

a) Review of fishery

Canadian and Norwegian seal catches in the "Gulf" and "Front" areas in 1979 and 1980 were reported in SCS Doc. 80/VI/4 and 80/XI/33 respectively, the latter indicating a provisional catch of 171,929 harp seals during the 1980 season. The incomplete breakdown of catches by age-group was noted in the provisional 1980 statistics for Canada (Quebec), and the Secretariat was requested to obtain the appropriate figures for inclusion in SCS Doc. 80/XI/33 prior to its post-meeting distribution. No recent information on harp seal catches in the Canadian arctic and at West Greenland were included in the reports, but Denmark provided figures for Greenland catches in 1977-79 which, although incomplete, suggested that the 1980 catch at West Greenland would amount to more than 10,000 and possibly as many as 12,000-13,000 animals.

The age structure of harp seal catches in 1952-80 was retabulated (SCR Doc. 80/XI/168) because errors had been found in the data reported by Lett and Benjaminsen (1977, J. Fish. Res. Bd. Canada, 34: 1155-1187). The original data sources were used for this retabulation which provides the best estimates so far of catches at age. However, data on Canadian arctic catches are poor.

b) Research in 1980

Canada reported on estimates of harp seal production from mark-recapture experiments in the Gulf and Front areas (SCR Doc. 80/XI/162), on inconsistencies in ageing from teeth and a means of reducing the resulting biases in estimates of population parameters (SCR Doc. 80/XI/160), on the utilization of a simulation model to locate the set of possible combinations of population size in 1979 and natural mortality rates (SCR Doc. 80/XI/161), and on the development by the Committee on Seals and Sealing (COSS) of a handgun for killing seal pups. Denmark presented revised catch statistics and age compositions for 1977-79 at West Greenland, and reported on recoveries of tagged harp seals in Greenland during 1979 and 1980 (SCR Doc. 80/XI/171). Norway presented age composition data for harp seals at the Front in 1977-78.

c) Population assessment

i) Natural mortality

The following estimates of the instantaneous natural mortality coefficient (M) for Northwest Atlantic harp seals were considered:

Estimate	Source
0.106	Benjaminsen and Øritsland (unpublished data originally presented in 1976)
0.114	Lett and Benjaminsen (1977, J. Fish. Res. Bd. Canada, 34: 1155-1187)
0.100	Lett, Gray and Mohn (ICNAF Res. Doc. 77/XI/68)

0.098 Winters (1978, J. Fish. Res. Bd. Canada, 35: 1249-1261)

0.138, 0.143 Beddington and Williams (1980, US Dept. Commerce, Nat. Tech. Inf. Serv., Doc. No. PB80-206105, 127 p.)

0.095 Roff and Bowen (calculated from NAFO SCR Doc. 80/XI/161, using estimates of 400,000 and 370,000 for pup production in 1967 and 1979 respectively)

The report by Beddington and Williams (see above) entitled "The status and management of the harp seal in the Northwest Atlantic: a review and evaluation" was discussed. Their model assumes that selectivities of both the landsmen and large vessel hunts have remained constant over time. This assumption is important because observed and calculated catches are compared. In the case of the large vessel hunt, the progressive shortening of the hunting season during the early 1960's and the cessation of killing whelping females in 1967 produced significant changes in catch compositions, and hence selectivities, with reduced representation of mature (older) seals, particularly females. The expansion of the longliner component of the landsmen hunt during the late 1960's and early 1970's has undoubtedly changed the selectivity pattern of the landsmen hunt, because these vessels catch mainly bedlamers as opposed to the net catches of mainly adults. The test of Beddington and Williams for constant selectivities is not convincing because they were generated by the same model that tested them.

Information presented at this meeting (SCR Doc. 80/XI/160) indicates that age-reading consistency declines with the age of the tooth read. Estimated probabilities of correctly reading the age of a tooth by the methods employed for the age samples used in the paper by Beddington and Williams decline from about 50% at age 10 to about 10% at age 25. Therefore, the estimated age compositions of catches of animals older than age 12 bear little relation to the actual age compositions and are little better than "random numbers". The effective weighting applied by Beddington and Williams in their χ^2 analysis increases with age. The χ^2 estimate chosen is also statistically inefficient because samples of different sizes in different years are weighted in relation to catches and not sample sizes and because older ages have larger relative sampling errors (in addition to the ageing variation noted above) than younger ages. Inappropriate weighting of samples of components of the landsmen catches has also biased the catch-at-age data.

The high and declining pup natural mortality rates of the 1950's and 1960's lead by themselves to high estimates of adult natural mortality. Taken together, the vital rates for the 1952 population estimated from the two sets of catches lead to a paradox. The calculated replacement yields for 1952 are of the order of only 10,000 pups. This means that, unless mortality rates were lower or unless a higher proportion of age 1+ animals bore pups before 1952, the harp seal population must have been in a continuous decline since 1800 from a level of tens of millions of seals. For example, the age 1+ stock in 1946 would consist of at least 1 million more animals than the age 1+ stock in 1952. The high natural mortality rates imply that the 1952 population, even if not hunted, was almost stable. In view of the observed changes in vital rates from 1950 to 1980, the implications of the vital rate estimates of Beddington and Williams for the pre-1950 period (i.e. an unexploited population an order of magnitude greater than the 1952 population, but with the same vital rates) are such that they must be considered unrealistic. For these reasons, the estimates of Beddington and Williams were discarded.

Considering the remaining 5 estimates and their dependence on essentially the same data set, a value of M = 0.10 was adopted for further calculations, recognizing that values of M from 0.08 to 0.12 could not be ruled out by existing analyses, in view of the tendency for the methods and data used for some of these estimates to lead to underestimation of M (SCR Doc. 80/XI/160).

ii) Pregnancy

In SCR Doc. 80/XI/161, estimates of maturity and fertility were combined to give the percentage of females at age that reached late-term pregnancy. These estimates were considered more representative than those used at the November 1979 Meeting of the Council, because they incorporated information for ages 7+ females from 1965 onwards and because the maturity rate of age 4 females in the 1979 sample was anomalously high, and they were therefore adopted for calculations of yields and projections of catch and population size. The values used are as follows:

Age	1-3	4	5	6	7+
% late-term pregnancy	0	4.6	53.3	87	87

iii) Pup production

Seven estimates of pup production from mark-recapture experiments and one based on an aerial census in 1977 were presented in SCR Doc. 80/XI/162. Taken together, these gave a mean estimate of pup production for the 1977-80 period of 410,000 with a nominal standard error of 46,000. Survival index calculations reviewed at the November 1979 Meeting of the Council indicated an estimated pup production of 342,000 for 1973 with nominal 95% confidence limits of 267,000 and 625,000. Calculations, based on the data in SCR Doc. 80/XI/161, assuming M = 0.10 and 400,000 pups produced in 1967, led to an estimate of 335,000 for 1979 pup production.

The third estimate was considered less reliable than the others because of the 12-year projection with an assumed natural mortality rate. The remaining two estimates were considered about equally reliable. Allowing for calculated trends in pup production in the 1970's and giving these estimates equal weight, 375,000 was considered to be the best available point estimate of pup production in 1980. Although rigorous confidence limits could not be calculated, pup production in 1980 was considered to be between 300,00 and 500,000.

iv) Stock size and relationships

The 1979 stock size was calculated by adjusting proportionally the 1979 age composition (SCR Doc. 79/XI/12), because no moulting sample was taken in 1980. The estimated 1979 age composition was then projected to 1980, giving the following age composition of the population ('000 animals):

Age	0	1	2	3	4	5	6+
Number	375	214	219[1]	134	107	99	797

[1] This value was considered anomalous due to sampling error in the 1979 sample of moulting seals, and does not affect the projections of stock size and yield.

This age composition was used to project catches and stock size to 1985 and to calculate replacement yields.

Tag recaptures in 1980 qualitatively confirmed earlier observations that immature seals born in the Gulf and at the Front mixed to a considerable degree.

v) Yields

Replacement yields for 1981, calculated from the agreed estimates of natural mortality and 1980 pup productions and from alternative values, are as follows:

M	1980 pup production	1980 age 1+ population	1981 replacement yield
0.10	375,000	1.57×10^6	210,000
0.10	321,000[1]	1.35×10^6	180,000
0.12[1]	375,000	1.57×10^6	180,000

[1] These values were chosen to give a replacement yeild of 180,000 animals in 1981.

The sustainable yield, associated with the 1980 pup production estimate of 375,000 and the vital rates described in the above sections, was estimated, using the formula given in SCR Doc. 79/XI/12, to be 234,000 animals. The vital rates used correspond to a mean age of first maturity of 5.3 years and a fertility rate of 0.87. Age specific hunting mortality rates, estimated in SCR Doc. 79/XI/12, were used in the calculations. Because the 1980 population contains more immature animals than would be present in a population with a stable age distribution, this estimate of sustainable yield is less than the sustainable yield associated with the 1980 population and greater than the replacement.

vi) Population projections

Population abundance projected to 1985, assuming an annual harvest of 180,000 seals dis-

tributed over age-groups according to the estimated hunting mortality rates for 1979, indicated a pup production of 425,000 and 1.70 million age 1+ animals. This represents an annual growth rate of 1.7% for the age 1+ population from 1980 to 1985. With an annual catch of 210,000 animals distributed over ages in the same proportions, the population is projected to be approximately stable from 1980 to 1985. Catches less than 180,000 seals lead to projected growth of the age 1+ population at a higher rate then 1.7% per year.

Although point estimates of 0.10 for natural mortality (M) and 375,000 for the 1980 pup production were adopted for yield calculations and projections, available information indicates that natural mortality rates from 0.08 to 0.12 and 1980 pup productions from 300,000 to 500,000 are possible. Therefore, the projected increase of the harp seal population should not be interpreted as a firm prediction. If all other parameters are held constant and the natural mortality is set at 0.12 or the pup production is set at 300,000 no increase in the population is projected from 1980 to 1985. The available information best corresponds to an expanding harp seal population if the annual kill is 180,000 animals, but the rate of expansion could be larger or smaller than the 1.7% annual rate indicated above.

d) Future research

In order to improve the basis for assessment of the harp seal stocks, STACFIS

recommends

i) that further samples of moulting harp seals be taken at the Front;

ii) that further samples of migrating harp seals be taken in the Gulf of St. Lawrence in January and February for studies on age, reproduction, feeding and energetics;

iii) that observations on mother-pup interactions and other behavior be carried out in the Strait of Belle Isle;

iv) that Norway carry out a series of blind replicate tests on the sample of teeth discussed in SCR Doc. 80/XI/160 and also on a similar-sized or larger sample of teeth from Norwegian collections at the Front; and

v) that catch statistics be improved, particularly those for the Arctic and the Gulf of St. Lawrence.

STACFIS also noted the intention of the Canadian Committee on Seals and Sealing (COSS) to continue development and testing of a suitable handgun for killing seals and to initiate a study of the behavior of seals entrapped in nets.

2. Hooded Seals (SCS Doc. 80/VI/4, 80/XI/33; SCR Doc. 80/XI/158, 170)

a) Review of fishery

Canadian and Norwegian catches at the Front in 1979 and 1980 were reported in SCS Doc. 80/VI/4 and 80/XI/33, with a provisional catch of 15,125 hooded seals indicated for 1980. Denmark provided provisional catch statistics for West Greenland in 1977-79 and Norway provided revised statistics for the North Atlantic in 1945-79.

b) Research in 1980

Denmark reported on age at sexual maturity and reproductive performance of female seals from southern Greenland in 1970-71 (SCR Doc. 80/XI/158) and provided a review of all available information on age composition and feeding of hooded seals at Greenland for 1970-78 (SCR Doc. 80/XI/170). Norway made reference to a study by N. O. Jacobsen on pup production, age at first pupping, and natural mortality of hooded seals in the West Ice (Jan Mayen area of the Greenland Sea).

c) Population assessment

Because no new analyses were available, there was no basis for revising the assessment made at the November 1978 Meeting (ICNAF Redbook 1979, pages 11-14). STACFIS, therefore, reiterates the previous advice that a kill of 15,000 hooded seals at the Front under the present management regime is likely to permit the population to increase. It was noted that, again in 1980, less than 5% of the total kill consisted of adult females. STACFIS advises that the upper limit of 5% adult females in the total kill at the Front should be retained as a conservation measure in 1981.

d) Future research

In order to improve the basis for assessment of the hooded seal stocks, STACFIS

recommends

i) that all available unworked data on age composition, maturity and fecundity be analyzed and reported as soon as possible; **and**

ii) that detailed catch and effort data continue to be collected from all large vessels operating in the Front area.

II. SHRIMP IN SUBAREAS 0 AND 1

1. Fishery Trends

The nominal catch of shrimp in Subareas 0 and 1 (Table 1) increased from less than 10,000 tons prior to 1973 to 50,000 tons in 1976 and declined to 33,000 tons in 1979. The offshore shrimp fishery has been regulated by total allowable catch (TAC) since 1977. In 1977 and 1978, offshore catches in Subareas 0 and 1 were about 34,000 and 27,000 tons against TACs of 36,000 and 40,000 tons respectively. In 1979 the offshore fishery was regulated by a TAC of 29,500 tons of which about 26,000 tons were taken. Preliminary statistics for January to October 1980 indicate a total catch of about 30,000 tons from Subarea 0 and the offshore grounds in Subarea 1, with the TAC being 29,500 tons. The inshore fishery has remained relatively stable around 7,000-8,000 tons except in 1974 when 10,000 tons were taken.

Table 1. Nominal catches and total allowable catchs (metric tons) of shrimp (Pandalus borealis) in Subareas 0 and 1[1].

Area	Country	1972	1973	1974	1975	1976	1977	1978	1979	1980[2]
SA 0	CAN	-	-	-	-	-	-	-	-	175[3]
	FAROES	-	-	-	-	-	239	-	-	-
	DEN-G	-	-	-	-	-	-	-	149	1157
	DEN-M	-	-	-	-	-	68	86	67	-
	FRA-M	-	-	-	-	-	-	21	7	122
	NOR	-	-	-	-	65	150	15	738	-
	SPA	-	-	-	-	327	-	-	-	-
	TOTAL	-	-	-	-	392	457	122	961	1454
SA 1	CAN	-	-	-	-	-	-	-	245	2079[3]
	FAROES	755	1371	2023	5300	11179	12612	8070	6982	2000
	DEN-G(a)[4]	7342	7950	10064	8700	7300	7800	7600	7500	7500
	(b)	150	185	180	1089	2478	7081	5531	12527	21313
	DEN-M	-	196	308	1142	2717	5842	3382	1062	871
	FRA-M	-	-	-	-	803	924	805	352	126
	FRG	-	-	-	-	-	31	-	-	-
	JAP	-	-	-	-	146	-	-	-	-
	NOR	1409	2940	5917	8678	11658	7353	8959	4251	2494
	SPA	-	-	-	6948	6925	-	-	-	-
	USSR	-	-	3517	6033	6468	-	-	-	-
	TOTAL	9656	12642	22009	37890	49674	41643	34347	32919	36383
	OFFSHORE	2314	4692	11945	29190	42374	33843	26747	25419	28883
	TAC (0+1 offshore)						36000	40000	29500	29500

[1] Statistics for 1972-1978 pertain to ICNAF Statistical Area 0 and Subarea 1, and for 1979 and 1980 to the new NAFO Subareas 0 and 1.
[2] Preliminary to the end of October.
[3] Canadian data for 1979 include catches from cooperative arrangements with other countries.
[4] a = inshore, b = offshore catches.

2. Distribution (SCR Doc. 80/XI/159, 163, 165, 167, 169, 174, 175)

No research trawl surveys for shrimp were conducted in Subareas 0 and 1 in 1980, but the photographic survey in Subarea 1 was continued. Information from the fishing fleets of Greenland, Norway, France

and Canada indicated a concentration of fishing effort in the northern part of Div. 1B, in the eastern part of Div. 0A and in Div. 1A to 71°N. Fishing effort in Div. 0A and western Div. 1B was limited in the earlier months of the year, presumably due to ice conditions. The data from Greenland trawlers indicated a preference for fishing north of 68°N in 1980, in contrast to 1979 when effort was concentrated just south of this latitude. A relatively small area in Div. 1A northward of Disko Island, previously unexploited, produced catch rates which compare favorably with those for the more traditional fishing areas south of 68°N. Vessels other than those from Greenland were restricted to fishing in areas south of 68°N.

Data from the commercial fishery and the photographic survey confirm observations of previous years that the depths of maximum concentration of shrimp range from 200 to 400 m. No new information was available on hydrographic conditions. Recruitment patterns again remain uncertain but bottom photographs taken in 1980 indicated concentrations of small shrimp (< 18-20 mm carapace length) in Div. 1A and the northern part of Div. 1B. Shrimp of these sizes were especially numerous in the area between 68°N and 69°30'N.

The proportion of offshore shrimp grounds within the Greenland 12-mile limit was discussed (SCR Doc. 80/XI/175), and it was roughly estimated that about 19% of the Greenland offshore catch in Div. 1A and 1B in 1980 was taken inside the 12-mile limit.

3. Biology (SCR Doc. 80/XI/159, 167, 169)

New information on the biology of shrimp include depth relationships, diurnal variation and age interpretation. A breakdown of length frequencies by depths greater and less than 300 m indicate that ovigerous females occur more frequently at shallower depths. Data from the photographic surveys indicated that the highest biomass of shrimp in all areas is found around 300 m. Additional information on diel variability from the fishing activity of a French commercial vessel during July-September gave conversion factors at 4-hour intervals which compare favorably with those reported in previous studies (ICNAF Sel. Papers No. 4: 45-46). Analysis of length composition data from French catches by the Cassie method (1954, Austr. J. Mar. Freshw. Res., 5: 513-522) indicated at least 5 age-groups. The modes evident in this analysis were also apparent in the Canadian commercial data.

Although no new information was available on natural mortality of shrimp, there was a general consensus that the estimates for female shrimp used in assessing the stock were perhaps too high. Data from the 1979 surveys indicated that the spawning period extended into October, which is later than previously observed for shrimp in inshore areas. The Canadian data for 1980 showed signs of spawning in September, and the likely extension of spawning into October would tend to support the earlier observation.

4. Catch and Effort (SCR Doc. 80/XI/159, 163, 167, 174)

Mean monthly catches, based on logbook records (haul-by-haul) of French, Greenland and Norwegian vessels and on observers' reports from Canadian vessels, typically declined from a peak in March-April to a level in July to September 1980, which was higher than that observed for 1979. Observations from the French and Canadian data in Div. 0A and 1B indicated the same distribution of effort in 1980 as earlier. However, the Greenland data, based on reports from vessels of the Royal Greenland Trade Department which were not restricted from fishing north of 68°N latitude, indicated a shift in fishing activity farther northward than in previous years. This shift not only relates to areas just north of 68°N but extends as far north as 71°N.

Catch-per-unit-effort data for the months of July to September have been used in recent years to reflect stock abundance. Such catch rates declined from 1976 to 1978 but appeared to level off in 1979. All sources of information for these months in 1980 indicate an increase in catch-per-unit-effort of 20-30%. Some of this increase may be in part due to the utilization of trawls with greater vertical opening than used previously and in part to the northward shift of the Greenland trawler fishery. Although the pattern of fishing by Greenland trawlers gives some indication of a northward displacement of the stock in recent years, this is not reflected in the catch rates listed in Table 2. It was suggested that an in-depth analysis of all available data should be undertaken both in terms of the fishery, including interviews with fishing masters, and environmental factors.

Table 2. Fishing effort and catch rates of Greenland trawlers for the areas north and south of 68°N, 1976-80.

Area	Parameter	1976	1977	1978	1979	1980
68°-68°50'N	Effort (hours)	-	47	1464	131	1340
	Catch/hr (kg)	-	549	525	302	457
67°-68°N	Effort (hours)	916	2908	1971	3652	1962
	Catch/hr (kg)	775	555	478	396	496

5. Biomass Estimates (SCR Doc. 80/XI/169)

The only biomass estimate for 1980 was that obtained from the photographic survey. The application of a new mathematical model to the photographic survey data gave biomass estimates for 1977 to 1980 which, except for the possibility of a slight overestimate in 1980 due to a concentration of sampling in northern areas around 69°N, compare favorably with the trend in catch rates, the variance associated with the photographic survey data remains quite high. However, the trend in biomass estimates obtained by this method is supported by the results of trawl surveys in previous years. The method produces a 1980 biomass estimate of 177,000 tons, which can be considered the total biomass for the area between 66°N and 69°30'N latitude. Estimates of biomass from trawl surveys represent mean trawlable biomass.

A decrease in the mean size of shrimp was observed from 1977 to 1979 at a check station sampled in all years in the central area south of 68°N, but a small increase in size was noted at this station in 1980. As in previous years, greater proportions of small shrimp were found at some stations in the area northwest of Store Hellefiske Bank than at other stations.

6. Total Allowable Catch

At the November 1976 Meeting of the *ad hoc* Working Group on Shrimp in Subarea 1 (ICNAF Redbook 1977, page 15), in order to estimate the stock size of shrimp and how much of it should be harvested, natural mortality after first spawning (hatching) was assumed to be 1.5 and the time between recruitment to the fishery and first spawning was assumed to be 1.5 years. Under these assumptions, a fishing mortality of 0.40 would lead to a 50% reduction in the spawning stock biomass over several years if the level of fishing remains stable. Catch-per-unit-effort indices, based on weighted catch rates of a comparable group of Greenland trawlers for the July-September period of 1976-80, indicate a reduction of around 50% in the spawning stock biomass from the high (virgin) level of 1975-76:

Year	1976	1977	1978	1979	1980
Relative CPUE	1.00	0.73	0.67	0.50	0.64

In advising on the total allowable catch for 1981, information from both the photographic survey and catch-per-unit-effort data were considered. It was noted that the decline in abundance, evident from 1976 to 1978, had levelled off and some increase was indicated for 1980. However, there was some uncertainty whether the increase in abundance indices reflected in the catch-per-unit-effort data and the photographic survey in 1980 indicated a real increase in stock abundance. Considering this uncertainty and the rather limited information available, STACFIS advises that the overall TAC for the offshore grounds in Subarea 1 and adjacent parts of Subarea 0 in 1981 could remain at the same level as in 1980 (29,500 tons).

The portion of the shrimp stock in the area between 68°N and 69°30'N has been identified as likely having interrelationships with the inshore stock in the Disko Bay area. Consequently, it was generally agreed that the conservative practice of allowing only a small portion of the overall TAC for the offshore area to be taken in this area (68°-69°30'N) should be continued.

7. Discarding of Shrimp (SCR Doc. 80/XI/159, 163, 165)

The available data indicated variable patterns of discarding in the shrimp fishery of Subareas 0 and 1. Two levels of discarding shrimp were observed in the French fishery, first by the sorting machine and later by hand, both accounting for approximately 8% of the total shrimp catch. Discarding in the Norwegian fishery was estimated at 2.7%, the lowest level following a general decline in recent years. Canadian observers reported that discards exceeded 30% in some instances, the higher rates being mainly associated with the processing of the whole, cooked product. A general lack of information on discards was evident from the commercial logbook data, and it was agreed that the observer program should be intensified to more closely monitor this problem.

8. By-catches in the Shrimp Fishery (SCR Doc. 80/XI/159, 163, 165, 174)

The major by-catch in the shrimp fishery continues to be redfish (*Sebastes marinus*). Lesser quantities of other species occurred as well, including Greenland halibut, Atlantic halibut, wolffishes, Greenland shark and Atlantic cod. France reported no significant by-catches. Norway and Greenland indicated a decrease in by-catches, due mainly to a reduction in redfish catches. Canadian observers reported that redfish occurred as by-catch in varying proportions (2-33%) of the total catch. It was noted that most by-catches are discarded and that records of these are seldom kept.

9. Future Research

A number of essential requirements were identified in relation to improving the assessment of the shrimp stocks in Subareas 0 and 1. Considering the status of current assessment techniques for shrimp, the results of trawl surveys remain an important part of the data base. It was noted that the discarding of shrimp, if substantial and not reported, could have implications for the stock. Consequently, the importance of recording complete and accurate information on catches and discards in logbooks was emphasized. The need for reliable criteria for ageing shrimp was also stressed. STACFIS therefore

recommends

i) that stratified-trawl and photographic surveys should be conducted annually to establish a time series of abundance indices independent of those based on commercial catch rates;

ii) that the observer program should be continued with emphasis on monitoring the quantities and sizes of shrimp caught and discarded;

iii) that the logbooks presently used in the fishery be completed accurately and that appropriate steps be taken to ensure that the data are collected from all participants in the fishery; and

iv) that an ageing workshop on shrimp be held, with Mr J. Fréchette as convener (possibly in Quebec, Canada, during early May 1981), to conduct an in-depth analysis of shrimp samples with a view to developing criteria for the ageing of shrimp.

III. SHRIMP AT EAST GREENLAND

1. Description of Fishing Area (SCR Doc. 80/XI/164, 172, 173)

According to Icelandic data, shrimp were found in 1978 and the first half of 1979 on the part of Dohrn Bank which is inside the Icelandic fisheries management zone. In the second half of 1979 and in 1980, shrimp were found on Strede Bank to the north of Dohrn Bank. Data from the Faroese and French fisheries and the Greenland exploratory fishery in 1980 on the western side of the 200-mile limit indicate the following: in April-June, the fishery took place in an area transected by 66°N latitude and 30°W longitude; in July-August, shrimp had virtually disappeared from this area; in September-October, commercial concentrations were again found but the center of distribution had now shifted northward to an area transected by 66°45'N and 28°30'W; no data were available for the November-March period. The western part of the fishing area is bordered by deeps with soft muddy bottom, no fishable grounds being present, and, to the southeast, the area is bordered by the deep between the East Greenland and the Icelandic plateaus. No definite topographical barrier has been detected towards the north but the actual area of fishing is determined by the extent of ice cover. Hydrographic variation, especially the pulsations of polar water from the north, would be expected to influence the distribution of shrimp.

Exploratory trawling by Greenland and Danish vessels between 63°N and the main fishing area and to the west of this area in April, May, August and October indicated that shrimp were present all over the area but in very low concentrations (catch rates close to zero). Data from Icelandic research trawling during the past 15 years confirmed these observations.

2. Fishery

The fishery for shrimp, which was started in 1978 by an Icelandic vessel on the Icelandic side of the fishery limit between Greenland and Iceland, has continued since then. There was some Norwegian trawling in 1979, and a fishery on a large scale began on the Greenland side of the limit in 1980, especially by Norwegian and Faroese trawlers during March-July. Faroese fishing was stopped in July but vessels were allowed to enter the area again in October. Commercial fishing by Danish vessels and exploratory fishing by Greenland vessels occurred during the April-October period. Catches (metric tons) by country for the East Greenland area in 1978-80 were as follows:

Year	Denmark	Faroes	France	Greenland	Iceland	Norway	Total
1978	-	-	-	-	363	-	363
1979	-	-	-	-	485	±800	±1,285
1980[1]	667	4,036	53	186	500	2,278	7,720

[1] Preliminary data to end of October.

3. Catch-per-unit-effort

Catch rates for the main fishery area on the Greenland side of the 200-mile limit show the same trend in the different fleets, being high in March-April and declining during May and June. In 1980, about 85% of the total catch reported up to October was taken in the early part of the year. Catch rates (kg/hour) reported by month for 1980 are as follows:

Month	Denmark & Greenland	Faroe Islands	France	Iceland	Norway
March	-	1015	-	-	900
April	734	641	-	-	691
May	401	373	-	-	378
June	117	195	-	108	101
July	-	-	69[1]	84	-
August	19	-	-	109	227[1]
September	212	-	-	125	114
October	125	-	-	99	-

[1] Based on low catch figures.

4. Biology

Little is known about the general biology and life history of shrimp on the East Greenland Plateau. Samples have been taken in the Icelandic fishery since 1978 but these do not cover the main area of fishing. Samples taken on the Greenland side of the fishing limit in 1980 were reported by Greenland, Faroe Islands and France. All of these sampling data give a somewhat variable picture.

The Icelandic samples, which cover mainly the autumn season, show a much lower percentage of females than samples taken in April-May, and the same is seen in the French samples taken in July. There are indications from the Icelandic data that as many as 25% of the females do not mature. Nearly all females maturing have spawned by August. The 50% point of sexual reversal is 28.5 mm (carapace length) compared to 23 mm in shrimp on the Icelandic Plateau. This clearly indicates a difference in maturity of shrimp on the East Greenland and Icelandic plateaus. The main fishery in April-May clearly exploits berried females of very large size.

The Faroese and Greenland samples show differences in modes of length distributions of females and males + transitionals of about 5 mm between the East Greenland samples and comparable data for West Greenland. Some females (about 7-8%) still carried eggs in June. Very little is known about the horizontal and vertical distributions of shrimp at East Greenland, and no explanation could be offered for the very low catches of shrimp in the main area during July-August. It is possible that the low water temperature found in the area delays the metabolic processes responsible for sexual development, thus resulting in shrimp growing to a large size before changing sex.

5. Biomass Estimates (SCR Doc. 80/XI/172)

One biomass estimate (23,000 tons) for the western side of the fishing limit was presented. This estimate was based on a part of the catch-rate data for the Faroese fleet for only a 4-month period. After considerable discussion, it was agreed that this estimate could not be considered representative of the true stock size at East Greenland.

6. Total Allowable Catch

It was not possible to give any firm assessment of the factors which caused the very low catch rates during the summer, but fishing patterns and environmental factors were mentioned during the discussion. Consequently, it was not possible to provide any indication of what quantity could be removed from this stock. Considering the very limited information available and the uncertainty about the size of this stock, it was agreed that a cautious approach should be taken in allowing exploitation of this resource.

7. By-catches

Information on by-catches was available from the French, Greenland, Danish and Icelandic fishery, based on logbooks and observer reports. The by-catches included small quantities of redfish, cod, wolffishes, and some other species (e.g. blue whiting). Capelin in large quantities were occasionally caught, and cod and Greenland halibut were sometimes dominant. The length distribution of redfish, which was the dominant by-catch species in the Icelandic fishery, showed a length range of 10-24 cm. Some relative shrimp catches and by-catches (tons) in 1980 were as follows:

Month	Greenland and Denmark				France		
	Shrimp catch	By-catch			Shrimp catch	By-catch	
		redfish	capelin	mixed		redfish	cod
Apr	24	0.8	-	-	-	-	-
May	498	3.3	2.7	0.6	-	-	-
June	9	-	-	-	-	-	-
July	-	-	-	-	2.8	0.2	0.3
Aug	1	1.1	2.0	-	-	-	-
Sep	54	0.2	-	-	-	-	-
Oct	25	0.4	-	-	-	-	-

8. Future Research

Research requirements for the West Greenland area apply equally well to the East Greenland stock. In addition, biological sampling should cover all fishing areas and all months of the year. It was also noted that the East Greenland stock should, if possible be considered for a tagging study.

IV. ADJOURNMENT

There being no further business, the Chairman expressed his thanks to all participants, especially the conveners and rapporteurs of the two working groups, for their keen interest and cooperation during the course of the meeting, and to the Secretariat staff for their efficiency in the preparation of documents and reports.

APPENDIX II. AGENDA FOR NOVEMBER 1980 MEETING OF SCIENTIFIC COUNCIL

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

   a) Appointment of rapporteur
   b) Adoption of agenda
   c) Plan of work

2. Fishery Science (Chairman: Dr G. H. Winters)

   a) Review of harp and hooded seals (Convener: Dr A. Mansfield)

      i) Review of fishery
      ii) Research in 1980
      iii) Stock relationships
      iv) Population assessment
         - Vital rates
         - Pup production
         - Stock size
         - Sustainable yield
      v) Future research needs

   b) Review of shrimp stocks in Subareas 0 and 1, and at East Greenland[1] (Convener: Mr P. Kanneworff)

      i) Review of fishery trends
      ii) Distribution and biology
      iii) Catch and effort
      iv) By-catches in shrimp fishery
      v) Biomass estimates
      vi) Total allowable catches
      vii) Future research needs

   c) Other matters

3. Adoption of Reports

   a) Provisional report of September 1980 Meeting of Scientific Council (SCS Doc. 80/IX/32)

   b) Report of Scientific Council (this meeting), including the report of STACFIS

4. Review of Future Meeting Arrangements

   a) Special Meeting (17-21 February 1981)

   b) Regular Meeting (3-20 June 1981)

   c) Annual Meeting (12-18 September 1981)

5. Other Matters

   a) Scientific Council recommendations and proposals for 1980 and 1981 (NAFO Circular Letter 80/77)

   b) Progress report on publication of Vol. 1 of the Journal of Northwest Atlantic Fishery Science

6. Adjournment

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[1] Assessment of East Greenland shrimp stock included on the Agenda at the request of ICES and with the concurrence of the Executive Committee of the Scientific Council.

APPENDIX III. LIST OF PARTICIPANTS

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APPENDIX IV. LIST OF DOCUMENTS

1. RESEARCH DOCUMENTS

NOTE: Research documents 1 to 157 were presented at the February, June and September Meetings of the Scientific Council.

SCR Doc.	Serial	Title	Author(s)
80/XI/158	N244	Age at sexual maturity and reproductive performance of the female hooded seal (*Cystophora cristata* Erxleben) in South Greenland	E. W. Born
80/XI/159	N246	Catch, effort and biological characteristics of shrimp (*Pandalus borealis*) in the French fishery off West Greenland, 1980	F. Derible, H. Dupouy & J. P. Minet
80/XI/160	N247	Inconsistencies in reading the age of harp seal (*Pagophilus groenlandicus*) teeth, their consequences, and a means of reducing resulting biases	W. G. Doubleday & W. D. Bowen
80/XI/161	N248	One, two, many: how many harp seals are there?	D. A. Roff & W. D. Bowen
80/XI/162	N249	Estimates of harp seal pup production from mark-recapture	W. D. Bowen & D. E. Sergeant
80/XI/163	N250	Norwegian investigations on shrimps, *Pandalus borealis*, off West Greenland in 1980	T. Jakobsen & S. Torheim
80/XI/164 + Add.	N251	Observation on the shrimp fishery at East Greenland in 1980	D. M. Carlsson
80/XI/165	N252	Canadian observations on the shrimp fishery at West Greenland in 1980	D. G. Parsons
80/XI/166		(DOCUMENT WITHDRAWN)	
80/XI/167	N254	Information on catch and catch per unit effort for shrimp, *Pandalus borealis*, off West Greenland, 1980	D. G. Parsons & P. J. Veitch
80/XI/168	N255	Age structure of Northwest Atlantic harp seal catches from 1952 to 1980	W. D. Bowen
80/XI/169	N256	Biomass of shrimp (*Pandalus borealis*) in NAFO Subarea 1 in 1977-80 estimated by means of bottom photography	A. G. Jørgensen & P. Kanneworff
80/XI/170	N257	Review of studies of hooded seal in Greenland, 1970-1979	F. O. Kapel
80/XI/171	N258	Report on harp seal recoveries in Greenland, 1979-80	F. Larsen & F. O. Kapel
80/XI/172	N259	Observations on the Faroese prawn fishery in East Greenland, March to June 1980	K. Hoydal
80/XI/173	N260	Information on shrimp, *Pandalus borealis*, off East Greenland in 1980	J. P. Minet
80/XI/174	N261	Data on the Greenland shrimp fishery in NAFO Subarea 0+1 in 1980 compared to earlier years	D. M. Carlsson
80/XI/175	N262	Distribution of the offshore shrimp fishery in Division 1A-1B in 1980 in relation to previously known grounds and to the 12 nautical miles limit	Sv. Aa. Horsted

2. SUMMARY DOCUMENTS

Note: Summary documents 1 to 32 pertains to the February, June and September 1980 Meetings of the Scientific Council.

SCS Doc.	Serial	Title	Author(s)
80/XI/33	N245	Sealing statistics for the Northwest Atlantic, 1980	Assist. Executive Secretary
80/XI/34	N263	Report of Scientific Council, Dartmouth, Canada, 18-22 November 1980	