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Report of Standing Committee on Research and Statistics (STACRES)

Special Meeting of STACRES, November 1977

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REPORT OF STANDING COMMITTEE ON RESEARCH AND STATISTICS (STACRES)

Special Meeting of STACRES - November 1977

Chairman: A. W. May

Rapporteur: V. M. Hodder

STACRES met at ICNAF Headquarters, Dartmouth, Canada during 15-18 November 1977 (a) to consider the Commission's request for a review of conservation measures for the northern deepwater prawn (=shrimp) (*Pandalus borealis*) stocks in Subarea 1 and Statistical Area 0 (ICNAF Meet. Proc. 1977, page 159), and (b) to provide advice for the management of the seal stocks, as requested by Canada (ICNAF Com. Doc. 77/VI/13). The agenda is at Appendix I. Scientists attended from Canada, Denmark, France, Norway, Spain and United States of America (Appendix II). Research and summary documents presented to the meeting are listed in Appendix III.

Meetings of *ad hoc* Working Groups on Shrimp (convened by A. T. Pinhorn) and on Seals (convened by A. W. Mansfield) were held concurrently during 15-17 November, and their reports, as approved by STACRES, are at Appendices IV and V respectively. Brief summaries of these reports, together with other matters considered by STACRES, are given below.

1. Assessment of Shrimp Stocks (App. IV)

The total nominal catch in Subarea 1 was nearly 50,000 tons in 1976, of which 42,400 tons were taken on the offshore grounds. The fishery was brought under quota regulation in 1977 with a TAC of 36,000 tons for the offshore grounds. As a consequence of the management regime, the estimated total catch to the end of October 1977 was 36,500 tons, of which nearly 30,000 tons were taken from the offshore areas. Extension of the fishery to Statistical Area 0 occurred in 1976 with a catch of 392 tons. In 1977, the estimated catch to October was 126 tons.

New data on shrimp distribution in Subarea 1 are consistent with previous observations that the greatest concentrations are in Div. 1B. A groundfish survey in Div. 0B of Statistical Area 0¹ revealed shrimp concentrations in the northern part of that division. No information is available on the relationship of these concentrations to the stock off West Greenland, but it is probable that the distribution is continuous in a horseshoe-shaped pattern extending northward along the east coast of Baffin Island, eastward across the Davis Strait Ridge and southward along West Greenland.

The available catch-per-unit-effort data for Div. 1B indicate an increase from 1975 to 1976 and a decline in 1977 to the 1975 level, but the time series was considered not long enough to suggest a decline in stock abundance since the increase in 1976 may have been due to environmental factors. No clear annual trends in commercial catch rates were noted for other divisions during 1975-77, although research vessel survey data indicate declines in abundance in Div. 1C and 1D over the period.

Previous estimates of the offshore biomass in Div. 1B were supplemented by additional work in 1977. The results from bottom trawl and photographic surveys indicated that the biomass level in 1977 was similar to that estimated previously for 1976. Thus, 100,000 tons was again considered as a reasonable minimum estimate of the offshore fishable stock size in 1977 for Subarea 1. On the basis of an autumn survey in Div. 0B of Statistical Area 0 in 1977, 4,000 tons was indicated as a minimum estimate of the biomass. Depth configurations to the northward in Div. 0A indicate a potential for shrimp concentrations, but no data are yet available to support this view.

In the absence of any information that would warrant a change in the assumptions used for the 1976 assessment, it was concluded that the 1978 TAC for the offshore grounds in Subarea 1 should not exceed 40,000 tons (including discards), the same as recommended for 1977 by STACRES at the December 1976 Special Meeting. Consideration was again given to the possible partitioning of the TAC by smaller areas. However, the uncertainties about the inter-relationships between the concentrations on various fishing grounds and about the variation in distribution of the overall biomass precluded the recommendation of a breakdown of the TAC beyond that previously advised for the offshore area adjacent to Disko Bay (i.e. the offshore catches in the area east of longitude 59°00'W between latitudes 68°30'N and 69°30'N should not exceed 3,200 tons in 1978). The information available for Statistical Area 0 was insufficient to provide advice on a TAC for 1978.

Uncertainties about the population dynamics of this species make it important, for future assessments, to improve the collection of detailed data on the commercial fishery through sampling of catches, by-catches and discards and on the distribution and abundance of shrimp over all known and potential areas of shrimp concentrations. There is at present a critical lack of knowledge on recruitment, growth, mortality, migration and local movements, vertical distribution and environmental parameters, all of which are essential for the proper assessment of the stocks.

¹ See Fig. 1 of Appendix IV for divisions of new Statistical Area 0, as agreed by STACRES at this Meeting.

2. Assessment of Seal Stocks (App. V)

a) Harp seals

Estimates of natural mortality (M) ranging from 0.098 to 0.114 were derived from various re-search documents presented to the meeting. These estimates were averaged with weights inverse-ly proportional to their estimated variances, the resultant value of M being 0.102. Pup pro-duction estimates were available from aerial census data, cohort analysis, survival rates and catch and effort analysis. Projections for 1978 indicated pup productions of 309,000-347,000 animals. For M = 0.10, and age composition, sex ratios, maturity and fertility rates as in Lett and Benjaminsen (1977)², and for 1978 pup productions of 310,000 and 350,000, the sustain-able yields were projected to be 227,000 and 245,000 animals respectively.

The present analyses of production and yield are based on the unit stock concept, the evidence being inadequate to quantify the degree of intermixing between the adults of the Gulf and the Front. However, in view of evidence that some segregation at breeding ages occurs, it is suggested that it would be prudent to divert some hunting effort from the Front to the Gulf.

b) Hooded seals

Based on sequential population analysis, it was concluded that the stock size of age 1+ females appears to have increased from a low of about 53,000 in the early 1960's to 77,000 in 1977. Using a figure of 38,000 as the pup production in 1977, natural mortality M = 0.124 and a mean whelping age of 3.8 years with a catch comprising 10% mature females, the sustainable yield was estimated to be 22,000 animals. However, the available data were considered insufficient to recommend any change in the present total allowable catch.

3. Review of Progress on Publication of Shrimp Papers

STACRES was informed that the shrimp papers from the December 1976 Special Meeting, which are to be published in a special issue of the Selected Papers series, had been returned to the Editor and that some progress had been made in final editing. Due to pressure of other work and the delay encountered by some authors in not returning their revised manuscripts by the 30 June 1977 deadline, Dr Sandeman indicated that progress had been slow and that he would have little time to pursue this project in the near future. The Executive Secretary informed the Meeting that Dr Wilder, who has recently retired from the St. Andrews Biological Station after a long career on lobster research, would be willing to complete the editing of the shrimp papers.

It was pointed out that a number of shrimp papers presented at the current meeting might be suitable for inclusion in the special issue. STACRES agreed that a deadline of 1 February 1978 be set for the submission of revised papers from the current meeting and any further revisions to those of the December 1976 Meeting, so that the special issue of Selected Papers (on shrimp) can be published before the 1978 Annual Meeting.

4. Consideration of 3-alpha Codes for North Atlantic Species

STACRES was informed that the FAO 3-digit codes for species, adopted by ICNAF as one of the standard entries in logbooks (ICNAF Meet. Proc. 1975, page 61), were set up for internal use in data processing and were never intended for general use outside FAO. In fact, the so-called "FAO 3-digit" codes have been declared defunct by FAO, and the only official FAO codes for species are the 14-character taxonomic codes, which are completely unsuitable as a species identifier in logbooks.

At its triennial meeting in August 1977, the CWP (Coordinating Working Party on Atlantic Fisheries Statistics) recognized the urgent need for a simplified coding system to be used as standard species identifiers in logbooks, and recommended the use of a 3-alpha coding system for the North Atlantic (ICNAF Sum. Doc. 77/XI/36), as drawn up by the Secretariat representatives of ICNAF and ICES. It was noted that this coding system was adopted by ICES at its 1977 Annual Meeting. STACRES agreed that the matter be placed on its agenda for further consideration at the 1978 Annual Meeting.

5. Northward Extension of Statistical Area 0

In view of the reported catches from the region north of Statistical Area 0 in 1976 and 1977 and the possibility of the continuous distribution of shrimp from Baffin Island across the Davis Strait Ridge to Greenland, STACRES agreed to the extension of Statistical Area 0 northward to latitude 78°10'N, with Div. OB corresponding to the present Statistical Area 0 and the area to the north of 66°15'N and west of Subarea 1 to be named Div. OA. The western boundary of Statistical Area 0 extends northward along the coast of Baffin, Bylot, Devon and Ellesmere Islands and follows the 80°W

² Lett, P., and T. Benjaminsen. 1977. A stochastic model for the management of the Northwestern Atlantic harp seal (*Pagophilus groenlandicus*) population. J. Fish. Res. Bd. Canada, 34(8): 1155-1187.

longitude meridian in the waters between those islands. A map showing the division of the new Statistical Area 0 is given in Fig. 1 of the Report of the *ad hoc* Working Group on Shrimp (App. IV).

This realignment of Statistical Area 0 corresponds with the boundaries of Subarea 0 as proposed in the Convention of the new organization to replace ICNAF. It also agrees with the recommendation of the Coordinating Working Party on Atlantic Fishery Statistics (Report of Ninth Session of CWP, August 1977) that ICNAF extend the northern boundary of Statistical Area 0 to take account of catches being made north of this boundary.

The Secretariat was requested to advise FAO of this change and also to incorporate the change in the instructions for completing forms STATLANT 21A and 21B, so that fishery statistics for 1977 will be reported by Div. 0A and 0B separately.

6. Future Scientific Meetings

STACRES reviewed the scheduling of meetings for the first half of 1978 and confirmed the following:

- a) Special Meeting of STACRES on squids to be held at Havana, Cuba, during 13-17 February 1978 (Com. Doc. 78/II/2).
- b) Regular spring meeting of the Assessments Subcommittee to be held at ICNAF Headquarters, Dartmouth, Canada, during 4-12 April 1978.
- c) Annual Meeting of STACRES and its subcommittees to be held at Bonn, Federal Republic of Germany, during 18-27 May 1978, followed by a meeting of STACTIC on 29 May and Meetings of Commissioners during 30 May to 6 June 1978.
- d) The ICES/FAO/ICNAF Symposium on the Biological Basis of Pelagic Fish Stock Management will be held at Aberdeen, Scotland, on 3-7 July 1978.

7. Acknowledgement

The Chairman expressed his appreciation to the Secretariat for their usual efficient work, to the conveners and rapporteurs of the Working Groups, and to the rapporteur and members of STACRES for their cooperation during the course of the meeting.

APPENDIX I. AGENDA FOR STACRES MEETING, NOVEMBER 1977

1. Opening (Chairman: A. W. May)
 - a) Appointment of rapporteur
 - b) Adoption of agenda
2. *Ad hoc* Working Group on Shrimp (Convener: A. T. Pinhorn)
 - a) Review of fishery trends
 - b) Distribution and biology
 - c) Catch and effort data
 - d) Biomass estimates
 - e) Total allowable catch
 - f) Future research requirements
3. *Ad hoc* Working Group on Seals (Convener: A. W. Mansfield)
 - a) Conservation of harp seals
 - i) Research in 1977
 - ii) Population assessment
 - iii) Future research
 - b) Conservation of hooded seals
 - i) Research in 1977
 - ii) Population assessment
 - iii) Future research
4. Other matters
 - a) Review of progress on publication of shrimp papers
 - b) Consideration of 3-alpha code for North Atlantic species (Sum. Doc. 77/XI/36 and 37)
 - c) Northward extension of Statistical Area 0
5. Future meetings of STACRES
6. Adjournment

APPENDIX II. LIST OF PARTICIPANTS IN STACRES MEETING, NOVEMBER 1977

CANADA

J. F. Caddy	Fisheries and Marine Service, Resource Service, 580 Booth St., Ottawa, Ont.
A. W. May	" " " " " "
M. C. Mercer	" " " " " "
H. C. Rowsell	Department of Pathology, University of Ottawa, Ottawa, Ont.
D. M. Lavigne	Department of Zoology, University of Guelph, Guelph, Ont.
A. W. Mansfield	Fisheries and Marine Service, Biological Station, Ste. Anne de Bellevue, P.Q.
D. E. Sergeant	" " " " " "
J. Fr�chette	M. I. C., Complex Scientifique, 2700 Einstein Boulevard, Ste. Foy, P.Q.
J. P. Lussiaa-Berdou	" " " " " "
S. Labonte	Fisheries and Marine Service, Biological Station, St. Andrews, N.B.
P. Brodie	Fisheries and Marine Service, Marine Ecology Laboratory, B.I.O., Dartmouth, N.S.
D. F. Gray	" " " " " "
P. F. Lett	" " " " " "
R. K. Mohn	" " " " " "
A. T. Pinhorn	Fisheries and Marine Service, Biological Station, St. John's, Nfld.
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FRANCE

J. P. Minet	Institut Scientifique et Technique des P�ches Maritimes, St. Pierre et Miquelon
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NORWAY

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�. Ulltang	" " " " " "

SPAIN

E. C. Lopez-Veiga	Instituto de Investigaciones Pesqueras, Muelle de Bouzas, Vigo
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UNITED STATES OF AMERICA

S. H. Clark	National Marine Fisheries Service, Northeast Fisheries Centre, Woods Hole, Mass.
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APPENDIX III. LIST OF DOCUMENTS PRESENTED TO STACRES MEETING, NOVEMBER 1977

Summary Documents

<u>Doc. No.</u>	<u>Ser. No.</u>	<u>Title</u>	<u>Author</u>
77/XI/36	5130	Three-alpha code for use in logbooks to identify North Atlantic species names.	ICNAF Secretariat
77/XI/37	5134	Standard elements for fishing sheets and logbooks.	ICNAF Secretariat

Research Documents

<u>Doc. No.</u>	<u>Ser. No.</u>	<u>Title</u>	<u>Author</u>
77/XI/56	5131	A new approach to estimating harp seal production.	D.E. Sergeant
77/XI/57	5132	Research on hooded seals in the western North Atlantic in 1977.	D.E. Sergeant
77/XI/58	5133	Studies on harp seals of the western North Atlantic population in 1977.	D.E. Sergeant
77/XI/59	5135	The sealing season and Norwegian seal investigations off Newfoundland-Labrador in 1977.	B. Bergflódt
77/XI/60	5136	Document withdrawn.	
77/XI/61	5138	Norwegian investigations on the deep sea shrimp (<i>Pandalus borealis</i>) in West Greenland waters, 1977.	Ø. Ulltang & P. Øynes
77/XI/62 (Rev.)	5139	The 1977 census of western Atlantic harp seal <i>Pagophilus groenlandicus</i> .	D.M. Lavigne, S. Innes & W. Barchard
77/XI/63	5140	Comparison of on-ice counts of harp seal pups with counts from 35-mm ultraviolet aerial photography.	C.K. Capstick, D.M. Lavigne & S. Innes
77/XI/64	5141	Critical analysis of two harp seal population models.	R.K. Mohn
77/XI/65	5142	Estimated density of shrimp (<i>Pandalus borealis</i>) in Greenland waters, 1975-77, and calculation of biomass on the offshore fishing grounds, Div. 1A-1B, based on bottom photography.	P. Kanneworff
77/XI/66	5143	An estimate of the composition of the catch of harp seal in West Greenland, 1972-1975.	F.O. Kapel
77/XI/67	5144	Review of Danish trawl surveys on the offshore West Greenland shrimp grounds in 1977, and a comparison with material from previous years.	D.M. Carlsson, Sv.Aa. Horsted & P. Kanneworff
77/XI/68 (Rev.)	5145	New estimates of harp seal production on the Front and in the Gulf of St. Lawrence and their impact on herd management.	P.F. Lett, D.F. Gray & R. Mohn
77/XI/69	5146	Catch per unit effort in the Faroese prawn (<i>Pandalus borealis</i>) fishery in ICNAF Subarea 1, 1975-77.	K. Hoydal & H. Lassen
77/XI/70	5147	New biological data on the shrimp, <i>Pandalus borealis</i> , in the Baffin Island waters (ICNAF Statistical Area 0).	J.P. Minet, A. Forest & J.B. Perodou

APPENDIX IV. REPORT OF AD HOC WORKING GROUP ON SHRIMP

Convener: A. T. Pinhorn

Rapporteur: S. Clark

The *ad hoc* Working Group on Shrimp met during 15-17 November 1977 to assess the status of the shrimp (=northern deepwater prawn) stocks in Subarea 1 and Statistical Area 0, the matter having been referred to STACRES by the Commission at its 1977 Annual Meeting (ICNAF Meet. Proc. 1977, page 159). Scientists attended from Canada, Denmark (Greenland and Faroese laboratories), France, Norway, Spain and USA. The Working Group reviewed a considerable amount of new information relating to the distribution and abundance of shrimp: Res. Doc. 77/XI/61, 65, 67, 69 and 70, and several working papers.

1. Fishery trends

Nominal catches of shrimp (Table 1) in Subarea 1 increased from less than 10,000 tons prior to 1973 to nearly 50,000 tons in 1976. Preliminary statistics for 1977 through October indicate a total catch of 36,000 tons, of which nearly 30,000 tons were taken on the offshore grounds. While catches offshore increased rapidly to 42,000 tons in 1976, those of the inshore fishery remained relatively stable at least to 1975 with a decline in 1976. The first record of shrimp catches in Div. 0B of Stat. Area 0 was in 1976, when Spain reported 327 tons, but none have been reported to date in 1977. However, in Div. 0A, Norway caught 65 tons in 1976 and Denmark (F) caught 126 tons in 1977. The fishery in 1977 was for the first time brought under quota regulation with an overall TAC of 36,000 tons for the offshore grounds, with a breakdown of the TAC over 4 management areas. The lower total catch in 1977 is a consequence of the management regime in the area.

Table 1. Nominal catches (metric tons) of shrimp in Subarea 1, 1970-77.

	1970	1971	1972	1973	1974	1975	1976	1977 ²
Denmark (F)	130	496	755	1,371	2,023	5,300	11,179	11,560 (Oct) ³
Denmark (G) a ¹	8,394	9,237	7,218	7,950	10,064	8,700	7,300	6,704
b	165	200	150	185	180	1,089	2,478	5,730 (Oct)
Denmark (M)	-	-	-	196	308	1,142	2,717	5,384 (Oct)
France	-	-	-	-	-	-	803	756 (Dec)
F. R. Germany	-	-	-	-	-	-	-	34 (Oct)
Japan	-	-	-	-	-	-	146	-
Norway	-	-	1,409	2,940	5,917	8,678	11,658 ⁴	6,406 (Oct)
Spain	-	-	-	-	-	6,948	6,925 ⁵	-
USSR	-	-	-	-	3,517	6,033	6,468	-
TOTAL SA 1	8,689	9,933	9,532	12,642	22,009	37,890	49,674	36,574
Total offshore	295	696	2,314	4,692	11,945	29,190	42,374	29,870

¹ a = inshore, b = offshore grounds.

² Preliminary 1977 data for year to end of month indicated in parentheses.

³ In addition, 126 tons taken in Div. 0A of Stat. Area 0.

⁴ In addition, 65 tons taken in Div. 0A of Stat. Area 0.

⁵ In addition, 327 tons taken in Div. 0B of Stat. Area 0.

Data on discards were presented for the Norwegian fishery. However, these data were considered too limited to permit a complete evaluation of the size composition or the magnitude of the discard for this fishery on an annual basis. The Working Group did, however, note the need for discard data and stressed the importance of collecting such data in the future.

2. Distribution (Res. Doc. 77/XI/65, 67, 69, 70)

New data for Subarea 1 are consistent with earlier observations indicating the highest levels of off-shore abundance in Div. 1B. A seasonal northwestward shift in fishing activity for Denmark (G) and Denmark (F) occurred in Div. 1B, similar to that first noted in 1976 (Res. Doc. 76/XII/150). It appears that this shift may have resulted from seasonal movements of shrimp concentrations, vessel

movements in response to reductions in stock abundance, or ice conditions. In almost all months for which data are currently available, fishing activity extended farther northward in 1977 than in 1976.

Survey data collected by R/V *Cryos* in Div. 0B of Statistical Area 0 in the autumn of 1977 indicate that shrimp are concentrated primarily in the northern part of this area at depths ranging from 300 to 420 m (164-230 fm). Major concentrations occurred in the area between latitudes 64°10' and 65°40'N, but ice conditions prevented full coverage of the northern part of the area. It was noted that there is currently no information available on the distribution of shrimp offshore in Davis Strait between the areas of known concentrations in Subarea 1 and Statistical Area 0, but that the distribution may be continuous between these areas, extending for some distance along the eastern coast of Baffin Island. Preliminary larval distribution data (Danish plankton hauls) were presented for Davis Strait. Coverage of offshore areas is at present inadequate, and no conclusions could be drawn relative to differences between areas or trends over time.

3. Biology (Res. Doc. 77/XI/70)

Bottom trawl survey data collected by R/V *Cryos* in the autumn of 1977 indicated the presence of four age groups of shrimp in Statistical Area 0, these being age 2 (immatures), age 3 (males), age 4 (transitional stages), and age 5+ (females), with mean carapace lengths of 12.9, 17.9, 23.1 and 29.5 mm respectively.

4. Catch and Effort Data (Res. Doc. 77/XI/61, 67, 69)

Catch and effort data were presented for fisheries by Denmark (G), Norway and Denmark (F) in Subarea 1 for 1975-1977. Statistical analyses of Denmark (F) catch and effort data indicated that 39-92% of the variance was explained by variation due to ship, time of day, statistical rectangle and year. The catch-per-unit effort (CPUE) estimates from the model showed good correspondence with the CPUE data previously used. Examination of the data for Div. 1B revealed a close correspondence in seasonal trends for the different countries for periods in which their fleets were active, i.e. catch rates peaked in the spring and subsequently declined to an annual low in the autumn. Similar seasonal differences in catch rates were evident for Div. 1D.

Annual catch rates for the Norwegian fishery in Div. 1B increased from 1975 to 1976 and declined in 1977; the available data suggest a similar trend for the Denmark (F) fishery. However, the corresponding Denmark (G) figures increased from 1975 to 1976 and then remained at about the same level in 1977. It was pointed out that annual catch rates for the Denmark (G) fishery were not strictly comparable to Norwegian and Denmark (F) data due to seasonal differences in distribution of fishing effort. Accordingly, the Working Group concluded that the Norwegian and Denmark (F) data would be the more useful for comparisons between years, i.e. an increase in annual catch rates from 1975 to 1976 followed by a decline in 1977 to the 1975 level. Thus, no significant net decline in catch rates occurred from 1975 to 1977, although it was pointed out that, since intensive fishing activity was comparatively recent and had focused primarily on recruiting females, stock-recruitment effects, if any, would not be evident during the period. The Working Group was uncertain of the basis for the observed increase in 1976, although environmental factors may have been involved.

No clear annual trends in commercial catch rates from 1975 to 1977 were documented for Div. 1D. However, Denmark (G) research vessel survey data indicate declines in abundance for Div. 1C and 1D during this period.

5. Biomass Estimates (Res. Doc. 77/XI/65, 67, 70)

Previous swept-area estimates of the biomass on the offshore grounds in Div. 1B, based on research data for Denmark (G) in 1976 (Res. Doc. 76/XII/150), were supplemented by additional work in 1977. Although the 1977 survey was not as complete as in 1976, the results indicate that the biomass level in Div. 1B is similar to that estimated for the previous year. Estimates from photographic surveys in Div. 1B in 1977 also agreed quite well with swept-area estimates calculated in 1976. It was agreed that bottom and off-bottom photographic surveys were valuable in providing a basis for evaluation of swept-area procedures. Limitations of the swept-area method have been documented previously (*ICNAF Redbook* 1977, p. 13-17).

The Report of the *ad hoc* Working Group on Shrimp in Subarea 1 (*ICNAF Redbook* 1977, p. 13-17) provided a minimum estimate of biomass of 100,000 tons for Subarea 1 (offshore) for 1976. Inasmuch as no evidence was presented indicating marked changes in stock abundance during 1975-1977, it was agreed that the minimum biomass estimate for Subarea 1 (offshore grounds) should remain at 100,000 tons for 1977.

A minimum biomass estimate of 4,000 tons was indicated for Div. 0B of Stat. Area 0 on the basis of autumn groundfish survey data. It was noted that this figure should be regarded as very much a minimum, in that the survey had been conducted using a groundfish survey trawl with a codend mesh

size of 50 mm (stretched mesh). However, available data did not permit an evaluation of what the correction should be. Considerable interest was expressed in the possible distribution of shrimp in Div. OA of Statistical Area 0. It was noted that depth configurations indicate a potential for shrimp concentrations in that area, but no biomass estimates are as yet available.

6. Total Allowable Catch

In deriving a total allowable catch (TAC) for Subarea 1, the Working Group drew attention to the fact that biological data are limited and that no information is currently available relative to recruitment. Accordingly, the need for caution was stressed, and the Working Group consequently agreed that the approach used at the December 1976 Meeting (*ICNAF Redbook 1977*, p. 15) would again be appropriate. The same assumptions were adopted as for the 1976 assessment, i.e. spawning stock size should be maintained at a level equal to 50% of the virgin spawning stock size, which would require an F level of 0.4 in the model used, assuming an instantaneous natural mortality rate of 1.5 after first hatching and a time interval of 1.5 years between recruitment to the fishery and first hatching. With a mean fishable stock biomass of 100,000 tons, this level of fishing mortality would provide a catch of 40,000 tons. The Working Group therefore recommends that the 1978 TAC for shrimp should not exceed 40,000 tons (including discards) for the offshore grounds in Subarea 1.

As in the 1976 Meeting, the Working Group considered the possibility of subdividing the TAC for Subarea 1. Two aspects generated concern at the present Meeting: (a) stock relationships between offshore and inshore areas, particularly in the Disko Bay area; and (b) possible concentrations of small shrimp in Div. 1A (as evidenced by Norwegian and Denmark (F) catches), which appear to require special protective measures. The arguments for and against a breakdown of the TAC are summarized in the Report of the December 1976 Meeting (*ICNAF Redbook 1977*, p. 16). Such a breakdown of the TAC would have to take into account the distribution of biomass by whatever management areas are proposed. However, due to the uncertainty concerning the interrelationships between grounds and the uncertainty concerning the variation in distribution of the overall biomass, the Working Group was not able to advise on a further breakdown of the TAC beyond that previously recommended for the Disko Bay area (*ICNAF Redbook 1977*, p. 16), and it was agreed that this breakdown should be maintained. Accordingly, the Working Group recommends that the annual catch in the offshore area adjacent to Disko Bay, between latitudes 68°00'N and 69°30'N, east of 59°W longitude, not exceed 3,200 tons for 1978, recognizing that this figure may require future adjustment as new evidence relative to interrelationships between fishing grounds becomes available. The Working Group concluded that the information for Statistical Area 0 was inadequate for recommendation of a TAC.

7. Zone of Overlap

The Working Group considered management implications posed by the fact that part of Subarea 1 falls within the Canadian Fishing Zone and part of Statistical Area 0 falls within the Fishing Zone off Greenland (Fig. 1). A review of available data revealed that a relatively small portion of the estimated fishable biomass in Div. 1B falls within the Canadian Fishing Zone and that some of the fishing activity in Div. 1B occurs there; however, little or none of the biomass falls into the portion of the Canadian Fishing Zone lying within Div. 1C, 1D or 1E. In Div. 0A, shrimp occur both in the Canadian Fishing Zone and in the Fishing Zone off Greenland; however, in the developing fishery in 1976 and 1977, the fishing activity in Div. 0A occurred within the Canadian Fishing Zone. During 1977 (to October), 13% of the Denmark (F) catch in Div. 1B was taken in the Canadian Fishing Zone.

8. By-catch in the Shrimp Fishery (Res. Doc. 77/XI/61)

The Working Group reviewed available data relative to finfish by-catch in the shrimp fisheries. Several species are currently taken as by-catch, notably redfish, Greenland halibut, American plaice, cod, wolffishes and eelpouts; of these, redfish appears to be the most prevalent, and by-catches of this species in commercial shrimp fishing operations appear to be high enough to have a very significant effect on redfish stock abundance. One study by Denmark (G) indicated that the potential by-catch of small redfish in Subarea 1 is in excess of current nominal catch levels for commercial-sized redfish, but Norwegian data indicated much lower by-catches in the shrimp fishery. It was noted that precise estimates are currently not possible for Subarea 1 due to variability in by-catches both seasonally and between areas.

9. Future Research Requirements

The Working Group noted that there is considerable need for additional data from Subarea 1 and Statistical Area 0, if future assessments are to be improved, particularly because, as stressed at the December 1976 Meeting (*ICNAF Redbook 1977*, p. 15), knowledge about the stability of the size of the offshore shrimp stocks is very limited. Immediate information on the distribution of shrimp by area and season is required, together with data on vertical distribution, if reliable biomass estimates are to be made. Recruitment trends are at present unknown, and there is also a critical lack of knowledge relative to growth, mortality rates, migration and local movements, and other biological

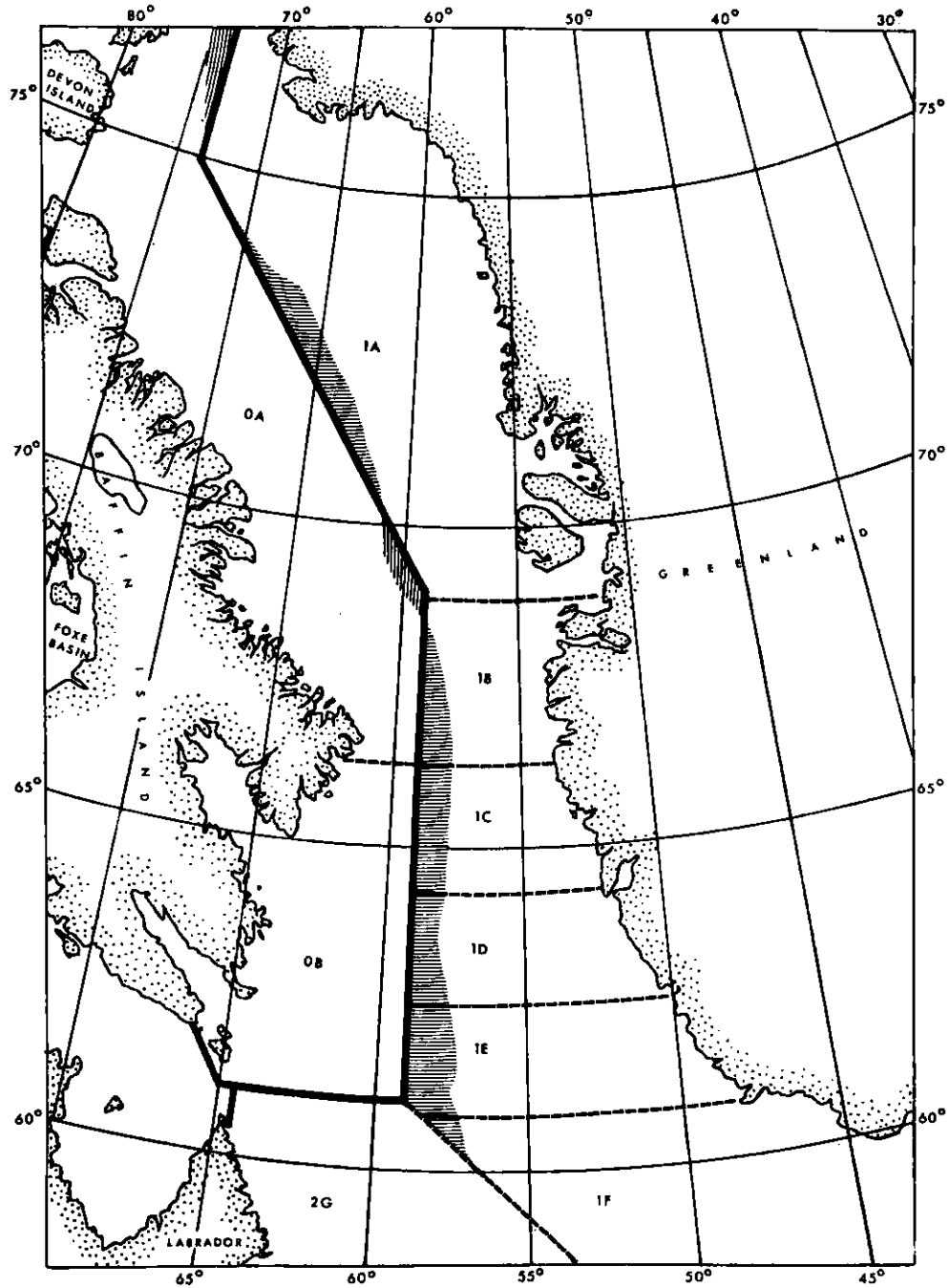


Fig. 1. Map showing the zones of overlap in Subarea 1 and Statistical Area 0 relative to extended fisheries jurisdiction of the coastal states.

and oceanographic parameters. Accordingly, the Working Group

recommends

- i) studies of vertical distribution with particular reference to effects of shifts in light intensity;
- ii) development of techniques to predict recruitment (which would involve expansion of current plankton surveys, sampling in nursery areas, etc.);

- iii) expansion of stratified bottom trawl and photographic surveys and completion of such surveys on an annual basis;*
- iv) tagging studies to evaluate migrations and local movements between grounds; and*
- v) general biological studies to provide additional data on growth and mortality rates, age composition, and other parameters. In particular, there is a critical need for development of reliable techniques that could be used to distinguish between older age-groups (females).*

10. Scheduling of Future Assessments

The Working Group considered possible scheduling of future meetings. It was suggested that future TACs might be set on a different basis (e.g. other than the calendar year); however, there was general agreement that this approach could lead to confusion at administrative levels and would probably not be appropriate, as fishing activity is currently more or less continuous throughout the year. Concern was expressed that, due to the limited knowledge currently available (particularly with respect to recruitment), more than one meeting a year might be necessary. It was recognized that scheduling requirements could vary in view of requirements of the coastal states involved and availability of data.

APPENDIX V. REPORT OF AD HOC WORKING GROUP ON SEALS

Convener: A. W. Mansfield

Rapporteur: M. C. Mercer

The Working Group on Seals met during 15-17 November 1977 to review the status of the harp and hooded seal populations in the Northwest Atlantic. Representatives attended from Canada (P. F. Brodie, D. F. Gray, D. M. Lavigne, P. F. Lett, A. W. Mansfield, M. C. Mercer, R. K. Mohn, H. C. Rowsell, D. E. Sergeant and G. H. Winters), Denmark (F. O. Kapel), and Norway (T. Benjaminsen). During the course of the discussions, the Working Group reviewed several working papers and the following research documents: Res. Doc. 77/XI/56, 57, 58, 59, 62, 63, 64, 66 and 68.

1. Conservation of Harp Seals

a) Research in 1977

Canada reported the results of 1977 studies relating to tag and brand recoveries and age composition of the catch (Res. Doc. 77/XI/58), an aerial census of the Front and Gulf herds (Res. Doc. 77/XI/62) with associated ice-level observations (Res. Doc. 77/XI/63), estimates of production utilizing catch and effort data combined with aerial survey results (Res. Doc. 77/XI/68), a critical evaluation of two harp seal population models (Res. Doc. 77/XI/64), and further analyses of mortality and production in harp seals (unpublished). Norway reported on field observations at the Front in 1977 (Res. Doc. 77/XI/59). Denmark presented estimates of catch levels and age composition for West Greenland in 1972-75 (Res. Doc. 77/XI/66).

b) Population assessment

i) Mortality estimates. Estimates of natural mortality (M) were derived from four sources of information as follows:

- (1) $M = 0.098$ was estimated from the updated results of Res. Doc. 76/X/127, the calculated 0-group mortality being similar at $M = 0.099$.
- (2) $M = 0.114$ was estimated by Lett and Benjaminsen (1977, J. Fish. Res. Bd. Canada, 34: 1155-1187).
- (3) $M = 0.099$ was estimated by Gray and Lett (unpublished), based on pup production estimates for 1962-69, as given by Benjaminsen and Øritsland (unpublished), and on sex ratios and catch-at-age data, as given by Lett and Benjaminsen (1977, *ibid.*).
- (4) $M = 0.1058$ from unpublished Norwegian data considered in 1976.

Since the estimates of (1) and (4) above were based essentially on the same data, they were averaged to give an estimate of $M = 0.1019$. This estimate and those of (2) and (3) were then averaged with weights inversely proportional to their estimated variances. The resultant value of $M = 0.102$, with standard error of 0.00604 and confidence interval of 0.034 at the 5% probability level, was used in the assessment.

ii) Pup production. Estimates of pup production were available from several sources.

- (1) An aerial ultraviolet photographic survey was conducted in 1977 (Res. Doc. 77/XI/62). A large herd located west of the Magdalen Islands in the Gulf was surveyed on 9-10 March, but complete coverage was not obtained due in part to a malfunction in the inertial navigation system. A small herd was photographed north of the Bird Rocks on 11 March, but another herd located north of the Magdalen Islands on or about 21 March was not surveyed. The census in the Gulf accounted for less than 30,000 seals, and the authors of Res. Doc. 77/XI/62 concluded that it was not reasonable to estimate total production in the Gulf on the basis of the coverage obtained.

The photographic coverage of the main herds at the Front was reasonably complete, except for a small group of seals south of the main patch (Res. Doc. 77/XI/62). The Working Group discussed the extent of the coverage, particularly with regard to concentrations of seals near the margins of the photographed areas and the possibility of extensive areas of low concentration which would not be accounted for in the survey of the main whelping herds. It was noted that Norwegian sealing ships passed through 45 miles of scattered concentrations of whelping harp seals, with 500-1,000 animals in each, before they reached the main patches (Res. Doc. 77/XI/59), and also through several small patches of harp seal pups over about 25 miles while steaming eastward toward the hooded seal concentrations on 18-20 March. However, the Working Group

could find no basis for any quantification of under-estimation attributable to small concentrations not covered in the survey.

Ice-level observations (Res. Doc. 77/XI/63) were conducted to complement the aerial survey. In the Gulf, difficulties were encountered with photographic imagery and environmental conditions causing incomplete coverage of some control areas, and also in the analysis of the survey results, especially in having the perception of boundary lines on the ice coincide with that of lines subsequently drawn on photographic imagery. Furthermore, there was a decrease in pup counts during the second flight, which suggested that pups were leaving the ground control area, thus causing an upward bias in the proportion of pups in the control area which were thought to have been photographed. Environmental conditions at the Front rendered the foregoing procedure impractical, and observers on the ice there classified pups qualitatively as being in the open, hidden from above or doubtful. On the basis of discussions at past meetings, it was agreed to approximate the percentage of pups available for photography within the photographed area as being 90%. Similar observations in the Gulf indicated a figure of 99% for that area.

Aerial survey estimates for the Front, including a 10% correction factor for seals not detected by the sensor, were computed in a number of ways (Res. Doc. 77/XI/62). The Working Group concluded that the simple random sampling procedure was the appropriate analysis to use, and this gave a mean estimate of 204,000 pups in the area surveyed.

- (2) Pup production in 1977 was estimated by the survival index method to be 330,000 animals, derived from a projection of the female breeding stock in 1972 (320,000 animals) and assuming a fertility rate of 92% and a maturity ogive as given in Res. Doc. 76/X/124. Pup production was also estimated for 1977 to be 320,000 animals, from age-specific population estimates by cohort analysis using the same fertility and maturity rates given above. Corresponding estimates for 1978 were projected to be 343,000 and 338,000 animals respectively.
- (3) From estimates of total and partial production figures based on the application of the Delury method to daily catch rates and cumulative catches, the total pup production at the Front was estimated to be 199,000 animals for 1977 (Res. Doc. 77/XI/68). It was noted that this estimate applies only to the sections of the herd hunted by landsmen and by large and small vessels and is therefore considered to be a minimum estimate. Analysis of statistics for the Gulf prior to closure of the large-vessel hunt in 1972 produced an estimate of the pup production of 90,000 animals in 1971. Projection of this estimate forward, under the assumption that the mixing of Gulf bedlamers with those of the Front was as indicated in Res. Doc. 77/XI/58 and that their frequency in the Front catch was one-third of the fraction indicated, gives a pup production of 93,000 animals in 1977. Total production of pups for the Gulf and Front in 1977 is therefore estimated to be 292,000 animals in 1977, with a projected production of 309,000 animals in 1978.
- (4) Pup production in 1977 was estimated by the survival index method from Norwegian data (Sum. Doc. 76/XII/47, App. III) to be 315,000 animals, with a projected production of 330,000 pups in 1978.
- (5) Projected estimates, based on the cohort analysis of Lett and Benjaminsen (1977, J. Fish. Res. Bd. Canada, 34: 1155-1187), indicated pup productions of 330,000 and 347,000 animals for 1977 and 1978 respectively.

The foregoing pup production estimates (thousands of animals) are summarized as follows:

	1977			Projected for 1978
	Gulf	Front	Total	
Aerial census	<30 ¹	204	-	-
Cohort analysis	-	-	320	338
			330	347
Survival indices	-	-	330	343
			315	330
Catch and effort analysis	93	199	292	309

¹ Survey incomplete and not considered a valid basis for an estimate of pup production.

- iii) Stock relationships. Returns of harp seals, tagged and branded in the Gulf and recovered in winter and spring at the Front and in the Gulf, are summarized in Res. Doc. 77/XI/58. Crossovers accounted for 79% of 80 returns at age 1, 69% of 16 returns at age 2, 11% of 9 returns at age 3 and none of 7 returns at older ages. However, the author reported that two 8-year-old seals, tagged as pups in the Gulf, were taken at the Front (in Notre Dame Bay) in 1977.

The Working Group reviewed historical trends in stock size for the Front and Gulf separately, based on the results of catch-effort and cohort analyses (Res. Doc. 77/XI/68). Under the assumption that mixing of bedlamers occurs as indicated in the preceding paragraph but that adults home to their area of birth, the results suggest that pup production in the Gulf is increasing and that at the Front is decreasing. Present analyses of production and yield are based on a unit stock concept, the evidence of mixing being inadequate to quantify the degree of interbreeding between the adults of the Gulf and Front areas. However, since some segregation of breeding age-groups apparently occurs, it would be prudent to divert some hunting effort from the Front to the Gulf.

- iv) Population models. A critical analysis of population models developed by Lett and Benjaminsen (1977, J. Fish. Res. Bd. Canada, 34: 1155-1187) and by Capstick *et al.* (Res. Doc. 76/X/132) was presented (Res. Doc. 77/XI/64), these being referred to as the L-B model and the Guelph model respectively. Using similar input data in both models, the pup production calculated in the Guelph model is 15% lower, of which 4% relates to different maturity ogives, 3.5% to sex ratio, 1% to pregnancy rate, and 6% to breeding animals over 25 years of age. A sensitivity analysis of the Guelph model (over a 20-year simulation) showed strong dominance of survivorship such that a 1% error in natural mortality would result in a 36% difference in the size of the breeding population. The variance in the final population size is 50 times more strongly affected by uncertainty in this parameter than in any other, due to weaker control of the density-dependent fecundity factor than in the L-B model. The L-B model displayed no dominant sensitivity, the stability being the result of two density-dependent controls.
- v) Sustainable yields. Using the L-B model, the Working Group developed estimates of sustainable yield for levels of pup production of 310,000 and 350,000 in 1978 with $M = 0.10$. Age composition, sex ratios, maturity ogives and fertility rates were applied as by Lett and Benjaminsen (1977, J. Fish. Res. Bd. Canada, 34: 1155-1187). The catch composition was assumed to comprise 80% young of the year and 20% older animals, as has recently occurred in the fishery. The results of the analysis indicate sustainable yields of 227,000 and 245,000 animals for pup production levels of 310,000 and 350,000 respectively. It was also determined that the current total allowable catch (TAC) of 170,000 seals is sustainable at pup production levels of 250,000 and above.

The model was applied as in the preceding paragraph to project population trends of age 1+ animals under varying levels of pup production and projected catches as follows:

1978 pup production	Projected catch	Population size (000 seals)				
		1979	1980	1981	1982	1983
310,000	170,000	1254	1276	1302	1327	1370
	190,000	1239	1238	1249	1268	1289
	210,000	1228	1213	1224	1241	1244
350,000	170,000	1413	1438	1460	1502	1548
	190,000	1395	1405	1415	1446	1481
	210,000	1378	1365	1373	1386	1410

The ranges of pup production associated with 1983 population projections are 352,000-357,000 and 380,000-385,000 animals for 1978 pup production levels of 310,000 and 350,000 respectively.

c) Future research on harp seals

- 1) The Working Group stressed the need for further data on the production and stock relationships of harp seals, and accordingly

recommends

that a large-scale tagging program be conducted in the Gulf and at the Front in 1978.

- ii) In considering the continuing need for data to be used in the calculation of mortality and reproductive rates, the Working Group

recommends

that samples of 1,200 moulting seals be collected in each of the Front and Gulf areas in 1978 for the determination of age, sex and maturity.

- iii) The Working Group considered a proposal regarding the application of tissue enzyme electrophoresis to the problem of stock identification, and

recommends

that Dr Lavigne and his co-workers undertake a study of tissue enzyme electrophoresis in seals, based on samples of 1,000 pups from each of the Front and Gulf areas with a view to examining up to 30 enzyme systems from 4 tissues.

- iv) The Working Group

recommends

that, if large-vessel effort is diverted from the Front to the Gulf, catch and effort data be collected so as to permit their application in stock assessments.

2. Conservation of Hooded Seals

a) Research in 1977

Canada reported the results of an aerial survey of breeding seals in Davis Strait, tagging and branding activities and recoveries, and age composition data (Res. Doc. 77/XI/57). Norway and Canada presented an analysis of hooded seal population data and a population model.

b) Population assessment

- 1) Production. An area estimate of herds in Davis Strait was obtained and pup production was estimated to be at a minimum of 7,500 (Res. Doc. 77/XI/57). It was concluded that the whelping of hooded seals in Davis Strait (63° to 64°N) was a relatively constant feature.

Pup production for the stock exploited at the Front was estimated to be 38,000 in 1977. This estimate was obtained by projection from a 1971 population estimate determined by sequential population analysis, with recruitment based on a density-dependent ogive (Benjaminsen and Lett, unpublished). Similar projection by sequential population analysis from a 1969 pup production of 27,000 (Res. Doc. 76/X/126) gave an estimated 1977 production of 34,000 pups.

- ii) Stock size and sustainable yields. Based on sequential population analysis (unpublished data), the stock size of age 1+ females appears to have increased from a low of about 53,000 in the early 1960's to 77,000 in 1977. Assuming a natural mortality rate (M) of 0.124, mean whelping age of 3.8 years, and a 1977 pup production of 38,000, and taking into account the current regulation restricting the catch of females to 10% of the total catch, the sustainable yield was estimated to be 22,000 animals, comprising 17,700 pups, 2,000 breeding females and 2,300 older males. However, the Working Group considered that the data were insufficient to recommend any change in the TAC.

c) Future research on hooded seals

- 1) The Working Group agreed on the desirability of intensive tagging of older seals in Davis Strait in order to elucidate stock relationships more quickly than by tagging pups, and

recommends

that a tagging technique, using drugs to immobilize older seals, be developed for use in 1978.

- ii) The Working Group, noting the availability of sampling data from Denmark Strait, agreed that tagging in this area was warranted, and

recommends

that a tagging program be developed for the Denmark Strait stock in order to determine stock relationships.

- iii) The Working Group considered the need for extensive age composition data from the Front herd and suggested that jaws be collected from all age 1+ hooded seals taken by large vessels operating in the area. In any case, the Working Group

recommends

that extensive age samples, segregated by sex, be collected from the harvest at the Front in 1978.

