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

Dartmouth, N.S. Canada
5-9 June 1995

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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 Methology for Harp and Hooded Seals was held 5-12 October 1992 in Archangelsk, Russia (ICES C.M. 1993/N:2).

Based on a request from Norway, the Joint Working Group met in September 1993 to assess the Greenland Sea stocks of harp and hooded seals, and give advice for the 1994 sealing season in that area (ICES C.M. 1994/Assess:5.

Based on a request by Denmark (on behalf of Faroe Island and Greenland), the present meeting was established to provide assessment advice on harp and hooded seals in the Northwest Atlantic, and impact of environmental changes and ecological interactions for all North Atlantic stocks. The terms of reference suggested by NAFO for the present meeting were:

a) Assess stock sizes, distributions and pup production of harp and hooded seals in the Northwest Atlantic and estimate replacement and sustainable yields both at present stock sizes and in the long term under varying options of age compositions in the catch;

b) Assess the effects on harp and hooded seal populations of recent environmental changes or changes in food supply and possible interactions with other living marine resources in the North Atlantic; and

c) Provide proposals for future research programs.

Based on the report of the Joint Working Group, NAFO Scientific Council will then - at it's June 1995 Meeting advise on catch options for harp and hooded seals in the NAFO area.

In May 1995, the ICES Secretariat forwarded a request from NAMMCO that, in addition to the aforementioned request, a request for assessment advice on harp seal in the White Sea and Barents Sea, and harp and hooded seals in the Greenland Sea. In response, the Chair of this working group noted that few papers pertaining to those stocks will be available for review. Given that, and the short time available for the meeting, the Chair indicated that the Working Group would not be able to meet NAMMCO's request at this meeting, but that it would review available information on the stocks in the Greenland Sea, White Sea and Barents Sea.

2. MEETING ARRANGEMENTS

The Working Group, chaired by G. Stenson, and comprised of scientists from Canada, Denmark (Greenland), Norway, and the U.S.A, met at Keddy's Dartmouth Inn, Dartmouth, N.S., Canada from 5 to 9 June 1995. 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

Harp seal tag recoveries in Greenland, 1949-1994, were reviewed (Kapel, this meeting, SEA-59). The Greenland recoveries contribute to the knowledge on the general distribution of harp seals and the routes and timing of the annual migrations, but cannot be used for assessment purposes because reporting efficiency is variable or unknown. Monthly distribution patterns

generally corresponded to seasonal hunting patterns. Tag returns in recent years indicate that more animals may be overwintering in Greenland waters, which confirms hunters' observations. These data suggest that a slight revision of known distribution patterns is required. Newfoundland hunters also report that harp seals are staying longer in their waters.

The Working Group noted that current information was insufficient to determine the reasons for the apparent distribution shift. Several suggested causes were discussed including population growth, food availability, and environmental affects.

Information on movements of adult harp seals from the Gulf of St. Lawrence and Newfoundland was obtained from Canadian satellite tagging (Stenson *et al.*, this meeting, SEA-60). Two adult females tagged in March 1992 at the Gulf whelping concentration remained in the Gulf until the moulting period when the transmitters lost. Transmitters were deployed on two female seals captured off Newfoundland; one during the southern migration in October 1993 and the other caught on the Grand Banks in January 1994. Information on the movements and diving patterns of both animals were obtained until April 1994.

Preliminary results from Canadian DNA studies suggest that east and west Atlantic stocks can be discerned. Norwegian isoelectric studies (Meisfjord and Nævdal, 1995) indicated that White Sea and Barents Sea are closely related.

The Working Group concluded that current studies do not provide any data to change current stock boundaries, although satellite tagging data are providing new details on distribution and migration.

3.2 The Northwest Atlantic Stock of Harp Seals

3.2.1 Recent catches and regulatory measures

Recent catches of harp seals in southeastern Canada (Gulf and Front) were reviewed (Sjare *et al.*, this meeting, SEA-62; Appendix IV, Table 10. The landsmen catches in 1994 (61,184) were at the same level as in the period 1989-1992 (53,000-68,000), following a low catch in 1993 (26,884). In recent years 'large vessel catches' represent research catches, and amount to only a few hundred animals annually, at most. It was noted that this paper presents the age structure of catches used in the harp seal population model.

New data on harp seal catches in Greenland were presented (Kapel and Rosing-Asvid, this meeting, SEA-61). A system of reporting catches (Lists-of Game) which ended in 1985, estimated that total catch of harp seals in Greenland increased rapidly

from about 8,000 in 1976 to 19,000 in 1985. Information on the purchase of harp seal skins suggests that this increase continued, rising from 9,000 in 1985 to 18,000 in 1992. A change in policy in the purchase of harp seal skins, including a limitation on the number purchased, does not allow us to use purchase statistics to estimate trends in catches in recent years.

In 1992, a new system of collecting hunting statistics for Greenland was introduced, and results are now available for 1993 and the first nine months of 1994. For harp seals, the new information indicated a catch level much higher than previously reported (55,683 in 1993, and an estimate of about 47,000 for 1994). It was discussed whether the increase might be due to misidentification of species or over-reporting. However, the catch levels reported for ringed and hooded seals were of the same magnitude as previously reported for those species. Although a more detailed examination of the new hunting statistics is needed, it cannot be excluded that the present catch of harp seal is about 45,000-55,000 annually, and that the total harp seal catch was underestimated by the earlier collection system.

It was noted that the statistical information on seal catches in Greenland presented in NAFO Statistical Bulletin for 1987-1992 covers only West Greenland and represents purchases of skins, rather than catches.

Since 1993, the only change in regulatory measures for the Northwest Atlantic Stock occurred in 1995 when Canada issued personal licences (Appendix V, Table 3a).

3.2.2 Current research

A variety of studies addressing the seasonal and geographic variation in diets, distribution and migration using satellite tagging, and variability in female reproductive parameters have been completed since 1993. A model to assess the consumption of fish by harp seals is being developed. The main focus of these studies is to determine potential interactions between seals and commercial fisheries. With the demise of the Northern Cod Science Program, most of these projects are being scaled down. However, there will be an attempt to maintain all long term data sets (particulary the information on reproductive parameters and some aspects of the diet work). The modelling of seal consumption will continued.

In June of 1995, 12 satellite tags were deployed on moulted harp seals captured in northeast Newfoundland. Several cooperative energetics studies on captive seals involving Memorial University were also initiated in 1995.

3.2.3 Biological Parameters

A summary of annual age specific pregnancy rates and mean ages at sexual maturity were presented and compared to the historical time series (Sjare *et al.*, this meeting, SEA-64). The annual age specific pregnancy rates were highly variable and difficult to interpret for most age classes. However, there was evidence of a notable drop in rates across all age classes during the 1990s. The overall pregnancy rate (the number of mature females pregnant in a sample regardless of age) has dropped steadily from 95% in the 1960s to approximately 70% in the 1990s. In order to obtain larger sample sizes and to smooth some of the annual variability in the age specific pregnancy rates, sequential X^2 tests were conducted to group the data objectively. The mean age of sexual maturity was 5.8 yrs in the mid-1950s, dropped to 4.6 yrs in the early-1980s and then increased to 5.4 yrs in the early-1990s.

3.2.4 Population Assessment

An estimate of 1994 pup production of harp seals in the Northwest Atlantic was obtained using a combination of photographic and visual aerial surveys off eastern Newfoundland and in the Gulf of St. Lawrence (Stenson *et al.*, this meeting, SEA-65). Surveys were carried out between 7 and 23 March in the southern Gulf of St. Lawrence, northern Gulf, and off the coast of southern Labrador and northeast Newfoundland. Ten whelping areas were identified. Visual and photographic surveys were available for three concentrations while only photographic surveys were available for six. A single visual survey was available for one small concentration. If multiple estimates were available, the average (weighted by the inverse of the variance) was used. Photographic counts were corrected for misidentified pups by comparing multiple readings of photographs made by two or more readers. Estimates were also corrected for pups absent from the ice at the time of the survey. Based on these surveys, pup production was estimated to be 446,700 (SE = 57,200) at the Front, 57,600 (SE = 13,700) in the northern Gulf and 198,600 (SE = 24,200) in the southern Gulf, for a total of 702,900 (SE = 63,600).

The recent estimate of pup production was significantly greater than the 1990 estimate of 578,000 (SE = 38,000; Stenson *et al.*, 1993) which was obtained using similar techniques. Although different techniques were used, estimated pup production in 1994 was also significantly greater than estimates from the late-1970s or early-1980s based on either mark-recapture experiments (Bowen and Sergeant, 1983, 1985) or age composition data (Benjaminsen and Øritsland, 1975; Winters, 1978; Cooke, 1985).

The largest increase in pup production between 1990 and 1994 occurred in the Gulf while production at the Front was slightly lower than in the earlier survey. This is likely due to the movement of females between whelping areas. The proportion of the total production which occurs in each area varies among years but traditionally, approximately a third of the pups are born in the Gulf. The increased production observed in Gulf during 1994 marks a return to this traditional level.

A two parameter exponential population model that uses a time series of independent pup production estimates to describe population trajectory and size was presented (Shelton *et al.*, this meeting, SEA-66). The model estimates an instantaneous mortality (M) and pup exploitation rate (S). The main inputs of the model are catch at age data and age specific pregnancy rates. The model was applied to the 1994 estimate of pup production and 5 previous independent survey estimates. Maximum likelihood estimates of the parameters M and S were obtained using a non-linear weighted regression applying the Newton iterative method. The survey estimates of pup production were weighted by the inverse of their variance. The model was run using two different mortality schedules; one assumed constant natural mortality for all age groups while the other assumed pup mortality was three times that of the 1+ population.

The approximation of the 95% CI for the population trajectory incorporates uncertainty associated with the model parameters of natural mortality (M) and pup exploitation (S). However, there are other sources of uncertainty that have not been addressed including those associated with the age specific pregnancy rates, the catch at age data, and the model itself.

It was noted that the level and composition of catches in Arctic Canada and Greenland was held constant in the model. If catches in Greenland in fact have increased to higher levels in recent years (Kapel and Rosing-Asvid, this meeting, SEA-61), the population size estimated by the model would be slightly less.

The model indicated that pup production declined from the late-1950s through the mid-1970s, increased until 1987, declined rapidly to 1990 and then increased to its present level. The decline in the late-1980s resulted from the lower pregnancy rates during that time period.

Estimates of the total population declined during the 1960s, reached a minimum in the early-1970s, and then increased steadily to the present. The total population in 1994 was estimated to be approximately 4.8 million (95% CI 4.1-5.0) when pup mortality was equal to seals older than 1 year. The total population was 4.5 million when pup mortality was three times that of older seals (the current model could not produce confidence intervals for this estimate in the required time). Since 1990 the population has been growing at approximately 5% per year.

The biological relevance of using sequential X^2 tests to group the annual age specific pregnancy data used in the model was discussed. Although the technique proved to be an objective way to group data, it created sharp breaks in the time series that were difficult to interpret biologically.

The Working Group felt that the abruptness of the changes in maturity for the various age groups, as given in Figure 2 of Shelton *et al.* (this meeting, SEA-66), was partly an artifact of the method used to define groups of years with similar maturity rate. The apparent increase in pup production estimated by the model in the mid-1980s and the sharp decline to 1990 are probably a result of this.

Additional runs of the model where pregnancy rates did not change as abruptly were tried. Some of these runs fit the data well and produced similar estimates for the 1994 population. For example, adding two intermediate steps when pregnancy rates changed significantly produced an estimate of 4.72 million compared to 4.76 million for the original model. The effect of varying how annual pregnancy rates were grouped on the total population estimate was less than that of varying the mortality rate of pups. The Working Group concluded that the model produced the best estimates of population size available at this time, although it could benefit from refinements in the treatment of annual pregnancy rates.

3.2.5 Replacement Yields

The harp seal population model (Shelton *et al.*, this meeting, SEA-66) was projected forward to 1996 to estimate approximate replacement yields under differing assumptions of pup mortality and age structure of the catch. The first scenario assumed that the age structure of the catch was the same as the most recent year available; pups accounted for 49% of the catch. To illustrate the influence of the age composition, a run using a catch consisting of only seals 1 year of age and older (i.e. no pups) was made. The influence of pup mortality was explored by assuming that pup mortality was the same ($m_0 = m_1$) or 3 times that of older seals ($m_0 = 3m_1$). To further explore the influence of the proportion of pups in the catch, a run was made using a catch composition similar to the average seen in the last five years (57% pups). However due to time constraints, only the run assuming constant mortality could be made. Estimates of replacement yield using these assumptions are presented in Table 3.2.5a.

Table 3.2.5a. Estimated 1996 harp seal replacement harvest ('000s).

Harvest Regime	Mortality $m_0 = m_1$[1]	$m_0 = 3m_1$[2]
49% pups	287	275
57% pups	295	-
1+ only	236	**222**

[1] estimated 1996 population is 5.1 million
[2] estimated 1996 population is 4.6 million

Model runs were also made using different levels of the population in 1994. The age composition of the catch was assumed to be equal to the most recent year available and pup mortality was assumed to the same as older seals ($m_0 = m_1$). The point estimate for the 1994 population and the upper and lower confidence limits were used (Table 3.2.5b).

Table 3.2.5b. Estimates of 1996 replacement yield under different assumptions of 1994 population.

1994 population (million)	Estimated 1996 population	Replacement Yield (thousands)
4.1	4.4	208
4.8	5.1	287
5.0	5.2	293

The model assumes that no density dependent changes in the population are occurring; if natural mortality or vital parameters change, the estimates provided here will be invalidated. Since changes in reproductive rates have been shown to occur historically in harp seals, it is important that vital parameters continue to be monitored and new estimates made on a periodic basis.

3.3 The Greenland Sea Stock of Harp Seals

3.3.1 Recent Catches and Regulatory Measures

Available information on recent Norwegian and Russian catches of harp seals in the Greenland Sea pack-ice, the West Ice, is listed in Appendix IV, Table 2. Both nations participated in the hunt in 1994 and 1995. In 1994 the total catch was 8,193 sub-adult and adult harp seals. No information was available on Russian catches in 1995 but the Norwegian catches in the West Ice this year totalled 8,206 harp seals, including 317 weaned pups

taken under permit for scientific purposes.

Available information on Norwegian and Russian sealing effort directed at both harp and hooded 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 1994 is given in Appendix V, Table 1.

3.3.2 Current Research

Sampling was continued in 1994 and 1995 for studies of the age- and sex-compositions in Norwegian catches of moulting harp seals. Data from these studies and the recaptures of 115 tagged harp seals in these catches in 1994 have been applied in a further update of mark-recapture estimates of pup production (Øien, this meeting, SEA-67). A total of 107 recaptures of harp seals tagged as pups in the West Ice through the years from 1977 to 1991 were recorded in Norwegian catches of moulting harp seals in this area in 1995. New taggings were limited to 15 harp seal pups in 1994 and none in 1995.

3.3.3 Information of state of the stock

An update of mark-recapture estimates of pup production was presented (Øien, this meeting, SEA-67). The updates had been made for all cohorts with major taggings over the period 1977-1991, in total ten cohort estimates, using Norwegian catch data up to and including 1994. These cohort estimates were similar to those presented earlier, with the exception that the 1991 estimate was increased by some 10% to 65,100 (95% confidence interval 53,600 - 76,800). The Working Group did, however, not feel that this finding would make any change to the assessments made of this stock at the Working Group's 1993 meeting, since the revised estimate was within the range of values investigated at that meeting.

No other information was presented at the meeting that would allow the Working Group to revise the assessment presented at the 1993 meeting, and it is unlikely that such information will be available in the near future.

3.4 The White Sea and Barents Stock of Harp Seals

3.4.1 Recent Catches and Regulatory Measures

Recent Russian and Norwegian catches of harp seals in the White and Barents Sea are listed in Appendix IV, Table 5. The combined catches in 1994 totalled 42,000 in 1994, ie still on a level comparable to previous years since 1989. The Norwegian catch in the southeastern Barents Sea, the East Ice, was 6,842 harp seals in 1995. This figure included 260 weaned pups taken under permit for scientific purposes.

Available information on recent sealing regulations for the White and Barents Seas is summarized in Appendix V, Table 2.

3.4.2 Current Research

Russian taggings of harp seal pups were continued in the White Sea in 1994 and 1995 but no further information on Russian studies of harp seals in this area was reported to this meeting.

However, recaptures from the tagging program in the White Sea have been reported from the northern Barents Sea, the Greenland Sea moulting lairs, the eastern and southern coasts of Greenland and from the coast of Norway. Recaptures in fishing gear along the Norwegian coast during winter and early spring in 1994 (15 recaptures) and 1995 (37 recaptures) were distributed from Finnmark in the north to Rogaland in the south, with concentrations in the north in both years (Øritsland, 1995; Haug *et al*, this meeting, SEA-71).

Sampling for studies of the age composition in Norwegian catches of moulting harp seals in the Barents Sea was continued and the data show a persistent under-representation of the year-classes 1986, 1987 and 1988, produced in the years of extremely large winter invasions of harp seals in Norwegian coastal waters (Kjellqwist *et al*, in press; Øritsland, 1995).

3.4.3 Information of the state of the stock

Detailed information on the design and techniques used in past aerial surveys has not been made available and there were no new estimates of abundance presented to the Working Group. It was however noted that Russia was conducting aerial surveys in the breeding patches in the White Sea, and that a tagging program in cooperation with the Institute of Marine Research, Bergen, is going on. Age samples are collected from Norwegian moulting catches in the southeastern Barents Sea, which indicates that a mark-recapture pup production estimate may potentially be available in a couple of years.

Age distributions presented (Kjellquist *et al.*, 1995) confirmed the very low representation of the 1986-1988 year-classes in Norwegian catches of moulting harps in the Barents Sea. However, later cohorts show a normal representation in the moulting catches.

The Working Group concluded that it would not be able to assess the present state of the stock until further results of previous and present studies are available.

4. HOODED SEALS (*CYSTOPHORA CRISTATA*):

4.1 Stock Identity, Distribution and Migrations

Kapel (this meeting, SEA-59) provided an overview of hooded seal recaptures at Greenland. Since 1951, about 9,500 hooded seals have been tagged or branded by Canada, Norway and Russia. Greenland recaptures (n = 62) have been made primarily at southeast (Ammasalik district) and southern Greenland, and all but one came from the western stock. It was noted that after the 1986 season, only small numbers of hooded seal pups had been tagged in the Greenland Sea due to the prospective of small moulting catches from that area.

Information on three recaptures in the Russian moulting catches north of Jan Mayen (Stenson and Sjare, this meeting, SEA-68) of hooded seals tagged at the Front and in the Davis Strait was presented. The recaptured hoods were 7-9 years of age. This is a significant finding which indicates that some hooded seals from the western stock migrate to a moulting region which was previously thought to be used only by Greenland Sea hoods. Attention was drawn to hunting statistics from Greenland (Kapel and Rosing-Asvid, this meeting, SEA-61), showing that in 1994 exceptionally high catches of hoods were taken in Thule (northernmost part of west Greenland) in June. This suggested that as least some hoods moulted in Davis Strait or Baffin Bay, because they were caught in Thule immediately prior to the moulting period.

During the period 1991-1994, 29 adult hooded seals were tagged with satellite transmitters at the Gulf and the Front. Detailed information on the movements and diving behaviour during the period between whelping (March) and moult (late June) was obtained from 26 animals. Animals tagged in the Gulf remained in the Gulf or on the continental shelf of Newfoundland for extended periods, while the movements across the Labrador Sea were rapid. Transmitters were usually lost shortly after arrival in Greenland waters. Hoods tagged at the Front had a slightly different migration pattern. Females travelled to the Flemish Cap area, while most of the males went to the area of the Reykjanes Ridge before moving to the moulting areas off Greenland. Following the breeding period, the seals underwent extensive dives along shelf edges in the different areas. Except for one animal who went to Baffin Island, seals from both the Front and Gulf crossed the Labrador Sea to Greenland near or east of Cape Farewell. These movement patterns should be compared to information on catches and tag returns from South Greenland.
Results of studies on satellite tracking of hooded seals in the Greenland Sea are being published (Folklow *et al.*, 1995)

It was noted that genetic studies to differentiate stocks are in progress, but no result were available.

The Working Group concluded that present evidence suggests that the majority of Northwest Atlantic hooded seals moult in the Denmark Strait, but that some hoods may moult in the region north of Jan Mayen in the Greenland Sea and some in Baffin Bay.

4.2 The Northwest Atlantic Stock of Hooded Seals

4.2.1 Recent catches and regulatory measures

Catches of hooded seals in southeastern Canada (Gulf and Front) remained at a very low level in 1993 and 1994: 38 and 221, respectively, part of which were research catches (19 and 72, respectively).

Catches in Greenland remained at about 6,000 annually during the period 1976-1985, based on the old system (Lists-of-Game) of collecting hunting statistics in Greenland. For the years 1986-1992 information on the catch of hooded seals in Greenland is insufficient or lacking. Under the new data collection system (see section 3.2.1) the catch of hooded seals in Greenland was 6,906 in 1993 and 6,772 during the first nine months of 1994. Although the reliability of the new reporting system needs further evaluation, these data appear to indicate that the present catches of hooded seals in Greenland are at the same level observed in the late-1970s and early-1980s, or slightly higher.

No new regulatory measures for the catch of hooded seals in the Northwest Atlantic have been introduced since 1993 (Appendix V, Table 3b).

4.2.2 Current research

Studies on hooded seals in recent years has parallelled that of harp seals. Emphasis has been placed on determining seasonal distribution, migration patterns, and variability in the diet. Collection of biological samples has been ongoing and will continue.

4.2.3 Biological parameters

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

4.2.4 Population assessment

A description of surveys carried out in 1990 to estimate pup production at the Front was presented in (Stenson *et al.*, this meeting, SEA-69). The techniques used were similar to those described for harp seals (see 3.2.4) and outlined in the Report of the Harp and Hooded Seal Survey Methodology Workshop (ICES C. M. 1993/N:2). The resulting estimate was 82,182 (SE = 12,636). This estimate is higher than a previous estimate of 62,400 (95%

C.I. 4,700-89,400) obtained in 1984 using similar survey methodology (Bowen *et al.*, 1987) but the difference is not statistically significant.

The first estimate of Gulf pup production (1,674 SE = 470) was obtained in 1990 using visual survey techniques similar to those used in 1984 and 1990 at the Front (Hammill *et al.*, 1992). A subsequent survey in 1991 resulted in a similar estimate of 2,006 (SE = 190; Hammill *et al.*, 1992). Photographic and visual surveys were carried out in 1994 but the analysis has not been completed.

The only estimate of pup production in the Davis Strait was obtained in 1984. Photographic and visual surveys resulted in an estimate of 18,600 (95% C.I. 14,000-23,000; Bowen *et al.*, 1987).

The total pup production for the Northwest Atlantic stock is unknown because the three whelping areas have not been surveyed in the same year and estimates obtained in different years cannot be combined without information on the degree of mixing. In the absence of such information, minimum estimates of pup production of 81,000 and 84,000 are obtained by combining estimates obtained from the Front and Davis Strait in 1984 and Front and Gulf in 1990, respectively. Therefore, the Working Group agreed to use a minimum pup production estimate of 84,000 (SE = 12,600) for the assessment, realizing that this does not account for possible whelping in Davis Strait in 1990 or changes in the total pup production since these surveys.

Presently, there is no recent population model available to estimate total population.

4.2.5 Replacement Yields

A method to estimate replacement yields of hooded seals in the Northwest Atlantic, based on estimates of pup production, was presented (Myers and Stenson, this meeting, SEA-70). In the absence of recent data on vital parameters or the age composition of the catch, the population dynamics were assumed to be described by a simple Leslie matrix model. The sexual maturity ogive was assumed to be constant and was based upon data collected at the Front in 1979 and 1985. The pregnancy rate was assumed to be 0.94 (Born, 1982) and the sex ratio at birth was 1:1.

Recent estimates of natural mortality are not available. Therefore, two estimates of natural mortality (0.07 and 0.13), which are thought to represent the probable range of M (NAFO, 1983) were used. The model was run under two mortality schedules; one in which natural mortality during the first year of life (m_0) was assumed to be equal to the mortality of seals 1 year of age and older (m_{1+}), another assuming $m_0 = 3m_{1+}$. Hunting mortality on 1+ seals was assumed to be equal on all ages.

Replacement yields were estimated as a ratio of catch to total pup production under three harvest regimes: 1) pups only, 2) 60% pups, 40% older and 3) only 1+ animals (Table 4.2.5a).

Table 4.2.5a. Replacement harvest expressed as a proportion of estimated pup production (catch/pup production).

Harvest Regime	$m_0 = m_{1+}$		$m_0 = 3m_{1+}$	
	0.07	0.13	0.07	0.13
Pups only	0.72	0.44	0.68	0.27
60% pups	0.69	0.37	0.61	0.20
1+ only	0.62	0.30	0.51	0.14

The resulting proportions were then multiplied by the estimate of minimum pup production (84,000) and the approximate confidence limits (2 SE = 25,000) to provide the results in terms of estimated harvest (Table 4.2.5b).

Table 4.2.5b. Estimated replacement yields ('000s) for various levels of pup production (1990 minimum estimate ± 2SE), natural mortality, and harvest regimes.

Harvest Regime	Pup Production	Mortality $m_0 = m_1$		Mortality $m_0 = 3m_1$	
		0.07	0.13	0.07	0.13
Pups only	59,000	42.5	26.0	40.1	15.9
	84,000	60.5	37.0	57.1	22.9
	109,000	78.5	50.0	74.1	29.4
60% pups	59,000	40.7	21.8	36.0	11.8
	84,000	58.0	31.1	51.2	16.8
	109,000	75.2	40.3	66.5	21.8
1+ only	59,000	36.5	17.7	30.1	8.3
	84,000	52.1	25.2	42.8	11.8
	109,000	67.6	32.7	55.6	15.3

Although this simple model provides estimates of replacement yields with the limited data base available for hooded seals, a number of factors contribute to uncertainties in the estimates:

1) The model does not incorporate density-dependent changes in mortality or fertility rates.

2) It is assumed that the age distribution is stable; however, the present age structure of the population is unknown.

3) The harvest is assumed to be taken equally from all three whelping areas in proportion to their pup production. If this is not the case, then knowledge of the relative combination of each stock unit is necessary, and calculation of replacement yields should be carried out for each stock unit separately. Currently, the largest harvest occurs in Greenland where seals from all areas are taken (Kapel, this meeting, SEA-59) in unknown proportions.

4) Survival rates used in this model are based on estimates made prior to the end of the large vessel hunt at the Front and the reproductive rates are based on samples collected over a decade ago.

The Working Group concluded that the estimates of replacement yield provided by this model should be considered illustrative in nature and used with caution. Furthermore, the Working Group considers that a more detailed population model incorporating recent estimates of vital parameters, catch composition, and pup production be used in future assessments.

4.3 The Greenland Sea Stock of Hooded Seal

4.3.1 Recent catches and regulatory measures

Recent Norwegian and Russian catches of hooded seals are given in Appendix IV, Table 1. Norwegian catches have remained low in recent years due to a reduction in hunting effort. In 1995, Norwegian researchers were issued a scientific permit to catch 750 pups, but only 368 were taken. Russian catches in 1994 totalled 4,252 seals; 1995 statistics were not available.

4.3.2 Current research.

Norway informed the Working Group that an attempt to estimate pup production by aerial survey in March-April 1994 was unsuccessful, and that it was planned to conduct aerial surveys at the moulting patches in the Greenland Sea in 1996.

4.3.3 Information on the state of the stock.

Since the first meeting of the Working Group in 1985 it has been stated that recent estimates of pup production or stock size were needed to enable the Working Group to assess the state of the stock and provide scientific advice on sustainable or replacement yields. No new information on present pup production or stock size was tabled at this meeting. The Working Group

concluded that before the results of the above mentioned surveys were available, it would not be possible to assess the present state of the stock.

5. ECOLOGY OF THE SEAL STOCKS:

Two papers on variation in body condition or biological parameters and the possible relation to environmental changes were presented at the meeting (Nilssen *et al.*, this meeting, SEA-72, and Chabot *et al.*, this meeting, SEA-73). In addition, information from a number of recently published documents was presented and discussed (Hammill *et al.*, 1995, Haug and Nilssen, 1995, Kjellquist *et al.*, 1995; and Nilssen, 1995). The main points of these presentations and the following discussion are summarized below.

5.1 Information on environmental changes

In the Barents Sea substantial changes in the marine ecosystem has occurred during the course of the past 30 years. The most important changes relate to the changes in the abundance of two pelagic shoaling fish species. The Norwegian spring spawning herring (*Clupea harengus*) stock collapsed in the late-1960s but is now recovering. Immature herring have been abundant in the southern parts of the Barents Sea since 1988, when the strong 1983 year-class spawned for first time. The Barents Sea capelin (*Mallotus villosus*) stock collapsed in the mid-1980s, recovered to some extent in the early-1990s, collapsed again in 1993 and has remained at a low level. The stock size of the Barents Sea polar cod (*Boreogadus saida*) is not known, but results of annual acoustic surveys conducted since 1986 suggest that the stock is depleted (Haug and Nilssen, 1995).

Climatic conditions in the Barents Sea have been quite variable from the late-1970s until present. The period 1977-1982 was very cold, but since then there have been both warm (1983-1984 and from 1989 until present) and cold (1985-1988) periods (Haug and Nilssen, 1995).

5.2 Changes in biological parameters

A description of growth, short-term and long-term fluctuations in the size and condition of harp seals in the Northwest Atlantic was presented (Chabot *et al.*, this meeting, SEA-73). This work was based on a large sample of harp seals (n = 8165) from Labrador and northeast Newfoundland collected between November and May of most years between 1979 and 1994. Additional data from previous studies (1976-79, 1988-92) was included. A comparison of the most commonly used condition indices indicated that Sergeant's condition index (Sergeant, 1973), Ryg's LMD index (Ryg *et al.*, 1990) and sculp mass expressed as a percentage of body mass, were all correlated with body length. The first two are designed to estimate the third one, which they do, especially

LMD. However, difference in the age or length distribution of groups of animals could affect the results of comparisons of condition between the groups. A different condition index similar to those used by Trites and Bigg (1992) and Hammill *et al.* (1995) corrects for body length and is better suited for monthly or yearly comparisons of condition.

Growth curves were calculated using seals sampled in April only to remove variations due to seasonal changes instead of growth. Males grow to 169.9 cm and 103.3 kg, about 4.7 cm and 4.7 kg more than females.

Mass, sculp mass, core mass, girth, blubber thickness and even body length fluctuated significantly between November and May, with maximum and minimum values encountered in February and May, respectively. Therefore peak values of condition were reached later in winter than in Northeast Atlantic harp seals (Nilssen *et al.*, this meeting, SEA-72). The latter also have more pronounced seasonal variations in blubber thickness than seals from the Northwest Atlantic. It was also noted that seals of both sexes lost body mass in March, but this was due to a lower core mass whereas sculp mass did not change significantly. In April and May both core and sculp mass were reduced.

The population of harp seals in the Northwest Atlantic has increased during the study period (Shelton *et al.*, this meeting, SEA-66). The last 5-8 years have seen climatic changes and the collapse of several stocks of commercial fish in the study area, and both could have affected negatively the abundance of food for harp seals. Past studies have suggested that harp seal growth or condition could be adversely affected in such conditions (Innes *et al.*, 1981, Hammill *et al.*, 1995), but were unable to demonstrate it clearly. Using data for April to remove seasonal variability, young females (<5 y) were found to grow more slowly in both length and mass in the period 1990-94 than in previous periods (1976-79, 80-84, and 85-89). Young males did not differ in growth rate between periods, but had lower length and mass at a given age in 1990-94 than seals from previous periods. Older seals of both sexes were in worse condition in April 1992 than in April 1982, 83 and 84, but did not differ from those sampled in 1981 or 1979. No differences were observed in birth mass, length, or neonatal growth between seals from this study and earlier ones, but it was noted that the way young harp seals are aged could have impaired such an analysis. The decline in growth and condition observed in recent years is paralleled by a decline in fertility rates and increased mean age at sexual maturity in females (Sjare *et al.*, this meeting, SEA-64).

In Norwegian samples of moulting harp seals in the Barents Sea from 1978 to 1994, age compositions by sex indicate that recruitment to the stock was poor during the late-1980s, mainly due to the complete absence of the year-classes 1986, 1987 and 1988. Data from reproductive organs, measurements and age determinations of Barents Sea harp seals suggest decreased growth rates and reduced maximum lengths for both sexes from 1963-1972 to 1990-1993. There was also an apparent increase in age at sexual maturity in both sexes over the same time-span and indirect indices suggest an appreciable reduction in fecundity of females during the past three decades (Kjellqwist *et al.*, 1995). These findings may be related to overall trends in the availability of food sources in the Barents Sea. A comparison of the Norwegian and Canadian results indicated that although females in the Northwest Atlantic show similar trends, they appeared to attain maturity at a much earlier age. The reasons for this difference are not known. It will be important to establish whether or not the different techniques used to determine mean age at maturity are in some way responsible for the differences.

In the discussion it was pointed out that growth curves based on the data from the Barents Sea showed that females were larger than males, which is in contrast to the above mentioned data from the Northwest Atlantic. It was suggested that this difference might be due to the fact that the samples used were not homogenous with respect to sampling time; the second sample included time periods not represented in the first sample.

5.3 Ecological interactions

Harp seals sampled in the Barents Sea were observed to be very lean in mid-June with mean dorsal blubber thickness of less than 20 mm. Condition improved during the course of summer and the seals were in good condition in September and in October when the mean dorsal blubber thickness was approximately 88 mm (Nilssen *et al.*, this meeting, SEA-72). These findings indicate that late summer and autumn are the most intensive feeding periods and that the pelagic amphipod *Parathemisto libellula* appears to be the dominant prey from September until mid-October. During October, a shift in the diet from pelagic crustaceans to fish seems to occur. Capelin, and to a lesser extent polar cod, are major prey during the late autumn. In February immature herring was the main harp seal prey in the southeastern Barents Sea. The energy reserves stored during summer and autumn are maintained until February. During breeding (March) and moult (April-May) the stores of blubber decrease rapidly, indicating restricted food intake at this time. In the short period between lactation and moult (March/April) adult females have been observed to migrate along the Murman coast and further west to the northeastern coast of Norway where they feed intensive on spawning capelin (Nilssen, 1995).

Some preliminary studies from the Newfoundland area by telemetry show that males seem to be hanging around during the breeding season. Slight increases have also been recorded in weight of females between breeding and moulting.

Changes in harp seal migrations that have resulted in invasions of seals to coastal areas of northern Norway have been recorded on several previous occasions, e.g. in the periods 1901-1903 and 1916-1919. The reason for the invasions is by no means fully understood, but low temperatures and salinity, extensive ice-cover and a westerly distribution of potential prey species have been suggested to be important factors (Haug and Nilssen, 1995).

In contrast to previous harp seal invasions, which ceased after a few years, the recent invasions have persisted throughout the period 1978-1995, but with variable intensity. Both the long duration of the recent invasions and the large size of the 1986-1988 invasions do not seem to comply with the cold-climate hypothesis (Haug and Nilssen, 1995). Harp seals sampled during the seal invasions to North Norwegian coastal waters in February 1988 were in poorer condition than seals captured in the Barents Sea in February 1993 (Nilssen *et al.*, this meeting, SEA-72). Capelin has been observed to be an important prey species during late autumn for the harp seals in the Barents Sea and given the fact that the Barents Sea capelin stock collapsed in the mid-1980s, it seems likely that the seals may have faced a food shortage in late autumn and early winter. The low stock sizes of both capelin and herring in the Barents Sea in the mid-1980s combined with increasing numbers of seals within the population have been proposed as being important factors underlying the large seal invasions in 1986-1988. Observations of effects (decreased growth rate, increased age at maturity and reduced female fecundity) that could indicate density-dependent responses within the population may also support a hypothesis that food shortage has been a factor contributing to the seal invasions (Haug and Nilssen, 1995).

It was noted that there was an apparent lag of one year between the collapse of the capelin stock and the first year of seal invasions (1986). For comparison, it was mentioned that cetaceans seem to react immediately to changes in the abundance of prey. No explanation for the time-lag could be presented.

6. FUTURE RESEARCH

The Working Group discussed future research priorities, focusing on the Northwest Atlantic stocks, and recommends that:

1) additional information on reproductive rates of harp and hooded seals be obtained to overcome the problem of small sample sizes.

2) the manner in which reproductive data is analyzed and incorporated into population models be explored.

3) a population model for hooded seals be developed.

4) accurate estimates of harp and hooded seal catches be obtained from the Canadian Arctic and Greenland.

5) the importance of incorporating detailed catch at age data in the assessment models be investigated and, if significant, both samples collected in the past and new material should be used to improve and update the current estimates.

The Working Group also concluded that the following research recommendations identified in the 1993 report (ICES C.M. 1994/Assess:5) should be carried forward.

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 analyzed 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,

10) Possible methods of mapping seasonal relative abundances should be investigated and reported.

7. FUTURE ACTIVITIES OF THE WORKING GROUP

The Working Group discussed the prospects of having a new meeting in the near future, and concluded that it is very unlikely that sufficient new information or analyses would be available on any stock until late-1996 at the earliest. Thus, new assessments of any stocks will not be possible until 1997, unless Russia provides appropriate data for the White Sea harp seals.

The Working Group agreed that it was not feasible to carry out a detailed assessment for more than two stocks at a five day meeting.

Because it had been difficult to allocate sufficient time for the discussion of seal ecology during an assessment meeting, it was suggested that a special meeting on the ecology of harp and hooded seals be held, and that the scope and detailed objectives of such a meeting be determined following the NAFO/ICES Symposium on the Role of Marine Mammals in September 1995.

APPENDIX I

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APPENDIX II

AGENDA

1. Opening remarks

2. Meeting arrangements

   2.1 Meeting schedule.
   2.2 Appointment of rapporteur(s).
   2.3 Review of Terms of Reference.
   2.4 Adoption of the Agenda.
   2.5 Review of documentation.

3. Harp Seals (*Phoca groenlandica*).

   3.1 Stock identity, distribution and migrations.
   3.2 The Northwest Atlantic Stock.
      3.2.1 Information on recent catches and regulatory measures.
      3.2.2 Current research.
      3.2.3 Biological parameters.
      3.2.4 Population Assessment.
      3.2.5 Replacement Yields.
   3.3 The Greenland Sea Stock:
      3.3.1 Information on recent catches and regulatory measures.
      3.3.2 Current research.
      3.3.3 Information on the state of the stock.
   3.4 The White Sea and Barents Sea Stock.
      3.4.1 Information on recent catches and regulatory measures.
      3.4.2 Current research.
      3.4.3 Information on the state of the stock.

4. Hooded Seals (*Cystophora cristata*).

   4.1 Stock identity, distribution and migrations.
   4.2 The Northwest Atlantic Stock.
      4.2.1 Information on recent catches and regulatory measures.
      4.2.2 Current research.
      4.2.3 Biological parameters.
      4.2.4 Population Assessment.
      4.2.5 Replacement Yields.
   4.3 The Greenland Sea Stock:
      4.3.1 Information on recent catches and regulatory measures.
      4.3.2 Current research.
      4.3.3 Information on the state of the stock.

5. Ecology of seal stocks.

   5.1 Information on ecological changes.
   5.2 Changes in biological parameters.
   5.3 Ecological interactions

6. Future research needs.

7. Future activities of the Working Group.

8. Recommendations.

9. Other business.

10. Adoption of report

APPENDIX III

REFERENCES

I. DOCUMENTS PRESENTED AT MEETING

SEA-59 KAPEL, F. O. Recoveries in Greenland, 1949-1994, of tagged or branded harp and hooded seals. NAFO SCR Doc. 95/35, Serial No. N2544 (16 pages; 5 Tables; 3 Figures).

SEA-60 STENSON, G. B., M. O. HAMMILL, and B. SJARE. Satellite telemetry of harp and hooded seals in the Northwest Atlantic. NAFO SC Working Paper 95/7 (6 pages; 10 Tables; 4 Figures).

SEA-61 KAPEL, F. O., and A. ROSING-ASVID. Seal hunting statistics for Greenland 1993 and 1994, according to a new system of collecting information, compared to the previous Lists-of-Game. NAFO SCR Doc. 95/49, Serial No. N2560 (13 pages; 8 Tables; 4 Figures).

SEA-62 SJARE, B., G. B. STENSON, and E. A. PERRY. Catch at age of harp seals in the Northwest Atlantic, 1952-1994. NAFO SCR Doc. 95/36, Serial No. N2545 (9 pages; 5 Tables).

SEA-63 NAFO SECRETARIAT. Catch statistics of harp and hooded seals. NAFO SC Working Paper 95/1 (1 page).

SEA-64 SJARE, B., G. B. STENSON, and W. G. WARREN. Summary of female harp seal reproductive parameters in the Northwest Atlantic. NAFO SCR Doc. 95/37, Serial No. N2546 (9 pages; 6 Tables; 3 Figures).

SEA-65 STENSON, G. B., M. O. HAMMILL, M. C. S. KINGSLEY, B. SJARE, W. G. WARREN, and R. A. MYERS. 1994 pup production of the Northwest Atlantic harp seals, *Phoca groenlandica*. NAFO SCR Doc. 95/17, Serial No. N2524 (23 pages).

SEA-66 SHELTON, P. A., G. B. STENSON, B. SJARE, and W. G. WARREN. Model estimates of harp seal numbers at age for the Northwest Atlantic. NAFO SCR Doc. 95/20, Serial No. N2527 (23 pages).

SEA-67 ØIEN, N. Update of mark-recapture estimates of harp seal pup production in the Greenland Sea. NAFO SCR Doc. 95/38, Serial No. N2547 (1 page).

SEA-68 STENSON, G. B., and B. SJARE. Newfoundland hooded seal tag returns in the Northeast Atlantic. NAFO SCR Doc. 95/39, Serial No. N2548 (1 page).

SEA-69 STENSON, G. B., R. A. MYERS, I-H. NI, and W. G. WARREN. Pup production of hooded seals (*Cystophora cristata*) in the Northwest Atlantic. NAFO SCR Doc. 95/16, Serial No. N2523 (16 pages).

SEA-70 MYERS, R. A., and G. B. STENSON. Replacement yield of hooded seals off the northern coast of Newfoundland. NAFO SCR 95/40, Serial No. N2549 (5 pages).

SEA-71 HAUG, T., K. T. NILSSEN, and T. ØRITSLAND. Norwegian studies of harp seal invasions and the ecology of harp and hooded seal pups in their first year of life in 1995. NAFO SC Working Paper 95/5 (4 pages).

SEA-72 NILSSEN, K. T., P. E. GROTNES, T. HAUG, and V. POTELOV. Seasonal variation in body condition of adult Barents Sea harp seals, *Phoca groenlandica*. NAFO SCR Doc. 95/41, Serial No. N2550 (12 pages; 9 Figures).

SEA-73 CHABOT, D., G. B. STENSON, and N. B. CADIGAN. Short- and long-term fluctuations in the size and condition of harp seal (*Phoca groenlandica*) in the Northwest Atlantic. NAFO SCR Doc. 95/42, Serial No. N2551 (23 pages).

II. PUBLISHED BACKGROUND DOCUMENTS

BENJAMINSEN, T. and T. ØRITSLAND. 1975. The survival of year-classes and estimates of production and sustainable yield of northwest Atlantic harp seals. ICNAF Res. Doc. 75/121, -- p.

BOWEN, W. D., R. A. MYERS and K. HAY. 1987. Abundance estimation of a dispersed, dynamic population: hooded seal (*Cystophora cristata*) in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci.* **44**: 282-295.

BOWEN, W. D. and D. E. SERGEANT. 1983. Mark-recapture estimates of harp seal pup (*Phoca groenlandica*) production in the northwest Atlantic. *Can. J. Fish. Aquat. Sci.***40(6)**: 728-742.

BOWEN, W. D. and D. E. SERGEANT. 1985. A mark-recapture estimate of 1983 harp seal pup production in the northwest Atlantic. *NAFO SCR Doc.* 85/I/1, Ser. No. N935, 14 p.

COOKE, J. G. 1985. Population estimates of Northwest Atlantic harp seal (*Phoca groenlandica*) based on age structure data. *Can. J. Fish. Aquat. Sci.*, **42**:

FOLKOW, L. P., P.-E. MÅRTENSSON, and A. S. BLIX. 1995. Distribution and diving behaviour of hooded seals. *In:* Whales, seals, fish and man. A. S. Blix, L. Walløe and Ø. Ulltang (eds.) Elsevier Science B. V. pp. __-__.

HAMMILL, M. O., M. C. S. KINGSLEY, G. G. BECK, and T. G. SMITH. 1995. Growth and condition in the Northwest Atlantic harp seal. *Can. J. Fish. Aquat. Sci.*, (in press).

HAMMILL, M. O., G. B. STENSON and R. A. MYERS. 1992. Hooded seal (*Cystophora cristata*) pup production in the Gulf of St. Lawrence. *Can. J. Fish. Aquat. Sci.*, **49**: 2546-2550.

HAUG, T., and K. T. NILSSEN. 1995. Ecological implications of harp seal (*Phoca groenlandica*) invasions in northern Norway. *In*: Whales, seals, fish and man. A. S. Blix, L. Walløe and Ø. Ulltang (eds.) Elsevier Science B. V. pp. 545-556.

ICES. 1987. Report of the ICES Working Group on Harp and Hooded Seals in the Greenland Sea, Copenhagen, September 1985. *ICES Coop. Res. Rep.*, **148**: 20-39.

ICES. 1988. Report of the Working Group on Harp and Hooded Seals in the Greenland Sea, Copenhagen, October 1987. *ICES C.M. 1988/Assess*: 8.

ICES. 1990. Report of the Working Group on Harp and Hooded Seals, Bergen, October 1989. *ICES C.M. 1990/Assess*: 8.

ICES. 1992. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, Copenhagen, September 1991. *ICES C.M. 1992/Assess*: 5.

ICES. 1993. Report of the ICES/NAFO Workshop on survey methodology for harp and hooded seals, Archangelsk, October 1992. *ICES C.M. 1993/Assess*: 2 (NAFO SCS Doc. 93/8).

ICES. 1994. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, Copenhagen, October 1993. *ICES C.M. 1994/Assess*: 5.

INNES, S., R. E. A. STEWART, and D. M. LAVIGNE. 1981. Growth in Northwest Atlantic harp seals *Phoca groenlandica*. *J. Zool., Lond.*, **194**: 11-24.

KJELLQWIST, S. A., T. HAUG, and T. ØRITSLAND. 1995. Trends in age composition, growth and reproductive parameters of Barents Sea harp seals (*Phoca groenlandica*). *ICES J. Mar. Sci.*, **52**: (in press).

MEISFJORD, J., and G. NÆVDAL. 1995. Using isoelectric focusing to discern enzyme variation in Northeast Atlantic stocks of harp seals. *Hereditas*: (in press).

NILSSEN, K. T. 1995. Seasonal distribution, condition and feeding habits of Barents Sea harp seals (*Phoca groenlandica*). *In*: Whales, seals, fish and man. A. S. Blix, L. Walløe and Ø. Ulltang (eds.) Elsevier Science B. V. pp. 241-254.

NAFO, 1983. NAFO Scientific Council Reports, 1983: 83-113.

ØRITSLAND, T. 1995. Norsk fangst og undersøkelser av sel i 1994 (Norwegian catches and investigations of seals in 1994.) *Fiskeri og Havet*, **1995(3)**:1-22. [In Norwegian with an English summary]

RYG., M., C. LYDERSEN, N. H. MARKUSSEN, T. G. SMITH, and N. A. ØRITSLAND. 1990. Estimating the blubber content of phocid seals. *Can. J. Fish. Aquat. Sci.*, **47**: 1223-1227.

SERGEANT, D. E. 1973. Feeding growth, and productivity of Northwest Atlantic harp seals (*Pagophilus groenlandicus*). *J. Fish. Res. Board Can.*, **30**: 17-29.

STENSON, G. B., R. A. MYERS, M. O. HAMMILL, I-H. NI, W. G. WARREN, and M. C. S. KINGSLEY. 1993. Pup production of harp seals, *Phoca groenlandica*, in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci.*, **50**: 2429-2439.

TRITES, A. W., and M. A. BIGG. 1992. Changes in body growth of northern fur seals from 1958 to 1974: density effects or changes in the ecosystem? *Fisheries Oceanography*, **1**: 127-136.

WINTERS, G. H. 1978. Production, mortality and sustainable yield of Northwest Atlantic harp seals (*Pagophilus groenlandicus*). *J. Fish. Res. Board Can.*, **35**: 1249-1261.

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.

	Norwegian catches			Russian catches			Total catches		
Year	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
1994	0	492	492	23	4229	4252	23	4721	4744
1995	368	565	933						

[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.

	Norwegian catches			Russian catches			Total catches		
Year	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
1994	0	8121	8121	0	72	72	0	8193	8193
1995	317	7889	8206						

[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 Total	Crew number Average	Average duration of trips (days)	Average tonnage Gross	Average tonnage Net	Average Horse-power
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	.	.	.	.	.	.
1994	2	.	.	.	.	.	.
1995	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].

Year	Number of vessels	Average crew number	Average duration of trips (days)	Average tonnage Gross	Net	Average Horse power
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	-	-	-	-	-	-
1993	1	.	.	.	.	.
1994	1					
1995						

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].

	Norwegian catches[b]			Russian catches			Total catches		
Year	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
1994	0	9500	9500	30500	2000	32500	30500	11500	42000
1995	260	6582	6842						

[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 coasts[1].

Year	Norwegian coast	Murman coast	Total
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.

Year	Norway sealing	Greenland sealing[a]	Norway scient. sampling
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 N	NW-S	Total	East Greenland SE	KGH[c]	NE	TOTAL	Total Greenland
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 N	West Greenland NW-S	West Greenland Total	East Greenland SE	East Greenland NE	East Greenland Total	Total Greenland
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].

	Large Vessel Catch				Landsmen Catch[c]				Total Catches			
Year	pups	1+	unk	Total	pups	1+	unk	Total	pups	1+	unk	Total
1946-50	108256	53763	0	162019	44724	11232	0	55957	152981	64995	0	217976
1951-55	184857	87576	0	272433	43542	10697	0	54240	228399	98274	0	326673
1956-50	175351	89617	0	264969	33227	7848	0	41075	208578	97466	0	306044
1961-65	171643	52776	0	224420	47450	13293	0	60743	219093	66069	0	285163
1966-70	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]	48	44	0	92	33144	22087	2903	58134	33192	22131	2903	58226
1991	0	0	0	0	42379	10186	0	52565	42379	10186	0	52565
1992[e]	94	792	0	886	43767	23956	0	67723	43861	24748	0	68609
1993[e]	8	111	0	119	16393	10491	0	26884	16401	10602	0	27003
1994[e]	43	127	0	170	25180	36004	0	61184	25223	36131	0	61354

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.

Table 11. Published values for **harp seal** catches in the Canadian Arctic, 1952-1984.

Year	Bowen[1] 0	Bowen[1] 1+	Bowen[1] Total	D.E.S.[2] Total	Roff and Bowen[3] 0	Roff and Bowen[3] 1+	Roff and Bowen[3] Total	NAFO[4]	Stewart *et al.*[5] N Que	Stewart *et al.*[5] Baffin	Stewart *et al.*[5] N Lab
1952	60	1724	1784								
1953	60	1724	1784								
1954	60	1724	1784								
1955	60	1724	1784								
1956	60	1724	1784								
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					272		
1977	60	1724	1784	1508				1508	306		
1978	60	1724	1784		72	2057	2129	2129	44		
1979	60	1724	1784		128	3492	3620	3707	87		
1980	60	1724	1784		215	6135	6350	6459	52		2062
1981					158	4514	4672	4672		6263	20775
1982					166	4715	4881	4268		5849	1226
1983								1287		2433	86
1984											288

1 Bowen, W. D. 1982. Age structure of Northwest Atlantic harp seal catches, 1952-80. *NAFO Sci. Coun. Studies*, **3**: 53-65. Mean catch of 1768 for years 1962-1971 from Smith and Taylor (1977) and values of 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. Fish. Aquat. Sci.*, **43**: 553-564.

4 Anon. 1985. Provisional report fo 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].

	Large Vessel Catches				Landsmen Catches[c]				Total Catches			
Year	pups	1+	unk	Total	pups	1+	unk	Total	pups	1+	unk	Total
1946-50	4029	2221	0	6249	429	184	0	612	4457	2405	0	6862
1951-55	3948	1373	0	5321	494	157	0	651	4442	1530	0	5972
1956-60	3641	2634	0	6275	106	70	0	176	3747	2704	0	6451
1961-65	2567	1756	0	4323	521	199	0	720	3088	1955	0	5043
1966-70	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	53	0	94[d]	0	0	636	636	41	53	636	730
1991	0	14	0	0	0	0	6411	6411	0	14	6411	6425
1992	35	60	0	95[d]	0	0	119	119	35	60	119	214
1993	0	19	0	19[d]	0	0	19	19	0	19	19	38
1994	19	53	0	72[d]	0	0	149	149	19	53	149	221

[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.

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] – Total	Pups	Fem.	Males	Allocations 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
1994	26 March	30 June	9,000	0	0	incl.	1,700	7,300
1995	26 March	10 July					1,235	
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]	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
1994	10 April	31 May		0	0	0[5]	10,600	
1995	10 April	31 May					10,140	

[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: Soviet sealers	Opening dates: Norwegian vessels	Closing date	Quotas - Allocations: Total	USSR	Norway
Harp seals[2]						
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
1994		-	-			9,500
1995		-	-			8,750[5]

[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).

[5] Included 750 weaned pups under permit for scientific purposes.

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	Amendments 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.
1995	Personal sealing licences allowed. TAC remains at 186,000 including personal catches. Quota divided among Gulf, Front and unallocated reserve.

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 responsiblity 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.