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REPORT OF THE JOINT ICES/NAFO WORKING GROUP ON HARP AND HOODED SEALS

Copenhagen, 15 - 21 September 1993

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1 TERMS OF REFERENCE

In 1984 an ICES Working Group on Harp and Hooded Seals in the Greenland Sea was established (C.Res. 1984/2:4:18); meetings were held in September 1985 and October 1987 (ICES Coop. Rep. 148 and ICES C.M. 1988/Assess:8). In 1988 the terms of reference were expanded to include harp seals in the White and Barents Seas (C.Res. 1988/2:4:27), and the Working Group met in October 1989 (ICES C.M. 1990/Assess:8).

In 1989 it was recommended that a Joint ICES/NAFO Working Group on Harp and Hooded Seals be established, with the following mandate (C.Res. 1989/3:1):

" ... for the purpose of assessing the status of these stocks and providing related advice and information in the areas of both organizations. Contracting Parties to either organization or regulatory commissions who might desire advice on harp and/or hooded seals in a particular geographical area must refer their request to the organization (NAFO or ICES) having jurisdiction over or interest in that area. Advice based on reports of the Joint Working Group would be provided by ACFM in the case of questions pertaining to the official ICES Fishing Areas (FAO Area 27) and by NAFO Scientific Council in the case of questions pertaining to the legally-defined NAFO area. ICES will administrate the Joint Working Group in terms of convening meetings, formulating terms of reference, handling membership and chairman-ship, and processing, printing, and distributing Working Group reports."

Following a request from Norway, the Joint Working Group met for the first time in October 1991 (ICES C.M. 1992/Assess:5).

The Joint Working Group did not meet in 1992, but reacting upon its recommendation an ICES/NAFO Workshop on Survey Methodology for Harp and Hooded Seals was held 5-12 October 1992 in Archangelsk, Russia (ICES C.M. 1993/N:2).

In April 1993 ICES received a request from Norway, asking for assessment of the Greenland Sea stocks of harp and hooded seals, and advice for the 1994 sealing season in that area. This request led to the formulation of the following terms of reference for the present meeting: the Joint Working Group shall meet to

- a) Review any new data on stock identity and migrations for harp and hooded seals;

- b) Assess the stock size and pup production of harp and hooded seals in the Greenland Sea;
- c) Provide catch options for the 1994 sealing season in the Greenland Sea;
- d) Review any new data on the feeding of harp and hooded seals in order to assess possible interactions with other living marine resources; and
- e) Review the available data used to assess the state of stocks of harp and hooded seals and give proposals for future research programmes.

It is noted that the Joint Working Group is not requested to make any assessment, or provide catch options, on the harp and hooded seal stocks in the White and Barents Sea or the Northwest Atlantic, but available scientific information on these stocks should be reviewed, when relevant for addressing the terms of reference.

2 MEETING ARRANGEMENTS

The Working Group, chaired by F.O. Kapel, and comprised of scientists from Canada, Denmark, Norway, Russia and the U.S.A, met at the Greenland Fisheries Research Institute, Copenhagen, from 15 to 21 September 1993. A list of participants is given in Appendix I.

The Working Group reviewed available information on catches and relevant scientific information on harp and hooded seals, including documents prepared for this meeting. The Agenda adopted for the meeting is shown in Appendix II, and the papers referred to are listed in Appendix III.

3 HARP SEALS (*PHOCA GROENLANDICA*)

3.1 Stock Identity, Distribution and Migrations

No new genetical evidence was presented. A study of underwater vocalizations of harp seals during the breeding season in the Gulf of St. Lawrence and north of Jan Mayen (Terhune, in prep), found each herd to have one unique call type and 17 shared call types. This was considered to support the theory of reproductive separation of these two stocks.

In a review of recent tag recaptures (Øien, this meeting, SEA-47) it was noted that three immature harp seals (born in 1989, 1990 and 1991) marked in the West Ice were caught in the southeastern Barents Sea during the catch operations on moulting harp seals there in April 1992. Recaptures of harp seals tagged on the White Sea breeding ground have been made in the White Sea, in the southeastern Barents Sea, south of Spitsbergen, in the

northern Barents Sea, along the Norwegian coast, and at East and Southwest Greenland. This adds to the general picture pointed out in earlier reports of the Working Group that immatures have a very wide distribution overlapping the general division into three main stock areas, but does not provide evidence of mixing on breeding grounds.

Information on movements of adult harp seals from the West Ice was obtained from satellite tagging (Folkow and Blix, 1993). Most seals stayed near the ice edge off the east coast of Greenland throughout the tracking period. One seal travelled to the Barents Sea south of Spitsbergen.

3.2 The Greenland Sea (Jan Mayen, West Ice) Stock

3.2.1 Catches, regulatory measures, and research

Recent Norwegian and Russian catches of harp seals in the Greenland Sea are listed in Appendix IV, Table 2. Both countries participated in the West Ice sealing in 1992, but because of exceptionally poor ice conditions, one Russian ship returned from this area before operations started in 1993. The total catches taken in 1992 and 1993 were 9633 and 3520 harp seals respectively. Of these only 590 were pups taken by Russia for scientific purpose in 1992. In 1993 one Norwegian ship operating mainly in the West Ice, caught 717 harp seals south of Spitsbergen, east of 14°E. This catch is recorded under catches from the Barents and White Seas (Appendix IV, Table 5).

Available information on Norwegian and Russian sealing effort directed at both hooded and harp seals in the West Ice, is given in Appendix IV, Tables 3 and 4.

An updated summary of sealing regulations for the Greenland Sea for 1985 through 1993 is given in Appendix V, Table 1.

Data from the Norwegian photographic and visual surveys of harp seals in 1991 (Øien and Øritsland, 1993) have been analysed, and results were reported to this meeting (Øien, this meeting, SEA-46). Sampling was continued in 1992 and 1993 for studies of the age composition in Norwegian catches of moulting harp seals (Anon., this meeting, SEA-44). The data from these studies have been applied to an update of mark-recapture estimates of pup productions (Øien, this meeting, SEA-47) and used also in a revised stock assessment by simulations of a population model for this stock (Ulltang, this meeting, SEA-48). Norwegian research also included tracking of West Ice harp seals by satellite transmitters deployed on three adults in July 1992 and six adults in March 1993 (Folkow and Blix, 1993).

In 1992 Russian scientists, using one ship and one aircraft, collected information on the distribution, migration, age-composition, reproduction, moulting, feeding and physical condition of harp seals in the Greenland Sea. A total of 1719 harp seals were sampled for these studies (Anon., 1992b). No field work was carried out by Russia in this area in 1993.

3.2.2 Biological parameters

There were no new information on biological parameters of this stock.

Estimates of natural mortality (M) derived from the population model for harp seals in the Northwest Atlantic (Cadigan et al., this meeting, SEA-52) are greater for this stock than previously assumed. It is unknown, however, whether this is an actual increase in M or if the increase is influenced by unreported catches.

An apparent increase in age of female sexual maturity in the White and Barents Sea (Kjellqwist *et al.*, this meeting, SEA-42) was believed to be related to environmental changes in the Barents Sea area; and therefore not considered relevant for assessment of Greenland Sea harp seals.

The Working Group accordingly decided to continue using the biological parameters previously adopted for assessments of harp seals in the Greenland Sea (reviewed by Ulltang, this meeting, SEA-48).

3.2.3 Population size and pup production

Updates of mark-recapture estimates of pup production were presented by Øien (this meeting, SEA-47). The estimate for 1991 pup production was 57,800 with a 95% confidence interval of 46,000-69,000. The validity of the underlying assumptions of these mark-recapture estimates was discussed at the previous meeting of the Working Group (Anon., 1992a), and also discussed by Øien and Øritsland (1992). The Working Group concluded that violations of the randomness assumptions could give the most serious problems. The tags put out in 1991 during the survey expedition in the Greenland Sea were thought to have been distributed uniformly. The pup production in 1991, estimated from 1992 catch data, was similar to an estimate incorporating 1993 data. The author thought that this put a higher degree of confidence to the estimate.

Results from visual and photographic surveys conducted in 1991 to estimate pup production in the Greenland Sea were presented by Øien and Øritsland (1993) and by Øien (this meeting, SEA-46). Four whelping patches were identified, but neither visual nor photographic surveys covered all patches. Therefore, an estimate of total pup production based on either method cannot be

provided. Visual and photographic estimates were available from two of the four patches. Although not significantly different, the visual estimates for these two patches tended to be considerably higher than the corresponding photographic estimates. Øien (this meeting, SEA-46) combined estimates, weighted by variances, into an overall estimate of pup production in the four identified patches. This produced an estimate of total production of 55,300 with a 95% confidence interval of 44,500-68,500.

Differences between visual and photographic results could not be explained, particularly with reference to the largest patch which was surveyed concurrently. In corresponding studies at Newfoundland, the estimates from visual and photographic surveys were similar. The differences in the Norwegian surveys may be the results of non-identified systematic errors, which the Working Group were unable to resolve.

Given the difficulties mentioned above, and the additional argument that the survey estimate refers to identified patches only, the Working Group chose to base its best estimate for pup production in 1991 on the mark-recapture data, despite the problems usually associated with this technique.

3.2.4 Management considerations

Using the model given by Ulltang (1989a), stock and catch projections were carried out for the Greenland Sea harp seal population by Ulltang (this meeting, SEA-48), assuming a pup production in 1991 of 50,000 as used at the last meeting (Anon., 1992).

These projections were re-run using estimates of pup production obtained from the mark-recapture studies (see 3.2.3), namely 46,000 (lower 95% confidence limit), 58,000 (mean) and 69,000 (upper 95% confidence limit) pups.

The projections were run for the same alternative scenarios as in the 1991 report (Anon., 1992a):

- (a) no catch of pups;
- (b) catch of pups only; and
- (c) a ratio between pup catch and catch of 1-year-old and older seals approximately equal to the mean ratio during 1979-1988.

For all three scenarios, annual exploitation rates (catch/stock size) of pups (u_0) and older seals (u_{1+}) were selected to stabilize the population.

Biological parameters are unchanged from the 1991 assessment. That is, natural mortality $M=0.11$, with natural mortality of age group 0 equal to $3M$; fertility rate $f=0.94$; and step-wise maturity ogive (10% of 5 years old, 50% of 6 years old, and 100% of 7 years old seals recruited to the breeding stock).

The mean estimate of 1991 pup production (58,000), gave $N_0 = 59,800$ and $N_{1+} = 285,800$ stock sizes in 1994 (Table 3.2.1). Using the lower (46,000) and upper (69,000) 95% C.I. estimates resulted in 1994 stock sizes that were 23% below and 21% above the reference values, respectively.

The Working Group considers that the catches calculated above (and shown in Table 3.2.1) are at levels that would result in the stabilisation of stock size. Upper and lower confidence limits of the mean estimate of 1991 pup production are included to provide the potential range of variability associated with the pup production estimates.

Table 3.2.1

1991 N_0 = 46,000; 1994 N_0 = 46,300; N_{1+} = 220,700

Exploitation rates		Catches					
of pups	of 1+	1994			Equilibrium		
u_0	u_{1+}	Pups	1+	Total	Pups	1+	Total
a) 0	0.046	0	10,200	10,200	0	10,400	10,400
b) 0.443	0	20,500	0	20,500	24,900	0	24,900
c) 0.225	0.025	10,400	5,500	15,900	11,300	5,500	16,800

1991 N_0 = 58,000; 1994 N_0 = 59,800; N_{1+} = 285,800

Exploitation rates		Catches					
of pups	of 1+	1994			Equilibrium		
u_0	u_{1+}	Pups	1+	Total	Pups	1+	Total
a) 0	0.046	0	13,100	13,100	0	13,500	13,500
b) 0.443	0	26,500	0	26,500	32,100	0	32,100
c) 0.225	0.025	13,500	7,100	20,600	14,600	7,100	21,700

1991 N_0 = 69,000; 1994 N_0 = 72,200; N_{1+} = 345,900

Exploitation rates		Catches					
of pups	of 1+	1994			Equilibrium		
u_0	u_{1+}	Pups	1+	Total	Pups	1+	Total
a) 0	0.046	0	15,900	15,900	0	16,200	16,200
b) 0.443	0	32,000	0	32,000	38,800	0	38,800
c) 0.225	0.025	16,200	8,600	24,800	17,600	8,600	26,200

3.3 The White and Barents Seas Stock of Harp Seals

3.3.1 Catches, regulatory measures, and research

Russian and Norwegian catches of harp seals in the White and Barents Seas are listed in Appendix IV, Table 5. The combined catches in 1992 and 1993 were 35,661 and 40,258 harp seals, respectively; i.e. on a level comparable to catches in 1989 and 1990.

Sealing regulations for the White and Barents Sea stock, which have remained unchanged since 1989, are summarized in Appendix V, Table 2.

Norwegian research in 1992 and 1993 included continued sampling for age analyses of catches (Anon., this meeting, SEA-44), studies of feeding and condition (Nilssen and Haug, this meeting, SEA-43), and growth and reproduction (Kjellqwist et al., this meeting, SEA-42). Studies of harp seal energetics in the Barents Sea are being continued at the Department of Arctic Biology, University of Tromsø, but results were not reported to this meeting. Harp seals and minke whales have now been included as predators in the multispecies model for the Barents Sea (MULTSPEC - Bogstad et al., 1992). Further development of the model includes a feed-back from prey abundance to these predators.

Russian research in 1992 and 1993 included age analyses and studies of feeding, abundance, and tagging. Age samples collected on the breeding and moulting grounds during the past three decades have been analyzed (Anon., 1991, 1992b). In 1993, Russian reconnaissance surveys were conducted in late February and early March to determine the harp seal distribution during the breeding season (Timoshenko, this meeting, SEA-56). Results of a Russian 1993 experimental survey that used IR technology to estimate seal abundance were presented (Chernok et al., 1993).

3.3.2 Information on the state of the stock

Russian evaluations of the status of the stock are based on results from aerial surveys. The latest survey, conducted in 1991, resulted in an estimate of 141.6 thousand breeding females in the White Sea (Popov, this meeting, SEA-58).

Russian age composition data and surveys also indicate that significant changes have occurred in the structure, migrations, distribution, and a dramatic reduction in the number of young animals, of White Sea harp seals during the last decade (Timoshenko, 1991, 1992). Russian scientists believe these changes are related to environmental changes in the Barents and White Seas, and this has caused concerns about the status of the stock.

Large by-catches in coastal Norwegian gillnet fisheries through 1986-1988 (Haug et al., 1991) may have influenced these cohorts, particularly the 1987 year-class. Age composition data show a consistent low representation of these cohorts in Norwegian catches of moulting harp seals in the East Ice in recent years (Anon., 1991, SEA-29; Anon., this meeting, SEA-44). This may be related to an apparent delay in the age at sexual maturity of females sampled in the Barents Sea (Kjellqwist et al., this meeting, SEA-42).

3.4 The Northwest Atlantic Stock of Harp Seals

3.4.1 Catches, regulatory measures, and research

Recent catches of harp seals are given in Appendix IV, Table 10. Catches remained relatively constant between 1989 and 1992. Preliminary estimates for 1993 indicate that catches declined to approximately 25,000 seals. This appears to be due primarily to decreased effort in response to poor markets. The age structure of the landsmen catches was not available for 1990-1992.

The TAC for harp seals in Canadian waters remained at 186,000 (Appendix V, Table 3a). The Seal Management Plan, which outlines recent Canadian sealing policies, was adopted in 1992. The final stage of this plan, the banning of the use of nets to capture seals south of 54°N, occurred in 1993.

Canadian research includes analysis of the 1990 aerial survey data and development of the harp seal population model (see Section 3.4.2). Studies of the diet and condition of harp seals in the Gulf and nematode parasites of seals from Newfoundland have also been completed. Biological sampling of seals from inshore areas has continued to monitor potential changes in vital rates. Efforts to sample seals in offshore areas have increased. Studies on the distribution and diet of harp seals in the Newfoundland area are near completion and preliminary results have been reported (Lawson et al. 1993; Stenson and Kavanagh 1993). Analysis of the morphological measurements taken from seals collected in Newfoundland between 1979 - 1993 has been initiated. As part of this study, over 700 moulting harp seals were sampled during 1992. Also satellite-linked time-depth recorders were attached to two female harp seals captured on the whelping patch in the Gulf of St. Lawrence in March 1992.

Greenland reported on additional analyses of harp seal feeding patterns in Southwest Greenland (Kapel, this meeting, SEA-49), on trends in catch and purchase of skins (Kapel, this meeting, SEA-51).

3.4.2 Information on the state of the stock

Analyses of the 1990 surveys to estimate Northwest Atlantic harp seal pup production are given in Stenson *et al.* (1993). The best estimate of pup production at the Front, based on visual surveys, was 467,000 (SE=31,000). The photographic estimates were comparable. Pup production estimates for the southern (Magdalen Island) and northern (Mecatina) Gulf whelping concentrations were 106,000 (SE=23,000) and 4,400 (SE=1,300), respectively. Thus, total pup production was estimated to be 578,000 (SE=39,000).

Previously, pup production was estimated from age composition data, aerial surveys and mark-recapture experiments. It is difficult to directly compare the 1990 results to earlier estimates to quantify changes in pup production. Different methods involve assumptions that may bias the estimates to different degrees. Although aerial survey techniques have been used previously, both the Front and Gulf have not been surveyed satisfactorily in the same year. Recognizing the difficulties inherent in comparing the results of different methods, and doing so cautiously, it appears as if pup production has increased, possibly to the levels estimated for the 1950's. However, the rate of increase cannot be estimated.

Cadigan *et al.* (this meeting, SEA-52) and Cadigan and Sheldon (1993) present a population dynamics model that estimates number at age trajectories for Northwest Atlantic harp seals. This model is derived from the approach of Roff and Bowen (1983; 1986) but incorporates aspects of the approach of Cooke (1985) to estimate initial age distribution. Cadigan *et al.* fit a population dynamics model incorporating observed catch at age and pregnancy rates to independent survey estimates of pup production. With explicit assumptions, confidence bounds for numbers at age are constructed. The model estimates the total population (including the 0-group) of harp seals in the Northwest Atlantic in 1990 to be 3.12 million with 95% confidence bounds of 2.58 million and 3.66 million.

Although the results of this model must be viewed with caution due to the possible lack of comparability between mark-recapture and aerial surveys and uncertainties about the catch and pregnancy data, model trajectories show little change over time (1965-1990). Examination of confidence curves for the change in pup and total population numbers between 1980 and 1990 suggest that there is no significant evidence that the population has increased or declined during this period. This is in contrast to an estimated growth rate of 5 - 7% which would result from a direct comparison of the 1990 population to an estimate of 1.5 - 1.75 million harp seals in 1978 made by the Royal Commission on

Seals and Sealing in Canada (Anon., 1986). This apparent discrepancy appears to be due to the pup production

estimates used. The Royal Commission (Anon., 1986) estimated pup production in 1978 to be 300,000 - 350,000, based primarily on estimates derived from age composition data. The model presented in Cadigan *et al.* (this meeting, SEA-52) requires estimates of pup production that are independent of catch at age and therefore, is fit to the higher mark-recapture estimates (500,000) for the 1978 - 1980 period.

Cadigan *et al.* (this meeting, SEA-52) also presents an analysis of the sensitivity of the estimates to some of the model assumptions. There does not appear to be appreciable bias in model estimates and confidence intervals because of the small number of surveys, when all other assumptions are known to be true. If catches are under-reported, then estimated trajectories are negatively biased while the presence of a M_0 larger than M_1 could cause a slight positive bias in total population numbers. The bias caused by density dependent pup mortality appears small.

Kapel (this meeting, SEA-51) showed a relationship between purchase statistics and catches for the period 1975 - 1985. Both show an increasing trend in catches of harp seals over the period. Although catch statistics are not available since 1985, the trend in purchase statistics continued until 1991 when a dramatic increase was observed. Recent hunting effort and the relationship between effort and purchases are unknown. If they have remained relatively constant, the increase in purchases would suggest an increase in local availability of harp seals.

4 HOODED SEALS (*CYSTOPHORA CRISTATA*)

4.1 Stock Identity, Distribution and Migrations

Kapel (this meeting, SEA-41) provides an update of recaptures of hooded seals tagged at Newfoundland and Jan Mayen and recaptured in Greenland in 1992 and 1993. The two new recaptures were noted as special. One provides evidence that hooded seals are overwintering in Greenland, and the second represents the first recovery in Greenland of Jan Mayen breeding animals.

Satellite telemetry studies of adult hooded seals from the West Ice were reported (Folkow and Blix, 1993). While several of the seals remained in or near the sea ice edge, close to the east coast of Greenland, for most of the tracking period, they generally seemed to travel over a vast area including the Norwegian Sea from south of the Faroe Islands to west of Svalbard, and eastwards to the coasts of the Norwegian mainland.

Similar studies of hooded seals breeding in the Gulf indicate that both males and females feed for a 1-2 month period in the deep waters of the Gulf before heading over

to the moulting grounds in the Denmark Strait. The study provided new information on the timing of migration and diving behaviour.

The satellite telemetry studies support earlier information on the seasonal distribution and stock identity of hooded seals.

4.2 The Greenland Sea Stock of Hooded Seals

4.2.1 Catches, regulatory measures, and research

Recent Norwegian and Russian catches of hooded seals in the Greenland Sea are listed in Appendix IV, Table 1. Russian catches, including catches of females and pups for scientific purposes, increased the total catch to about eight thousand hooded seals in 1992. With the absence of any Russian sealing effort the total catch again fell to a very low level of less than four hundred in 1993.

Available information on Norwegian and Russian sealing effort directed at both harp and hooded seals in the Greenland Sea is given in Appendix IV, Tables 3 and 4; and sealing regulations for this area are summarized in Appendix V, Table 1.

Norwegian satellite tracking of 15 adult hooded seals from the Greenland Sea in July 1992 and 4 in March-April 1993, have provided information on migrations, feeding areas and diving patterns (Folkow and Blix, 1993).

Russian research in March-April 1992 included the collection of information and material for studies of distribution, migration, age composition, reproduction, feeding, moulting and condition. Samples collected from pups and female hooded seals caught for scientific purposes in 1992 and previous years have not been presented to the Working Group.

4.2.2 Biological parameters

No new data on biological parameters were provided at this meeting.

4.2.3 Population size and pup production

No new data on population size and pup production were provided at this meeting.

4.2.4 Management considerations

The Working Group reiterates its conclusion at previous meetings, that insufficient data are available for assessment of the present state of this stock, and for providing scientific advice on catch levels. It was noted, however, that Norway plans to conduct an aerial photographic

survey of hooded seals during the 1994 breeding season, and that this may provide a basis for future management advice.

4.3 Hooded Seal in the Northwest Atlantic (Newfoundland and Davis Strait)

4.3.1 Catches, regulatory measures, and research

Recent catches of hooded seals are given in Appendix IV, Table 12. The low catches in 1992 and 1993 are likely due to low hunting effort. The 1991 preliminary catch level of 11,925 reported at the previous meeting of the ICES/NAFO Working Group has now been revised to 6,321 due to a tabulation error. An updated summary of the sealing regulations for the Northwest Atlantic hooded seal is given in Appendix V, Table 3b. In 1991 the TAC was increased to 15,000 from the previous level of 2,430. It was subsequently reduced to 8,000 in 1993.

No catches have been taken in the Davis Strait breeding area nor in the Denmark Strait moulting area.

Results of the 1990 and 1991 surveys documenting hooded seal pup production at the Gulf have been completed (Hammill *et al.*, 1992). Similar information for the Front is being prepared. A total of 14 hooded seals from the Gulf of St. Lawrence were fitted with satellite-linked time depth recorders. Information on their movements and diving behaviour have been analysed and will be submitted for publishing in the primary literature in the fall of 1993. A study of hooded seal diet has also been completed (Ross, 1993).

Sighting surveys and opportunistic observations on the seasonal distribution of hooded seals have been compiled (Stenson and Kavanagh, 1993). Biological sampling of hooded seals for reproductive samples and information on age, growth and body condition are continuing.

Greenland reported on new recaptures of hooded seals (Kapel, this meeting, SEA-41 (updated)), on by-catch of hooded seals on longlines (Pedersen, this meeting, SEA-50), and on trends in catches and purchase of skins (Kapel, this meeting, SEA-51).

4.3.2 Information on the state of the stock(s)

Northwest Atlantic hooded seal pup production was estimated from aerial surveys flown at the Front in 1990 (Stenson *et al.*, this meeting, SEA-55) and in the Gulf of St. Lawrence during March 1990 and 1991 (Hammill *et al.*, 1992). Two whelping concentrations were identified at the Front in 1990. The pup production (corrected for pups absent from the ice at the time of the survey) was estimated to be 48,684 (SE = 2,747). In addition an estimated 33,498 (SE = 12,450) pups were born outside the whelping concentrations. This estimate could not be

corrected for absence of pups due to the temporal distribution of births. Thus, total pup production was estimated to be 82,182 (SE = 12,636).

Visual surveys were conducted in the Gulf of St. Lawrence during March 1990 and 1991 (Hamill *et al.*, 1992). The estimate for pup production was 1564 (SE= 101) in 1990, and 2006 (SE= 190) in 1991. Only the 1991 estimate has been corrected for the temporal distribution of births.

A series of pup production estimates are available for the Front dating back to the mid-1960s, but many of these results were obtained using different methods and are not directly comparable. However, the survey techniques used in 1990 are similar to those used in 1984 (Bowen *et al.*, 1987). The 1984 results indicated that pup production was 62,000 (95% confidence interval of 43,700-89,400). When compared to 1990 results, this suggests that pup production has increased slowly (5% annually). However, because of the size of the confidence intervals and a lack of understanding concerning the relationships between the Front and other Northwest Atlantic populations, we cannot rule out the possibility of a stable or slightly declining pup production. There are no previous estimates of pup production in the Gulf.

No population model is available for hooded seals. However, assuming a ratio of pups to total population of 1:5, pup production in the Gulf and at the Front in 1990 would represent a total population of approximately 400,000-450,000 hooded seals.

There is no new information available on the Davis Strait breeding stock.

5 ECOLOGY OF THE SEAL STOCKS

5.1 Feeding Biology and Energetics of Seals

Norway presented data on the diet and condition of harp seals from surveys carried out in June, September and October in the northern parts of the Barents Sea, and in the period between the breeding and moulting seasons (March-May) in the southern Barents Sea and the White Sea (Nilssen *et al.*, 1991b; Nilssen *et al.*, 1992; Nilssen *et al.*, 1993; Nilssen and Haug, this meeting, SEA-43). Norway also informed about a survey carried out in February 1993 in the southeastern parts of the Barents Sea.

Contents of stomachs and intestines of harp seals sampled in the northern parts of the Barents Sea showed that the seals had been feeding intensively, mainly on the pelagic amphipod *Parathemisto libellula*, krill and prawns in September and on capelin and polar cod (*Boreogadus saida*) in October. In late winter (March-

April), in the southeastern parts of the Barents Sea (Varangerfjord, North Norway), harp seals appeared to have been feeding intensively on capelin. The harp seal diet in the East Ice in April consisted of prawns, capelin, cod, saithe, sculpins, snailfish and long rough dab. In the White Sea (April-May) the harp seals were feeding mainly on crustaceans and sandeel, capelin and White Sea herring. Late winter and spring feeding in the East Ice area and in the White Sea appeared to have been less intensive than further to the west. The harp seals sampled in June were not feeding, as only a few fragments of prawns and fish were found in some of the stomachs. The material collected from the harp seals in the southeastern parts of the Barents Sea in February have not been analysed, but trawling revealed that large amounts of herring were available (Nilssen and Haug, this meeting, SEA-43).

Norwegian data from stomach contents analyses of invading harp seals taken as by-catch in gill nets on the coast of Norway during winter in 1986-1988 (Haug *et al.*, 1991; Nilssen *et al.*, 1991a) were reported to the Working Group previously (Report of the 1991 Meeting, Anon., 1992). These results indicated opportunistic feeding on a variety of fish species like cod, saithe, haddock, Norway pout, herring and capelin.

Russia reported results from stomach contents analyses of harp seals taken in the White Sea during the breeding season (March) in 1989 and 1993. These results revealed a low feeding intensity during this period, thus Amphipoda, Euphausiacea and Decapoda were found in about 10% of the stomachs (Timoshenko, this meeting, SEA-57).

For the Greenland Sea, no papers on the feeding biology of seals were submitted to this meeting. It was suggested (Folkow and Blix, 1993) that data from satellite tracking of hooded seals in this region may be used to predict prey selection at different times of the year in different areas. The Working Group, however, questioned the usefulness of such data without analyzing stomach and intestine contents of the seals.

The diet of harp seals collected in Canadian waters between 1990 and 1993 was presented in Lawson *et al.*, (this meeting, SEA-53). The stomach and intestinal contents of 1353 seals were reconstructed using whole prey or hard parts. Length and wet weight of fish prey and squid were estimated from regression lines relating these two measures to otolith or beak dimensions. Over 40 prey types were identified although seven prey species (polar cod, herring, capelin, *Pandalus* shrimp, Teuthoid squid, rock cod and sculpins) accounted for almost 90% of the estimated wet weight of food eaten. Although preliminary, results indicate considerable seasonal, geographical and interannual variation in the diet of harp seals collected from nearshore areas. Polar cod was the

most important prey species in all years although its total contribution to the diet varied among years and seasons. For example, it was less important in 1992 or during the summer period. Atlantic cod (*Gadus morhua*) was not a major component of the diet with the exception of a small sample from the waters just south of Newfoundland (NAFO Area 3Psn).

Harp seals were also collected from offshore areas during 1992 and 1993 (Lawson *et al.*, this meeting, SEA-53). As in nearshore seals, prey items varied significantly among sampling periods. Generally, capelin, sand lance and righteye flounder accounted for most of the prey weight consumed by seals collected independently from commercial cod trawls. Atlantic cod were present in only two of the 122 seals examined. In contrast, cod were the predominant prey of harp seals caught in the nets of cod-directed trawls. The size classes of cod found in the stomachs were similar to, or smaller than, cod discarded by the trawlers.

Analyses of harp seal stomachs from the inshore waters of Southwest Greenland confirm previous information that pelagic crustaceans and capelin are the dominant prey species in May-June; the same items are also important in autumn-winter, but the diet is slightly more variable at that time of the year. In offshore waters, harp seal diet in August consist mainly of sandeel and pelagic crustaceans, apparently with local variation. The main target species for commercial fisheries play a minor role for harp seals feeding in these regions (Kapel, this meeting, SEA-49).

Quantitative information on the diet and energetic content of hooded seal prey are available only for the Northwest Atlantic stock. Generally, sample sizes are small. A total of 67 hooded seals were collected from inshore areas of Newfoundland between 1978 - 1992 (Ross, 1993). Fourteen prey groups (10 fish, 4 invertebrate) were identified (Ross, 1993). The most important prey species, expressed as the percentage of total wet weight of prey recovered, was Greenland halibut; followed in order of importance by redfish, polar cod, Atlantic herring, squid, Atlantic cod, and capelin. The relative contributions of prey species, expressed as the percent total energy recovered, indicated that Greenland halibut contributed 53% of the total energy consumed. Hooded seals fed mainly on fish 25-35 cm in length for larger species (e.g. halibut, redfish) and 15-25 cm for smaller ones (polar cod, capelin). The proportions of redfish and Atlantic herring consumed by hooded seals were significantly larger in the summer while a higher proportion of polar cod was consumed in the winter. There were no seasonal or sex differences in the lengths of fish eaten.

Atlantic cod, witch flounder, and *Illex* sp. were the most important prey species of 9 hooded seals collected from offshore areas of Newfoundland in 1992 (Lawson *et al.*,

this meeting, SEA-53). Blue hake and redfish also contributed significantly to their diet.

5.2 The State of Stocks of Prey Species

The need for summary information on the status of important prey stocks was reviewed. It was noted that these data are available, principally for commercially exploited species, in Norwegian and Canadian publications, thus could be extracted. Data on important invertebrate prey (i.e., euphausiids, decapods, etc.) and non-exploited fish stocks (i.e., capelin off Newfoundland and polar cod in all regions), however are not available. Furthermore, members could not identify any current or future studies that might provide the latter data. There was general agreement that it will be difficult to evaluate trophic interactions without these data.

5.3 Interactions with Fishing Gear

During the harp seal invasions in Norway 1986-1988, harp seals were observed to eat fish entangled in nets and were reported to cause considerable damage to gillnets and gillnet catches. Results from these studies also suggest that in presence of large numbers of seals, certain commercial fish species, such as cod, may change behaviour and disappear from traditional fishing grounds (Nilssen *et al.*, 1991a).

A discussion of incidental catches of seals in fishing gear indicated that it occurs at varying levels in all areas. Anecdotal reports of catches in trawls and bottom gillnets in Russia have been received but cannot be quantified. Anecdotal reports of catches were also received from Greenland (Pedersen, this meeting, SEA-50). Large catches of harp seals associated with the Norwegian seal invasions during 1986 - 1988 have not occurred in recent years although a low level of by-catch from gillnets has been reported (Nilssen and Haug, this meeting, SEA-43). In contrast, the Working Group was informed that ongoing studies off Newfoundland indicate that by-catches may have increased in recent years. However, the lack of data on fishing effort in the area has made it difficult to estimate the amount of total by-catch. The majority of the by-catches consisted of young harp seals although some hooded seals were included. By-catches occurred primarily in lumpfish and groundfish gillnets; low levels of by-catches occurring in trawls. Recent reductions in the groundfish fishery will likely reduce the level of incidental catches. The Working Group felt that the level of incidental catches should be quantified in all areas.

5.4 Influence of Other Man-made Activities on Seals

No information on this topic was provided to the Working Group and there was no detailed discussion on any

particular issue. However, it was the general consensus of the group that this topic is important and should receive more consideration in the future. Two issues of particular interest to the Working Group were the impact of large-scale hydrocarbon development in the southeast Barents Sea, and the more general concern of radioactive pollution in harp and hooded seal habitats. Any documents on these, or other issues, should be included in the next meeting of the Working Group. The Working Group recognized that other committees within ICES have addressed issues similar to these and it may be possible to take advantage of their information and expertise in the future - particularly on issues that could affect stock assessment.

5.5 The Role of Seals in the Marine Ecosystems

In 1994, the Norwegian Marine Mammal Research Programme is hosting the International Symposium on the Biology of Marine Mammals in the Northeast Atlantic. The Working Group received the first announcement of the symposium from the Norwegian delegates; all other members of the Working Group were invited to participate.

NAFO and ICES have agreed to sponsor a symposium on the role of marine mammals in the ecosystem in 1995. G. Stenson (coconvenor) invited all members of the working group to participate in the symposium and requested that members contact him with any suggestions relating to the proposed terms of reference. Although the two symposia are just a year apart, the general consensus of the Working Group was that the two events would likely complement each other. Potential problems in overlap could be minimized if the two organising committees co-operate on the selection and depth of coverage of the topics presented.

It was also brought to the attention of the Working Group attention that the SCAR group of specialists on seals is coordinating an international research program on Antarctic pack ice seals as indicators of environmental change. Many of the proposed studies will be of interest to the Working Group in the future.

6 FUTURE RESEARCH

The Working Group noted and endorsed the recommendation from the Workshop on Survey Methodology (Anon., 1993) that another workshop with special emphasis on analysis of survey data and associated problems should be held.

The Working Group further discussed and identified research priorities and recommends that:

- 1) comprehensive aerial surveys, including associated stage determinations and visual surveys, should be conducted periodically to provide estimates of current pup production for harp and hooded seals; efforts should be made to coordinate national programs to ensure comparability of survey results;
- 2) further detailed information on design and techniques used for aerial surveys of harp seals in the White Sea should be made available to the Working Group;
- 3) tagging of harp seals in the White and Barents Seas should be continued, and mark-recapture studies, included testing of the underlying assumptions, should be conducted to provide independent estimates of pup production;
- 4) in order to develop a pup production estimate from the mark-recapture experiments, sampling of harp seal moulting catches in the White and Barents Seas should be continued to determine age and sex composition of commercial catches.
- 5) radio- and/or satellite tagging experiments should be continued to provide information on movements, activity patterns and bioenergetics of individual seals;
- 6) all possible methods should be utilized to determine stock identity of all stocks of harp and hooded seals;
- 7) all available age composition data and biological samples should be analysed and presented to the Working Group to allow assessment of biological parameters;
- 8) studies on the diet of harp and hooded seals with concurrent estimates of possible prey abundance should be continued;
- 9) studies of food consumption rates and energy requirements of seals under experimental conditions and/or in the field should be encouraged in order to improve the basis for modelling possible interactions between seals and other marine resources, and
- 10) possible methods of mapping seasonal relative abundances should be investigated and reported.

7 FUTURE ACTIVITIES OF THE WORKING GROUP

The Working Group discussed when a new meeting would be appropriate, and considers that significant new data and analyses are needed to permit further assessments. An appropriate time for a next meeting may be when results are presented from the planned survey of hooded seals in the breeding season in the West Ice in 1994.

The members noted that Finn O. Kapel who had served as Chairman since the establishment of the Working Group in 1984 and through the reorganization of the group as a joint ICES/NAFO Working Group in 1990, now wishes to resign from this position. He was commended and thanked by the Group for his excellent leadership and guidance throughout his tenure.

APPENDIX I

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APPENDIX II AGENDA

1. Chairman's welcome, and opening remarks.
2. Meeting arrangements:
 - 2.1. Meeting schedule and practical information.
 - 2.2. Appointment of rapporteur(s).
 - 2.3. Adoption of the Agenda.
 - 2.4. Review of documentation.
3. Harp seals (Phoca groenlandica).
 - 3.1. Stock identity, distribution and migrations
 - 3.2. The Greenland Sea (Jan Mayen, "Vestis") Stock:
 - 3.2.1. Information on recent catch and effort, regulatory measures, research and data processing.
 - 3.2.2. Biological parameters.
 - 3.2.3. Population assessment.
 - 3.2.4. Management advice.
 - 3.3. The White Sea and Barents Sea ("Østis") Stock.
 - 3.3.1. Information on recent catch and effort, regulatory measures, research and data processing.
 - 3.3.2. Information on the state of the stock.
 - 3.4. The Northwest Atlantic (Newfoundland) Stock:
 - 3.4.1. Information on recent catch and effort, regulatory measures, research and data processing.
 - 3.4.2. Information on the state of the stock.
4. Hooded seals (Cystophora cristata).
 - 4.1. Stock identity, distribution and migrations
 - 4.2. The Greenland Sea (Jan Mayen, "Vestis") Stock:
 - 4.2.1. Information on recent catch and effort, regulatory measures, research and data processing.
 - 4.2.2. Biological parameters.
 - 4.2.3. Population assessment.
 - 4.2.4. Management advice.
 - 4.3. The Northwest Atlantic (Newfoundland and Davis Strait) Stock(s):
 - 4.3.1. Information on recent catch and effort, regulatory measures, research and data processing.
 - 4.3.2. Information on the state of the stock.
5. Ecology of the seal stocks:
 - 5.1. Feeding biology and energetics of seals.
 - 5.2. Information on the state of stocks of prey species.
 - 5.3. Evidence of interactions with fishing gear.
 - 5.4. Influence of other man-made activities on seals.
 - 5.5. "The role of seals in marine ecosystems"
6. Future research needs.
7. Future activities of the Working Group.
8. Recommendations.
9. Other business.
10. Adoption of report.

APPENDIX III

REFERENCES

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- SEA-42 Kjellqwist, S.A., Haug, T. and Øritsland, T.: Trends in growth and reproductive parameters of Barents Sea harp seals.
- SEA-43 Nilssen, K.T. and Haug, T.: Recent data on feeding and condition of Barents Sea harp seals Phoca groenlandica.
- SEA-44 Anon.: Age distribution in Norwegian catches of moulting harp seals in the Northeast Atlantic, 1992 and 1993 (provisional). Compiled by the Marine Mammal Division, Institute of Marine Research, Bergen.
- SEA-45 Anon.: Norwegian catches of harp and hooded seals in the Northeast Atlantic, 1992 and 1993. Compiled by the Marine Mammal Division, Institute of Marine Research, Bergen.
- SEA-46 Øien, N.: Summary of 1991 aerial and visual surveys to estimate harp seal pup production in the Greenland Sea. (Background: ICES Paper C.M. 1993/N:9).
- SEA-47 Øien, N.: Update of mark-recapture estimates of harp seal pup production in Greenland Sea. (Background: ICES Paper C.M. 1992/N:10)
- SEA-48 Ulltang, Ø.: Updated simulations of development in stock size and pup production for harp seals in the Greenland Sea 1946-1993, and corresponding catch and stock projections (Two Tables).
- SEA-49 Kapel, F.O.: Additional data on variation in the feeding of harp seals (Phoca groenlandica) in Southwest Greenland waters.
- SEA-50 Pedersen, S.A.: Incidental catch of hooded seals during experimental longline fishery in West Greenland, August 1993.
- SEA-51 Kapel, F.O.: A note on variations in the catch of seals and purchase of seal skins in Greenland, 1971-1992.
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APPENDIX IV

**CATCHES OF HARP AND HOODED SEALS
INCLUDING CATCHES TAKEN ACCORDING TO SCIENTIFIC PERMITS**

Table 1. Catches of hooded seals in the Greenland Sea ("West Ice"), 1946-1993^a, incl. catches for scientific purposes.

Year	Norwegian catches			Soviet catches			Total catches		
	pups	1 year and older	total	pups	1 year and older	total	pups	1 year and older	total
1946-	31152	10257	41409	-	-	-	31152	10257	41409
1951-	37207	17222	54429	-	-	- ^b	37207	17222	54429
1956-	26738	9601	36340	825	1063	1888 ^b	27563	10664	38228
1961-	27793	14074	41867	2143	2794	4938	29936	16868	46805
1966-	21495	9769	31264	160	62	222	21655	9831	31486
1971	19572	10678	30250	-	-	-	19572	10678	30250
1972	16052	4164	20216	-	-	-	16052	4164	20216
1973	22455	3994	26449	-	-	-	22455	3994	26449
1974	16595	9800	26395	-	-	-	16595	9800	26395
1975	18273	7683	25956	632	607	1239	18905	8290	27195
1976	4632	2271	6903	199	194	393	4831	2465	7296
1977	11626	3744	15370	2572	891	3463	14198	4635	18833
1978	13899	2144	16043	2457	536	2993	16356	2680	19036
1979	16147	4115	20262	2064	1219	3283	18211	5334	23545
1980	8375	1393	9768	1066	399	1465	9441	1792	11233
1981	10569	1169	11738	167	169	336	10736	1338	12074
1982	11069	2382	13451	1524	862	2386	12593	3244	15837
1983	0	86	86	419	107	526	419	193	612
1984	99	483	582	-	-	-	99	483	582
1985	254	84	338	1632	149	1781	1886	233	2119
1986	2738	161	2899	1072	799	1871	3810	960	4770
1987	6221	1573	7794	2890	953	3843	9111	2526	11637
1988	4873	1276	6149 ^c	2162	876	3038	7035	2152	9187
1989	34	147	181	-	-	-	34	147	181
1990	26	397	423	0	813	813	26	1210	1236
1991	0	352	352	458	1732	2190	458	2084	2542
1992	0	755	755	500	7538	8038	500	8293	8793
1993	0	384	384	-	-	-	0	384	384

^a) For the period 1946-1970 only 5-year averages are given.

^b) For 1955, 1956 and 1957 Soviet reported catches of harp and hooded seals at 3900, 11600 and 12900, respectively (Sov. Rep. 1975). These catches are not included.

^c) Including 1048 pups and 435 adults caught by one ship which was lost.

Table 2. Catches of harp seals in the Greenland Sea ("West Ice"), 1946-1993^a, incl. catches for scientific purposes.

Year	<u>Norwegian catches</u>			<u>Soviet catches</u>			<u>Total catches</u>		
	pups	1 year and older	total	pups	1 year and older	total	pups	1 year and older	total
1946-	26606	9464	36070	-	-	-	26606	9464	36070
1951-	30465	9125	39589	-	-	- ^b	30465	9125	39589
1956-	18887	6171	25058	1148	1217	2366 ^b	20035	7388	27424
1961-	15477	3143	18620	2752	1898	4650	18229	5041	23270
1966-	16817	1641	18459	1	47	48	16818	1688	18507
1971	11149	0	11149	-	-	-	11149	0	11149
1972	15100	82	15182	-	-	-	15100	82	15182
1973	11858	0	11858	-	-	-	11858	0	11858
1974	14628	74	14702	-	-	-	14628	74	14702
1975	3742	1080	4822	239	0	239	3981	1080	5061
1976	7019	5249	12268	253	34	287	7272	5283	12555
1977	13305	1541	14846	2000	252	2252	15305	1793	17098
1978	14424	57	14481	2000	0	2000	16424	57	16481
1979	11947	889	12836	2424	0	2424	14371	889	15260
1980	2336	7647	9983	3000	539	3539	5336	8186	13522
1981	8932	2850	11782	3693	0	3693	12625	2850	15475
1982	6602	3090	9692	1961	243	2204	8563	3333	11896
1983	742	2576	3318	4263	0	4263	5005	2576	7581
1984	199	1779	1978	-	-	-	199	1779	1978
1985	532	25	557	3	6	9	535	31	566
1986	15	6	21	4490	250	4740	4505	256	4761
1987	7961	3483	11444	-	3300	3300	7561	6783	14744
1988	4493	5170	9663 ^c	7000	500	7500	11493	5670	17163
1989	37	4392	4429	-	-	-	37	4392	4429
1990	26	5482	5508	0	784	784	26	6266	6292
1991	0	4867	4867	500	1328	1828	500	6195	6695
1992	0	7750	7750	590	1293	1883	590	9043	9633
1993	0	3520	3520	-	-	-	0	3520	3520

^a) For the period 1946-1970 only 5-year averages are given.

^b) For 1955, 1956 and 1957 Soviet reported catches of harp and hooded seals at 3900, 11600 and 12900, respectively (Sov. Rep. 1975). These catches are not included.

^c) Including 1431 pups and one adult caught by a ship which was lost.

Table 3. Norwegian sealing effort in the Greenland Sea ("West Ice"), 1946-1993^a.

Year	Number of trips/ boats	Crew number		Average duration of trips (days)	Average tonnage		Average Horse- power
		Total	Average		Gross	Net	
1946-	37	588	16	43	119	42	195
1951-	45	760	17	40	140	49	277
1956-	43	702	16	50	137	47	282
1961-	40	652	16	47	140	48	337
1966-	24	370	16	42	152	52	500
1971	18	242	13	23	154	51	548
1972	20	256	13	42	165	56	551
1973	16	202	13	37	164	55	526
1974	16	200	13	42	163	55	561
1975	15	188	13	39	163	54	573
1976	15	188	13	51	174	61	650
1977	13	156	12	43	174	61	642
1978	11	132	12	42	198	73	773
1979	10	130	13	46	224	84	910
1980	9	115	13	52	266	107	1034
1981	7	91	13	52	281	119	1070
1982	6	84	14	36	334	134	1348
1983	2	.	(10)	39	352	144	1325
1984	2	.	(10)	41	237	86	970
1985	1	11	11	37	178	72	940
1986	2	.	.	.	.	.	.
1987	5	.	.	.	.	.	.
1988	7(6) ^b	.	.	.	.	.	.
1989	3	.	.	.	.	.	.
1990	3	41	14	.	.	.	.
1991	2	26	13	.	.	.	.
1992	3	.	.	.	.	.	.
1993	2	.	.	.	.	.	.

Notes: ^a) For the period 1946-1970 only 5-year averages are given.

^b) One ship lost.

Table 4. Soviet/Russian sealing effort in the Greenland Sea ("West Ice"), 1958-1993^{a,b}.

<u>Year</u>	<u>Number of vessels</u>	<u>Average crew number</u>	<u>Average duration of trips (days)</u>	<u>Average tonnage</u>		<u>Average Horse power</u>
				<u>Gross</u>	<u>Net</u>	
1958-	6	23	22	200	.	.
1961-	7	23	45	200	.	.
1966	4	23	46	200	.	.
... ^c	-	-	-	-	-	-
1975	1	.	45	.	.	.
1976	2	.	24	.	.	.
1977	3	68	16	1971	597	3300
1978	3	.	22	.	.	.
1979	2	.	24	.	.	.
1980	2	.	21	.	.	.
1981	2	.	17	.	.	.
1982	2	.	22	.	.	.
1983	2	.	.	.	.	.
1984	-	-	-	-	-	-
1985	2	.	16	.	.	.
1986	2	.	(11)	.	.	.
1987	2	.	(23)	.	.	.
1988	3	.	.	.	.	.
1989	-	-	-	-	-	-
1990	1	.	.	.	.	.
1991	1	.	.	.	.	.
1992	2	.	.	.	.	.
1993	-	-	-	-	-	-

Notes: ^a) Information extracted from the Soviet reports to the Norwegian-Soviet Sealing Commission.

^b) For the period 1958-1965 only average are given.

^c) Soviet vessels did not participate in the hunt 1967-1974.

Table 5. Catches of harp seals in the White and Barents Seas ("East Ice"), 1946-1993^a.

Year	<u>Norwegian catches^b</u>			<u>Soviet catches</u>			<u>Total catches</u>		
	pups	1 year and older	total	pups	1 year and older	total	pups	1 year and older	total
1946-			25057	90031	55285	145316			170373
1951-			19590	59190	65463	124651			144241
1956-	2278	14093	15777	58824	34605	93549	61102	48698	109326
1961-	2456	8311	10761	46293	22875	69168	48749	31186	79929
1966-			12783	21186	410	21596			34379
1971	7028	1596	8624	26666	1002	27668	33694	2598	36292
1972	4229	8209	12438	30635	500	31135	34864	8709	43573
1973	5657	6661	12318	29950	813	30763	35607	7474	43081
1974	2323	5054	7377	29006	500	29506	31329	5554	36883
1975	2255	8692	10947	29000	500	29500	31255	9192	40447
1976	6742	6375	13117	29050	498	29548	35792	6873	42665
1977	3429	2783	6212 ^c	34007	1488	35495	37436	4271	41707
1978	1693	3109	4802	30548	994	31542	32341	4103	36344
1979	1326	12205	13531	34000	1000	35000	35326	13205	48531
1980	13894	1308	15202	34500	2000	36500	48394	3308	51702
1981	2304	15161	17465 ^d	39700	3866	43566	42004	19027	61031
1982	6090	11366	17456	48504	10000	58504	54594	21366	75960
1983	431	17658	18089	54000	10000	64000	54431	27658	82089
1984	2091	6785	8876	58153	6942	65095	60244	13727	73971
1985	348	18659	19007	52000	9043	61043	52348	27702	80050
1986	12859	6158	19017	53000	8132	61132	65859	14290	80149
1987	12	18988	19000	42400	3397	45797	42412	22385	64797
1988	18	16580	16598	51990	2501	54401	51918	19081	70999
1989	0	9413	9413	30989	2475	33464	30989	11888	42877
1990	0	9522	9522	30500	1957	32457	30500	11479	41979
1991	0	9500	9500	30500	1980	32480	30500	11480	41980
1992	0	5571	5571	28351	2739	31090	28351	8310	36661
1993	0	8758 ^e	8758	31000	500	31500	31000	9258	40258

^a) For the period 1946-1970 only 5-year averages are given.

^b) Incidental catches of harp seals in fishing gear on Norwegian and Murman coasts are not included (see Table 6).

^c) Approx. 1300 harp seals (unspecified age) caught by one ship lost are not included.

^d) An additional 250-300 animals were shot but lost as they drifted into Soviet territorial waters.

^e) Included 717 seals caught to the south of Spitsbergen, east of 14° E, by one ship which mainly operated in the Greenland Sea.

Table 6. Incidental catches and death of harp seals at the Norwegian and Murman coasts¹.

<u>Year</u>	<u>Norwegian coast</u>	<u>Murman coast</u>	<u>Total</u>
1978	.	.	.
1979	2023	1114	3137
1980	3311		
1981	2013		
1982	517		
1983	855		
1984	1236		
1985	1225		
1986	4409		
1987	56222		
1988	21538		
1989	314		
1990	368		
1991	-		

¹) Norwegian data are recorded catches, since 1981 recorded for compensation under regulations for damage to fishing gear.

Table 7. Catches of moulting hooded seals in the Denmark Strait, 1945-1978.

<u>Year</u>	<u>Norway sealing</u>	<u>Greenland sealing^a</u>	<u>Norway scient. sampling</u>
1945	3275	-	-
1946	17767	-	-
1947	16080	-	-
1948	16170	-	-
1949	1494	-	-
1950	17742	-	-
1951	47607	-	-
1952	16910	-	-
1953	2907	-	-
1954	18291	-	-
1955	10230	-	-
1956	12840	-	-
1957	21425	-	-
1958	14950	-	-
1959	6480	414	-
1960	7930	0 ^b	-
1961	-	773	-
1962	-	967	-
1963	-	813	-
1964	-	360	-
1965	-	-	-
1966	-	782	-
1967	-	358	-
1968	-	-	-
1969	-	-	-
1970	-	-	797
1971	-	-	-
1972	-	-	869
1973	-	-	-
1974	-	-	1201
1975	-	-	-
1976	-	-	323
1977	-	-	-
1978	-	-	1201

^a) Performed by KGH (Royal Greenland Trade Department) on behalf of the local inhabitants of Ammassalik, Southeast Greenland.

^b) The vessel was lost 23 June on its first trip that year; previous information on a catch of 773 seals is thus in error (probably confused with the 1961-catch).

Table 8. Catches of hooded seals in West and East Greenland, 1954-1987.

Year	West Greenland			East Greenland				Total Greenland
	N	NW-S	Total	SE	KGH ^c	NE	TOTAL	
1954	-	1,097	1,097	201	-	-	201	1,298
1955	1	971	972	343	-	1	344	1,316
1956	-	593	593	261	-	3	264	857
1957	5	792	797	410	-	2	412	1,209
1958	-	846	846	361	-	4	365	1,211
1959	2	778	780	312	414	8	734	1,514
1960	3	962	965	327	-	4	331	1,296
1961	14	659	673	346	803	2	1,151	1,824
1962	3	542	545	324	988	2	1,314	1,859
1963	7	885	892	314	813	2	1,129	2,021
1964	3	2,182	2,185	550	366	2	918	3,103
1965	3	1,819	1,822	308	-	2	310	2,132
1966	8	1,813	1,821	304	748	-	1,052	2,873
1967	18	1,590	1,608	357	371	1	729	2,337
1968	12	1,380	1,392	640	20	1	661	2,053
1969	5	1,817	1,822	410	-	1	411	2,233
1970	3	1,409	1,412	704	-	9	713	2,125
1971	2	1,632	1,634	744	-	-	744	2,378
1972	1	2,382	2,383	1,825	-	2	1,827	4,210
1973	16	2,638	2,654	673	-	4	677	3,331
1974	61 ^a	2,740	2,801	1,205	-	13	1,218	4,019
1975	143 ^a	3,536	3,679	1,027	-	58 ^a	1,085	4,764
1976	108 ^a	4,122	4,230	811	-	22 ^a	833	5,063
1977	102	3,649	3,751	2,226	-	32 ^a	2,258	6,009
1978	73	3,562	3,635	2,752	-	17	2,769	6,404
1979	152 ^a	3,460	3,612	2,289	-	15	2,304	5,916
1980	113 ^a	3,666	3,779	2,616	-	21	2,637	6,416
1981	101 ^a	3,644	3,745	2,424	-	28 ^a	2,452	6,197
1982	128 ^a	4,270	4,398	2,035	-	16 ^a	2,051	6,449
1983	79 ^a	4,076	4,155	1,321	-	9 ^a	1,330	5,485
1984	79	3,285	3,364	1,328	-	17	1,345	4,709
1985	51	3,137	3,188	3,689	-	6	3,695	6,883
1986	...	2,796 ^b	2,796 ^b	3,050 ^b	-	- ^b	3,050 ^b	5,846 ^b
1987	...	2,333 ^b	2,333 ^b	2,472 ^b	-	3 ^b	2,475 ^b	4.808 ^b
1988 ^d								

^a Only in these years do the figures for this region include estimates for non-reported catches.

^b These provisional figures do not include estimates for non-reported catches as for the previous years.

^c Royal Greenland Trade Department special vessel catch expeditions in the Denmark Strait, 1959-68.

^d For 1988 and following years, comparable catch statistics are not available.

Table 9. Catches of harp seals in West and East Greenland, 1954-1987.

Year	West Greenland			East Greenland			Total Greenland
	N	NW-S	Total	SE	NE	Total	
1954	...	18,912	18,912	475	32	507	19,419
1955	...	15,445	15,445	178	45	223	15,668
1956	...	10,883	10,883	180	5	185	11,068
1957	...	12,817	12,817	133	40	173	12,990
1958	...	16,705	16,705	360	30	390	17,095
1959	...	8,844	8,844	168	7	175	9,019
1960	...	15,979	15,979	350	16	365	16,244
1961	173 ^a	11,713	11,886	219	13 ^a	232	12,118
1962	63 ^a	8,331	8,394	211	10 ^a	221	8,615
1963	120 ^a	9,883	10,003	215	20 ^a	235	10,238
1964	67	9,073	9,140	125	7	132	9,272
1965	109	9,142	9,251	76	2	78	9,329
1966	65	6,964	7,029	55	6	61	7,090
1967	90	4,125	4,215	54	10	64	4,279
1968	117	6,909	7,026	180	4	184	7,210
1969	63	6,320	6,383	110	9	119	6,502
1970	150	6,028	6,178	182	15	197	6,375
1971	53	5,487	5,540	63	5	68	5,608
1972	49	5,903	5,952	84	6	90	6,042
1973	84	9,078	9,162	100	38 ^a	138	9,300
1974	327 ^a	6,746	7,073	144	27	171	7,244
1975	208 ^a	5,745	5,953	125	68 ^a	193	6,146
1976	332 ^a	7,455	7,787	260	27	287	8,074
1977	644 ^a	9,294	9,938	72	21	93	10,031
1978	282	10,258	10,540	408	30	438	10,978
1979	543 ^a	12,231	12,774	171	18	189	12,963
1980	352 ^a	11,918	12,270	308	45 ^a	353	12,623
1981	184 ^a	13,421	13,605	427	49 ^a	476	14,081
1982	335 ^a	16,909	17,244	267	50 ^a	317	17,561
1983	407 ^a	18,332	18,739	357	57 ^a	414	19,153
1984	409 ^a	17,258	17,667	525	61 ^a	586	18,253
1985	421 ^a	18,024	18,445	534	56 ^a	590	19,035
1986	...	13,932 ^b	13,932 ^b	533 ^b	37 ^b	570 ^b	14,502 ^b
1987	...	16,053 ^b	16,053 ^b	1060 ^b	15 ^b	1075 ^b	17,128 ^b
1988 ^c							

^a Only in these years do the figures for this region include estimates for non-reported catches.

^b These provisional figures do not include estimates for non-reported catches as for the previous years.

^c For 1988 and following years, comparable catch statistics are not available.

Table 10. Harp seal catches including research catches in south-eastern Canada ("Gulf" and "Front"), 1946-1991^{a,b}.

Year	Large Vessel Catch				Landsmen Catch ^c				Total Catches			
	pups	1+	unk	Total	pups	1+	unk	Total	pups	1+	unk	Total
1946-	108256	53763	0	162019	44724	11232	0	55957	152981	64995	0	217976
1951-	184857	87576	0	272433	43542	10697	0	54240	228399	98274	0	326673
1956-	175351	89617	0	264969	33227	7848	0	41075	208578	97466	0	306044
1961-	171643	52776	0	224420	47450	13293	0	60743	219093	66069	0	285163
1966-	194819	40444	0	235263	32524	11633	0	44157	227343	52077	0	279420
1971	169426	14343	0	183769	41153	6044	0	47197	210579	20387	0	230966
1972	104109	1646	0	105755	12701	11427	0	24128	116810	13073	0	129883
1973	63369	15081	0	78450	34966	10416	0	45382	98335	25497	0	123832
1974	85387	21828	0	107215	29438	10982	0	40420	114825	32810	0	147635
1975	109832	10992	0	120824	30806	22733	0	53539	140638	33725	0	174363
1976	93939	4576	0	98515	38146	28341	0	66487	132085	32917	0	165002
1977	92904	2048	0	94952	34078	26113	0	60191	126982	28161	0	155143
1978	63669	3523	0	67192	52521	42010	0	94531	116190	45533	0	161723
1979	96926	449	0	97375	35532	27634	0	63166	132458	28083	0	160541
1980	91577	1563	0	93140	40844	35542	0	76386	132421	37105	0	169526
1981 ^d	89049	1211	0	90260	89345	22564	0	111909	178394	23775	0	202169
1982	100568	1655	0	102223	44706	19810	0	64516	145274	21465	0	166739
1983	9529	1021	0	10550	40529	6810	0	47339	50058	7831	0	57889
1984 ^e	95	549	0	644	23745	6528	0	30273	23840	7077	0	30917
1985 ^e	0	1	0	1	13334	5700	0	19034	13334	5701	0	19035
1986	0	0	0	0	21888	4046	0	25934	21888	4046	0	25934
1987	2671	90	2	2763	30986	10266	20	41272	33657	10356	22	44035
1988	0	0	0	0	66950	13493	13493	94046	66950	13493	13603	94046
1989	0	0	0	0	53879	5504	5691	65074	53879	5504	5691	65074
1990 ^e	44	44	0	88	0	0	60040	60040	44	44	60040	60128
1991	0	0	0	0	0	0	52565	52565	0	0	52565	52565
1992 ^e	7	695	0	702	0	0	67428	67428	7	695	67428	68130
1993 ^{e,f}	13	108	0	121	22207	2968	0	25175	22220	3076	0	25296

a) For the period 1946-1970 only 5-years averages are given.

b) All values are from NAFO except where noted.

c) Landsmen values include catches by small vessels (< 150 gr tons) and aircraft.

d) NAFO values revised to include complete Quebec catch (Bowen, W.D. 1982: Age structure ...)

e) Large vessel catches represent research catches and may differ from NAFO catches.

f) Preliminary values.

Year								
1952								
1953	60	1724						
1954	60	1724						
1955	60	1724						
1956	60	1724						
1957	60	1724	1784					
1958	60	1724	1784					
1959	60	1724	1784					
1960	60	1724	1784					
1961	60	1724	1784					
1962	60	1724	1784					
1963	60	1724	1784					
1964	60	1724	1784					
1965	60	1724	1784					
1966	60	1724	1784					
1967	60	1724	1784					
1968	60	1724	1784					
1969	60	1724	1784					
1970	60	1724	1784					
1971	60	1724	1784					
1972	60	1724	1784					
1973	60	1724	1784					
1974	60	1724	1784	1117				
1975	60	1724	1784	2513				
1976	60	1724	1784	2017				
1977	60	1724	1784	1508			1508	
1978	60	1724	1784		72	2057	2129	2129
1979	60	1724	1784		128	3492	3620	3707
1980	60	1724	1784		215	6135	6350	6459
1981					158	4514	4672	4672
1982					166	4715	4881	4268
1983								1287
1984								

¹ Bowen, W.D. 1982. Age structure of northwest Atlantic harp seal catches, 1952-1971. *Sci. Coun. Studies*, 3: 53-65. Mean catch of 1768 for years 1962 - 1971 from Taylor (1977) and values for years 1974-1977 reported by Sergeant.

² Sergeant (pers. comm.) as cited in Bowen (1982).

³ Roff, D.A. and W.D. Bowen. 1986. Further analysis of population trends in the northwest Atlantic harp seal (*Phoca groenlandica*) from 1967 to 1985. *Can. J. Aquatic. Sci.*, 43: 553-564.

⁴ Anon. 1985. Provisional report of the Scientific Council. NAFO. SCS Doc. 85/I/2. Values include catches in the Northwest Territories and northern Quebec.

⁵ Stewart, R.E.A., P. Richards, M.C.S. Kingsley and J.J. Houston. 1986. Seals and sealing in Canada's northern and Arctic regions. *Fish. Aquat. Sci. Tech. Rep. No.* 1463.

Table 12. Hooded seal catches, including research catches, in southeastern Canada ("Gulf" and "Front"), 1946-1993^{a,b}.

Year	Large Vessel Catches				Landsmen Catches ^c				Total Catches			
	pups	1+	unk	Total	pups	1+	unk	Total	pups	1+	unk	Total
1946-	4029	2221	0	6249	429	184	0	612	4457	2405	0	6862
1951-	3948	1373	0	5321	494	157	0	651	4442	1530	0	5972
1956-	3641	2634	0	6275	106	70	0	176	3747	2704	0	6451
1961-	2567	1756	0	4323	521	199	0	720	3088	1955	0	5043
1966-	7483	5220	0	12702	613	211	24	848	8096	5430	24	13551
1971	7987	6875	0	14862	54	30	0	84	8041	6905	0	14946
1972	6820	5636	0	12456	108	36	0	144	6928	5672	0	12600
1973	4499	1930	0	6429	103	35	0	138	4602	1965	0	6567
1974	5984	3990	0	9974	7	18	0	25	5991	4008	0	9999
1975	7459	7805	0	15264	187	160	0	347	7646	7965	0	15611
1976	6065	5718	0	11783	475	127	0	602	6540	5845	0	12385
1977	7967	2922	0	10889	1003	201	0	1204	8970	3123	0	12093
1978	7730	2029	0	9759	236	509	0	745	7966	2538	0	10504
1979	11817	2876	0	14693	131	301	0	432	11948	3177	0	15125
1980	9712	1547	0	11259	1441	416	0	1857	11153	1963	0	13116
1981	7372	1897	0	9269	3289	1118	0	4407	10661	3015	0	13676
1982	4899	1987	0	6886	2858	649	0	3507	7757	2636	0	10393
1983	0	0	0	0	0	128	0	128	0	128	0	128
1984	206	187	0	338 ^d	0	56	0	56	206	243	0	449
1985	215	220	0	435 ^d	5	344	0	349	220	564	0	784
1986	0	0	0	0	21	12	0	33	21	12	0	33
1987	124	4	250	378	1197	280	0	1477	1321	284	250	1855
1988	0	0	0	0	828	80	0	908	828	80	0	908
1989	0	0	0	0	102	260	5	367	102	260	5	367
1990	41	46	0	87 ^d	0	0	636	636	41	46	636	723
1991	0	0	0	0	0	0	6321	6321	0	0	6321	6321
1992	0	6	0	6 ^d	0	0	119	119	0	6	119	125
1993 ^e	0	15	0	15 ^d	0	0	19	19	0	15	19	34

^{a)} For the period 1946-1970 only 5-years averages are given.

^{b)} All values are from NAFO except where noted.

^{c)} Landsmen values include catches by small vessels (< 150 gr tons) and aircraft.

^{d)} Large vessel catches represent research catches and may differ from NAFO values.

^{e)} Preliminary values.

APPENDIX V

SUMMARIES OF SEALING REGULATIONS

Table 1. Summaries of Norwegian sealing regulations for the Greenland Sea ("West Ice"), 1985-1991.

Season	Opening date	Closing date	Quotas ¹			Allocations		
			Total	Pups	Fem. Males	Norway	USSR	
Hooded Seals								
1985	22 March	5 May	(20,000) ²	(20,000) ²	0 ³	unlim.	8,000 ⁴	3,300
1986	18 March	5 May	9,300	9,300	0 ³	unlim.	6,000	3,300
1987	18 March	5 May	20,000	20,000	0 ³	unlim.	16,700	3,300
1988	18 March	5 May	(20,000) ²	(20,000) ²	0 ³	unlim.	16,700	5,000
1989	18 March	5 May	30,000		0 ³	incl.	23,100	6,900
1990	26 March	30 June	27,500	0	0	incl.	19,500	8,000
1991	26 March	30 June	9,000	0	0	incl.	1,000	8,000
1992	26 March	30 June	9,000	0	0	incl.	1,700	7,300
1993	26 March	30 June	9,000	0	0	incl.	1,700	7,300
Harp Seals								
1985	10 April	5 May	(25,000) ²	(25,000) ²	0 ⁵	0 ⁵	7,000	4,500
1986	22 March	5 May	11,500	11,500	0 ⁵	0 ⁵	7,000	4,500
1987	18 March	5 May	25,000	25,000	0 ⁵	0 ⁵	20,500	4,500
1988	10 April	5 May	28,000		0 ^{5,6}	0 ^{5,6}	21,000	7,000
1989	18 March	5 May	16,000	-	0 ⁵	0 ⁵	12,000	9,000
1990	10 April	20 May	7,200	0	0 ⁵	0 ⁵	5,400	1,800
1991	10 April	31 May	7,200	0	0 ⁵	0 ⁵	5,400	1,800
1992	10 April	31 May	10,900	0	0 ⁵	0 ⁵	8,400	2,500
1993	10 April	31 May	10,900	0	0 ⁵	0 ⁵	8,400	2,500

¹ Other regulations include: Prescriptions for date for departure Norwegian port ; only one trip per season ; licensing ; killing methods; and inspection.

² Basis for allocation of USSR quota.

³ Breeding females protected ; two pups deducted from quota for each female taken for safety reasons.

⁴ Adult males only.

⁵ 1 year+ seals protected until 9 April; pup quota may be filled by 1 year+ after 10 April.

⁶ Any age or sex group.

Table 2. Summary of sealing regulations for the White and Barents Seas ("East Ice"), 1979-1991.¹

Season	Opening dates		Closing date	Quotas - Allocations		
	Soviet sealers	Norwegian vessels		Total	USSR	Norway
Harp seals²						
1979-80	1 March	23 March	30 April ³	50,000 ⁴	34,000	16,000
1981	-	-	-	60,000	42,500	17,500
1982	-	-	-	75,000	57,500	17,500
1983	-	-	-	82,000	64,000	18,000
1984	-	-	-	80,000	62,000	18,000
1985-86	-	-	-	80,000		61,000
19,000						
1987	-	-	20 April ³	80,000	61,000	19,000
1988	-	-	-	70,000	53,400	16,600
1989-93	-	-	-	40,000	30,500	9,500

¹ Quotas and other regulations prior to 1979 are reviewed by Benjaminsen, 1979.

² Hooded, bearded and ringed seals protected from catches by ships.

³ The closing date may be postponed until 10 May if necessitated by weather or ice conditions.

⁴ Breeding females protected (all years).

Table 3a. Major management measures implemented for harp seals in Canadian waters, 1960 - 1991.

1961	Opening and closing dates set for the Gulf of the St. Lawrence and Front areas.
1964	First licensing of sealing vessels and aircraft. Quota of 50,000 set for southern Gulf (effective 1965).
1965	Prohibition on killing adult seals in breeding or nursery areas. Introduction of licensing of sealers. Introduction of regulations defining killing methods.
1966	Ammendments to licensing. Gulf quota areas extended. Rigid definition of killing methods.
1971	TAC for large vessels set at 200,000 and an allowance of 45,000 for landsmen.
1972 - 1975	TAC reduced to 150,000, including 120,000 for large vessel and 30,000 (unregulated) for landsmen. Large vessel hunt in the Gulf prohibited.
1976	TAC was reduced to 127,000.
1977	TAC increased to 170,000 for Canadian waters, including an allowance of 10,000 for northern native peoples and a quota of 63,000 for landsmen (includes various suballocations throughout the Gulf of St. Lawrence and northeastern Newfoundland). Adults limited to 5% of total large vessel catch.
1978 - 1979	TAC held at 170,000 for Canadian waters. An additional allowance of 10,000 for the northern native peoples (mainly Greenland).
1980	TAC remained at 170,000 for Canadian waters including an allowance of 1,800 for the Canadian Arctic. Greenland was allocated additional 10,000.
1981	TAC remained at 170,000 for Canadian waters including 1,800 for the Canadian Arctic. An additional allowance of 13,000 for Greenland.
1982 - 1987	TAC increased to 186,000 for Canadian waters including increased allowance to northern native people of 11,000. Greenland catch anticipated at 13,000.
1988	Ban on commercial hunting of whitecoats and hunting on large (>65 ft) vessels.
1992	Seal Management Plan implemented.
1993	Netting of seals south of 54°N prohibited.

Table 3b. Major management measures implemented for hooded seals in Canadian waters (1960 - 1991).

1964	Hunting of hooded seals banned in the Gulf area (below 50°N), effective 1965.
1966	ICNAF assumed responsibility for management advice for northwest Atlantic .
1968	Open season defined (12 March - 15 April).
1974 - 1975	TAC set at 15,000 for Canadian waters. Opening and closing dates set (20 March - 24 April).
1976	TAC held at 15,000 for Canadian waters. Opening delayed to 22 March. Shooting banned between 23:00 and 10:00 GMT from opening until 31 March and between 24:00 and 09:00 GMT thereafter (to limit loss of wounded animals).
1977	TAC maintained at 15,000 for Canadian waters. Shooting of animals in water prohibited (to reduce loss due to sinking). Number of adult females limited to 10% of total catch.
1978	TAC remained at 15,000 for Canadian waters. Limited number of adult females to 7.5% of total catch.
1979 - 1982	TAC maintained at 15,000. Catch of adult females reduced to 5% of total catch.
1983	TAC reduced to 12,000 for Canadian waters. Previous conservation measures retained.
1984 - 1987	TAC reduced to 2,340 for Canadian waters and previous conservation measures retained.
1988 - 1990	TAC maintained at 2,340 for Canadian waters. Hunting from large vessels (>65 ft) banned. Commercial hunt for bluebacks banned.
1991	TAC increased to 15,000.
1992	Seal Management Plan implemented
1993	TAC reduced to 8,000.