ICES WGHARP REPORT 2008

ICES ADVISORY COMMITTEE

ICES CM 2008/ACOM:17

REF. LRC; RMC

Report of the Working Group on Harp and Hooded Seals (WGHARP)

27 – 30 August 2008

Tromsø, Norway

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2008. Report of the Working Group on Harp and Hooded Seals (WGHARP), 27 - 30 August 2008, Tromsø, Norway. Diane. 63 pp.

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Executive summary

The ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) met during 27-30 August 2008 at the Institute of Marine Research, Tromsø, Norway to consider recent research and to provide catch advice on the North Atlantic stocks of harp (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*). In attendance were ten scientists representing Canada, Greenland, Norway, Russia, and United States.

On 27-28 August, the WG received presentations related to stock identity and distribution, catch (mortality) estimates, abundance estimates, biological parameters, and ecological relationships of Greenland Sea and White Sea/Barents Sea harp seal stocks, and provided catch options in response to a request from Norway. The WG also received information on the Northwest Atlantic harp seal stock. On the 28th of August, the group also reviewed data available on Greenland Sea hooded seals (providing catch options for this stock) and Northwest Atlantic hooded seals. The WG discussed additional requests for advice from Norway on stock assessments on the 29th, and concluded their meeting the afternoon of 30 August.

With respect to the Greenland Sea harp seal stock, a Norwegian survey of pup production was carried out during March-April 2007, and resulted in an estimate of 102,200 pups (SE = 25,400). This estimate is not significantly different from the estimate obtained with comparable methodology in the area in 2002. Incorporating these estimates into a population model produced a population estimate of 756,200 (std 105,318) animals in 2007, or 646,400 (std 104,080) age 1+ seals, and 109,800 (std 16,100) young of the year. However, the stock is currently considered to be data poor due to the lack of recent data on reproductive parameters, so the catch option should be based upon the use of the Potential Biological Removal (PBR) approach (ICES, 2006a). This produces a recommended Total Allowable Catch (TAC) of 40,383 seals. A harvest at this level, with takes of pups and older age animals in proportion to their composition of the population, would reduce the 1+ population over the next 10 years of 7%. Takes at twice the PBR level would lead to a 63% reduction in the population.

Russian scientists conducted a survey of the White Sea/Barents Sea harp seal stock during March 2008, and produced an estimate of 123,104 pups (SE = 24,511). While this estimate is not significantly different from the estimate produced in 2005, it suggests that there has been a drop in pup production of 2/3's since 2003. The WG expressed concern that the late timing of the survey may have strongly negatively biased the surveys results, and if not, the results (as with the results from the 2005 survey) were difficult to reconcile with WGHARP's understanding of the population dynamics of this stock. The potentially low accuracy of the survey led the WG to conclude that the stock had to be considered (for now) data poor. The WG recommends that the PBR approach be used to set the TAC for this stock, and this would be 21,881 seals. The WG also recommends that 1) inter-sessional discussions (by correspondence) be held to develop a survey design that can firmly establish whether pup production has indeed declined, and 2) a March 2009 pup survey be conducted.

The March-April 2007 Norwegian survey of pup production in the Greenland Sea also produced an estimate for hooded seal pup production, 15,370 pups (SE = 1,675). This estimate is not significantly different from the estimate obtained with comparable methodology in the Greenland Sea in 2005, but is considerably lower than the 1997 estimate. Incorporating these estimates into a population model produced a population estimate of 82,380 animals in 2007, or 66,890 (std 8,645) age 1+ seals, and

15,490 (std 1,528) young of the year. This stock size is well below N_{lim} (30% of N_{max} ~ 789,000 animals). As such, WGHARP recommends that no harvest be allowed for Greenland Sea hooded seals at this time because the stock size is below N_{lim}. This follows the Precautionary harvest strategy developed by WGHARP in its 2003, 2005, and 2006 meetings.

WGHARP members evaluated the proposed Norwegian Greenland Sea harp seal management strategy with respect to the precautionary principle. To a certain degree, the request is moot because the stock is currently considered to be data poor. The Norwegian management framework will, however, be relevant once the stock is considered data rich. Then the framework proposed by Norway is appropriate because it aligns well with the four-tier precautionary management system WGHARP proposed to and was accepted BY ACFM in 2005. The annual TACs proposed do not, however, appear to be precautionary. That is, they do not consider issues of uncertainty in the parameter (population) estimates, time to recovery above a threshold, or monitoring that is requisite to a precautionary management scheme.

WGHARP also considered the minimum size of a harp seal population that can be considered sustainable and that at the same time could give a maximum continued yield. The ideal level at which the population "should be" will depend primarily upon the management objective proposed. If the objective is to maintain a harvest of a given level, the population required to provide this yield can be estimated using the population models developed for Greenland Sea harp and hood seals. If the management objective is to reduce the population to a minimum level, WGHARP has identified a critical limit (N_{lim}) below which a further reduction in the population may cause serious and irreversible harm. A management objective to reduce predation on a specific prey species to aid in its recovery is more difficult to define. Current scientific knowledge on the population dynamics of the prey and mortality by seals (and other predators) is not sufficient to estimate this level for any population. Finally, if the management objective is to maximize yield then the N_{70} level is in the range of the maximum sustainable yield estimated for many marine mammal populations.

1 Opening of the meeting

The ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) met during 27-30 August 2008 at the Institute of Marine Research (IMR), Tromsø, Norway to consider recent research and to provide catch advice on the North Atlantic stocks of harp (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*). In attendance were scientists representing Canada (2), Greenland (1), Norway (4), Russia (2), and United States (1)(Annex 1).

2 Adoption of the agenda

The agenda for the meeting, as shown in Annex 2, was adopted at the opening of the meeting on 27 August 2008.

3 Terms of reference

In February 2008 the Norwegian Royal Ministry of Fisheries and Coastal Affairs requested ICES to assess the status of the stocks of harp seals in the Greenland Sea and White Sea/Barents Sea. The request was as follows:

A Working Group established by the Norwegian Director of Fisheries recommended in a report dated 15 August 2006 a management strategy for harp seals in the Greenland Sea based on the work done by the NAFO/ICES Working Group on Harp and Hooded Seals (WGHARP) on the precautionary management of seal stocks.

The Norwegian Working Group proposed that the long term stock size aim for harp seals in the Greenland Sea should be 430,000 animals, which is 70% of the current stock estimate. Dependent on the stock size the annual TAC should be as follows:

Stock size (1+)	*Annual TAC*
Larger than 430,000	*2.0 * sustainable catches*
Between 300,000 and 430,000	*0,75 * sustainable catches*
Between 200,000 and 300,000	*0,5 * sustainable catches*
Under 200,000	*0 (no hunt)*

Sustainable catches defined as the fixed annual catches that stabilize the future 1+ population.

The Norwegian WG also proposed that if the stock size was estimated to be greater than 430,000 animals then the annual TAC should not be changed more than 25% compared to the catches the previous year; such a limitation was not applied when the stock estimate is under 430,000 animals. In that case the exploitation pattern shall be as in the previous year. This implies that the catches shall be composed of 25% 1+ animals and 75% younger animals.

The Norwegian Royal Ministry of Fisheries and Coastal Affairs have not yet decided if this management strategy will be applied. They might in the future wish to apply an ecosystem based management. At this stage, however, they would like to request ICES to evaluate if the proposed management strategy is in accordance with the precautionary principle.

ICES should also assess the impact on the seal stocks in the Greenland Sea and the White Sea/Barents Sea of an annual harvest of:

- *Current harvest levels,*

- *Sustainable catches (defined as the fixed annual catches that stabilizes the future1+ population),*
- *Twice the sustainable catches as defined above*

Furthermore, they would like ICES to assess the minimum size of a harp seal population that can be considered sustainable and that the same time can give a maximum continued yield.

In summary, ICES has been asked the following questions:

- To assess the status of the harp seal stocks in the Greenland Sea and the White Sea/Barents Sea.
- To evaluate if the proposed management strategy is in accordance with the precautionary principle.
- To assess the impact on the seal stocks in the Greenland Sea and the White Sea/Barents Sea of an annual harvest of:
    - Current harvest levels,
    - Sustainable catches (defined as the fixed annual catches that stabilizes the future1+ population),
    - Twice the sustainable catches as defined above.
- To assess the minimum size of a harp seal population that can be considered sustainable and that the same time can give a maximum continued yield.

The request has been discussed with relevant experts and Chairs, and ICES has agreed to provide advice to the majority of the issues concerning this special request. ICES can take on request 1 (assessment of the stocks) and 3 (impact on the seal stock of the listed annual harvest options) at the August 2008 meeting of WGHARP. The ICES/NAFO WGHARP will consider requests 2 and 4 at their August 2008 meeting but additional work (by correspondence/extra meeting) may be needed afterwards.

4 Harp seals (*Pagophilus groenlandicus*)

4.1 Stock Identity, Distribution and Migration

New genetic analyses of population structure of Northeast Atlantic harp seals were presented in Frie and Svetochev (SEA 176). The material included two samples taken from Greenland Sea beaters in 2005 and 2007 and one sample taken from white coats in the White Sea in 2006. Significant variation in haplotype frequency distributions were found between samples by conventional F_{ST}-statistics and Fishers exact test. However, the pattern of substructuring was not a simple split between the two Greenland Sea samples and the White Sea sample. Differentiation observed between the two Greenland Sea samples was similar to that observed between each of these samples and the White Sea sample.

Neither tests based on molecular distances nor haplotype frequencies revealed any significant differences between control region samples. Comparisons using 8 microsatellite loci did not reveal significant differences based on F_{ST}-statistics, but Exact Tests of allelic differences as well as genotypic differences showed significant differences between the similarly sized Greenland Sea 2007 sample and the White Sea 2006 sample, but not with the smaller 2005 Greenland Sea sample. Overall the results rejected panmixia of the two management stocks, but also suggested that population

structure may be more complicated than a simple split between the Greenland Sea and White Sea stocks.

Rosing-Asvid (2008) described an observation of approximately 1000 white-coated harp seals on the drift ice off Southwest Greenland in April 2007. This ice drifted from the southeast coast suggesting that the seals were likely born around Cape Farwell, far from any of the traditional breeding grounds. Observations by local people indicate that whelping might have occurred there over several years. It is not obvious which whelping population these seals may be related to but the late date of pupping is more consistent with the timing of pupping in the Greenland Sea than in either the White Sea or Northwest Atlantic where pupping occurs earlier. Tissue samples were collected which, in conjunction with current studies of stock status using genetic techniques, may provide an indication of the origin of these animals.

4.2 The Greenland Sea Stock

4.2.1 Information on recent catches and regulatory measures

The 2006-2008 TACs for harp seals in the Greenland Sea was set as recommended by ICES (i.e., a level that would stabilize the population at present level) for 2006 and coming years: 31,200 1yr+ animals (seals one year old or older) or an equivalent number of pups where one 1yr+ animal should be balanced by 2 pups. Available information on Norwegian catches of harp seals in the Greenland Sea pack-ice in 2006-2008 is listed in Annex 7, Table 1. Russia has not participated since 1994. The total catches were 3,304 (including 2,343 pups) in 2006, 7,828 (6,188 pups) in 2007, and 1,263 (744 pups) in 2008. The number of participating vessels was 4 in 2006 and 2007, and one in 2008, whereas removals were, respectively, 7%, 15% and 3% of the identified sustainable level (Haug *et al*., SEA 165).

4.2.2 Current Research

Final analyses of the genetic data presented in Frie and Svetochev (SEA176) are still ongoing, and will be expanded by inclusion of NW Atlantic and Greenland samples.

4.2.3 Biological parameters

Frie (SEA177) reported new estimates of female reproductive rates based on material collected in the period 2000-2008. The new estimate of mean age of maturity (MAM) was 7 years and postpartum pregnancy rate of multiparous females was estimated at 0.79 (SD= 0.06). Both of these values represent a decrease in reproductive rates as compared to the earlier used estimates (MAM=5.6 years, F=83.3%), but because of problems with the sampling regime it is highly questionable if the results reflect a true biological change. Due to sampling bias towards large females these changes may not reflect biological reality, the WG found the uncertainty of the data too high to accept the new maturity ogive as a valid estimate. The sampling bias is also likely to have introduced positive bias in the estimated pregnancy rate of multiparous females.

4.2.4 Population assessments

Pup production

From 14 March to 3 April 2007, aerial surveys were carried out in the Greenland Sea pack-ice (the West Ice)(Øigård *et al*. SEA166) to assess pup production for populations of both hooded and harp seals. The prime target species for the survey was

hooded seals. Two fixed-wing twin-engine aircraft were used for reconnaissance flights and photographic strip transect surveys over the whelping patches once they had been located and identified. One aircraft was equipped with a camera shooting colour film, while the other aircraft had a digital camera. The WG recommends that comparisons between the two imaging system be conducted. A helicopter assisted in the reconnaissance flights, and was used subsequently to collect data for estimating the distribution of births over time. Three whelping patches were observed. Patch A was surveyed photographically using a low-density coverage (transect spacing 5 nm, two photos shot per 1 nm along each transect). Patches B and C, both with harp seal whelping concentrations and scattered hooded seal bluebacks, were surveyed using high-density coverage (transect spacing 2 nm, cameras operated to ensure about 80-90% coverage of the area along each transect line). Results from the staging flights suggest that the majority of harp seal females whelped from 15 to 21 March. The calculated temporal distribution of births were used to correct the abundance estimates obtained. The total pup production estimate obtained for harp seals was 102 200 (SE = 25 400, CV = 24.9%) which is not significantly different from the estimate obtained with comparable methodology in the area in 2002.

Population model

The model used to assess the abundance for NE Atlantic harp seal population was the version presented and used at the 2005 WGHARP meeting (ICES, 2006a). The population model estimates the current total population size using historical catch data and estimates of pup production. In principle, the model can also estimate biological parameters (M_{1+}, M_0 and F), but for the population to which the model is applied there is not enough data to provide accurate estimates of M_{1+} and M_0. To compensate for the lack of data, information from other similar populations are used as input to the model in the form of a prior distribution (mean and standard deviation) for each of M_{1+}, M_0.

The same population dynamic model was used for both of the northeast Atlantic harp seal populations, but with stock specific values of prior distributions for M_{1+}, M_0 and F. The parameters of the model are:

$N_{0,t}$ = number of pups born in year t,

$N_{i,t}$ = number of individuals at age i in year t,

N_{1945} = Population size in 1945,

M_0 = pup mortality,

M_{1+} = Mortality among 1+ animals,

$p_{i,t}$ = proportion of females at age I being reproductively active in year t

F = Natality rate (i.e. proportion of mature females giving birth)

It is assumed that the population had a stable age structure in year t_0 = 1945, i.e.

$$N_{i,t_0} = N_{1945} \cdot e^{-(i-1)M_{1+}}(1-e^{-M_{1+}}), \qquad i = 1,\ldots,A\text{-}1$$
$$N_{A,t_0} = N_{1945} \cdot e^{-(A-1)M_{1+}}$$

The maximal age group A=20 contains all individuals aged A or more. The catch records give information about the following quantities:

$C_{0,t}$ = catch in numbers of pups in year t,
$C_{1+,t}$ = catch in numbers of 1+ animals in year t.

Due to the lack of information about age specific catch numbers for adults (for the years with high catch levels) the following pro-rata rules were employed in the model:

$$C_{i,t} = C_{1+,t}\frac{N_{i,t}}{N_{1+,t}}, \qquad i = 1,...,A$$

.

Catches are assumed to have been taken prior to the occurrence of natural mortality, leading to the following set of recursion equations:

$$N_{1,t} = \left(N_{0,t\text{-}1} - C_{0,t\text{-}1}\right)e^{\text{-}M_0}$$
$$N_{i,t} = \left(N_{i\text{-}1,t\text{-}1} - C_{i\text{-}1,t\text{-}1}\right)e^{\text{-}M_{1+}}, \qquad i = 2,...,A-1,$$
$$N_{A,t} = \left(\left(N_{A\text{-}1,t\text{-}1} - C_{A\text{-}1,t\text{-}1}\right) + \left(N_{A,t\text{-}1} - C_{A,t\text{-}1}\right)\right)e^{\text{-}M_{1+}}.$$

The pup production is given as

$$N_{0,t} = \frac{F}{2}\sum_{i=1}^{A} p_{i,t}N_{i,t},$$

where $0.5N_{i,t}$ is the number of females at age i.

The model calculates a few diagnostic quantities. These include the mean birth rate for 1+ females in year t is calculated as

$$f_t = F\frac{\sum_{i=1}^{A} p_{i,t}N_{i,t}}{\sum_{i=1}^{A} N_{i,t}}, .$$

and the depletion coefficient:

$$\mathrm{D}_{1+} = \frac{\mathrm{N}_{2017,1+}}{\mathrm{N}_{2007,1+}}.$$

The estimated parameters are N_{1945} (the population size in 1945) along with the biological parameters M_{1+}, M_0 and F. These are found by minimizing an objective function consisting of the weighted (according to survey standard deviation) sum of

squares of the differences between the model value and the survey estimates of pup production. A penalty term resulting from the assumed (normal) priors on M_{1+}, M_0 and F is also added to the objective function. To minimize the total objective function the statistical software AD Model Builder (http://otter-rsch.com) is used. AD Model Builder calculates standard deviations for the model parameter, as well as the derived parameters such as present population size and D_{1+}.

Population estimates

The following parameters were used for the assessments of the Greenland Sea harp seals:

Age at maturity ogive:

Table 1. Estimates of proportions of mature females (p) at ages 2-10. From ICES (2006a).

AGE	2	3	4	5	6	7	8	9	10
p	0.01	0.02	0.04	0.10	0.24	0.53	0.89	0.99	1.00

Table 2. Estimates of Greenland Sea harp seal pup production. From ICES (2006a), and Øigård et al. (SEA166).

YEAR	ESTIMATE	C.V.
1983	58,539	.104
1984	103,250	.147
1985	111,084	.199
1987	49,970	.076
1988	58,697	.184
1989	110,614	.077
1990	55,625	.077
1991	67,271	.082
2002	98,500	.179
2007	102,200	.249

The prior distributions for M_{1+}, M_0 and F are given in Table 3. The mean of the prior for M_0 was taken to be approximately three times that of M_{1+}. The estimated population is presented in Table 3, and the population trajectories can be found in Fig. 1. The estimate of the harp seal 1+ year population abundance in the Greenland Sea is 646,400 (std 104,080), and pup production was estimated to be 109,800 (std 16,100) for a total population of 756,200 (std 105,318).

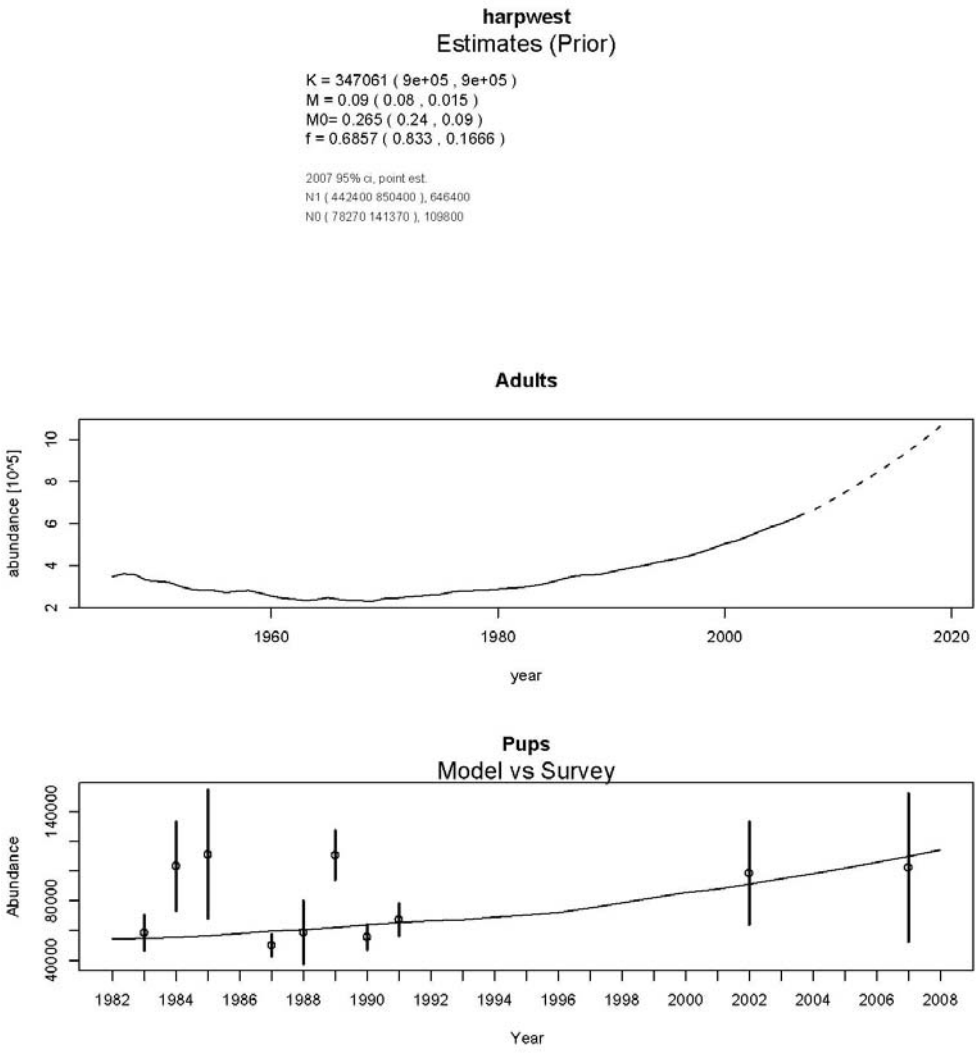

Figure 1.Fitted model and model diagnostics for harp seals in the Greenland Sea. Estimated N1+ population trajectory (panel labelled Adult). The lower-right panel shows 95% intervals (vertical bars) for available pup production estimates, and modelled pup production (solid line).

Table 3. Estimated 2007 status of harp seals in the Greenland Sea. The column "Estimate" shows the estimated parameters (point estimate and standard deviations), while the column "Prior" shows the prior distributions placed on parameters.

Parameter	Estimate		Prior	
	Est.	SD	Mean	SD
M_{1+}	0.09	0.012	0.08	0.015
M_0	0.27	0.087	0.24	0.090
F	0.69	0.130	0.833	0.167
$N_{1+}(2007)$	646,400	104,080		
$N_0(2007)$	109,800	16,100	102,200	25,499

4.2.5 Catch Options

The Greenland Sea harp seals are currently regarded as data poor due to old reproductive data, and if hunt is allowed, catch options should be based on the use of the Potential Biological Removals (PBR) approach (ICES, 2006a). The Potential Biological Removals has been defined as:

$$PBR = 0.5*R_{max}*Fr*N_{min},$$

where R_{max} is the maximum rate of increase for the population, Fr is the recovery factor with values between 0.1 and 1, and N_{min} is the estimated population size using 20th percentile of the log-normal distribution. R_{max} is set at a default of 0.12 for pinnipeds. The recovery factor Fr was set to 1. Options are given for three different catch scenarios as requested by the Norwegian Ministry of Fisheries and Coastal affairs;

1. Current catch level (average of the catches in the period 2003 – 2007)
2. PBR level.
3. Two times the PBR level.

The estimates for the various catch options are given in Table 4. The PBR removals are estimated to be 40,383. This assumes that the age structure of the removals is proportional to the age composition of the population. It is estimated that the current composition of the population includes 14% pups. A catch consisting of a higher proportion of pups would be more conservative, but a multiplier to convert age 1+ animals to pups is inappropriate.

Current catch level will likely result in an increase in population size of 43% over the next 10 years, whereas catches 2x PBR levels will result in the population declining by approximately 63%. These catch options are slightly lower than those recommended in 2005 (ICES, 2006a).

Table 4. Catch options with relative population size (D1+) in 10-years (2017) for harp seals in the Greenland Sea.

OPTION #	CATCH LEVEL	PROPORTION OF PUPS IN CATCHES	TOTAL CATCH	D_{1+}		
PRIOR				Lower CI	point	Upper CI
1	Current	74.5% (current level)	5,822[1]	1.19	1.43	1.67
2	PBR	14.0%	40,383	0.60	0.93	1.25
3	2 X PBR	14,0%	80,766	0.00	0.37	0.80

4.3 The White Sea and Barents Sea Stock

4.3.1 Information on recent catches and regulatory measures

The 2006 and 2007 TACs for White Sea/Barents Sea harp seals were as recommended by ICES (i.e., a level that would stabilize the population at present level) for 2006 and coming years: 78,200 1yr+ animals or an equivalent number of pups where one 1yr+ animal should be balanced by 2.5 pups. Due to concerns over a possible reduction in pup production in the White Sea after 2003, however, Russia and Norway agreed to reduce the TAC for 2008 to 55,000 1yr+ animals at the recommendation of the Joint Norwegian-Russian Fisheries Commission. Norway was allocated a quota of 10,000 1yr+ animals in 2006 and 2008, and 15,000 1yr+ animals in 2007 (with a similar equivalence between 1yr+ animals and pups)(Annex 8, Table 2). Recent Russian and Norwegian catches of harp seals in the White and Barents Sea are listed in Annex 7, Table 2. In 2007 the traditional Russian helicopter catches of harp seals were supplemented with boat-based catches in the White Sea. In 2008, the entire Russian hunt in the White Sea was boat-based (3 vessels). Two Norwegian vessels operated in the southeastern Barents Sea in 2006, one in 2007 and none in 2008. The combined catches were 17,193 (including 7,152 pups) in 2006, 11,629 (including 5,518 pups) in 2007, and 13 331 (pups only) in 2008. This is, respectively, 16%, 11% and 7% of the sustainable yields recommended by ICES in 2005 for this stock (Haug *et al*., SEA 165).

4.3.2 Current Research

A Joint Norwegian-Russian research programme on harp seal habitat use in the Barents Sea has been established for 2008-2012, and has proposed extensive deployment of satellite tags on Barents Sea harp seals. However, the project has been hampered by Russian regulations prohibiting the use of foreign satellite technology in Russian waters.

In 2006 material for a project on evaluation of contaminant load and general health status was collected and the project is currently evaluated for funding in the Norwegian Research Council.

An alternative probabilistic method for estimation of pup production was presented in Shafikov (SEA175); however the working group did not feel qualified to evaluate the method and recommended that the manuscript be submitted to a peer review journal.

[1] 4,322 pups and 1,490 1+ animals

Final analyses of the genetic data presented in Frie and Svetochev (SEA176) are still ongoing.

4.3.3 Biological Parameters

Svetochev and Svetocheva (SEA174) presented information on the timing of births in the White Sea for 1995, 1997, 1996, 1999, 2000, 2001, 2002, 2003 and 2005. The paper showed that pupping could begin as early as 14-17 February and end by 10-12 March. The peaking of pupping is near the end of February

New data on female reproductive parameters were presented by Frie (SEA177). Based on female reproductive samples collected during the Norwegian harp seal hunt in the Southeastern Barents Sea in 2006, mean age at maturity was estimated at 7.2 years for the White Sea-Barents Sea stock. This probably represents a decrease in MAM as compared with the previous estimate from the early 1990s (MAM = 8.5 years), but is still high compared to values observed in the Northwest Atlantic. Average post partum pregnancy rate of multiparous females was estimated at 64% and average ovulation rate of parous females was 95%. This pregnancy rate is 20% lower than the previously reported value (84%) based on directly observed implantation rates from a small sample (n = 32). This observed decrease is probably more likely due to differences in method than an actual change in pregnancy rates.

4.3.4 Population Assessment

Pup Production

Pup production estimates based on multispectral survey data (infrared [IR] and digital RGB imagery) from aerial surveys flown during 19-20 March 2008 were presented by Zabavnikov *et al* (SEA171). The total pup production estimate was 123,104 (SE=24 511), which is similar to the estimate obtained in 2005 (122, 658, SE = 19,900).

In addition, track lines of surveys flown 15 and 16 March were shown. Estimates for these two survey dates were not included in the paper but were reported to be 11 % lower than for the later survey dates and were only based on digital RGB imagery (no IR).

Generally, track lines were flown in areas with ice concentrations between 70-90 %. No direct satellite monitoring of ice drift was conducted, but according to information from Arkhangelsk hydro-meteorological station ice drift was assumed to be low.

The 2004, 2005, 2008 surveys show major pup production declines compared to a series of surveys flown during prior to 2004. Such declines cannot be easily explained biologically. The working group expressed concern about various aspects of the survey, which could have biased the result.

Late timing of the survey was a major concern for the 2008 survey as well as the 2005 survey. From Svetochev and Svetocheva (SEA174) it is evident that pupping begins as early as 14-17 February or may not begin until 2 March, but all whelping is complete by about 10-12 March. Counting surveys were not flown until 19-20 March, but some data are available from 15-16 March for the study area. From the information on timing of pupping and the delay until surveys were completed, it is possible that some animals may have reached the beater stage and entered the water prior to the survey being flown. Alternatively, pups born early in the season may have been lost due to drift of animals out of the region or because of ice destruction from the combination of thin ice and severe weather. In other areas harp seals are found to pup in ice concentrations down to 20 % and by limiting the survey to areas of high ice concen-

tration some pups may have been unobserved. Zabavnikov suggested some information on the timing of pupping may be obtained from the digital photographs.

The maps containing information on ice concentrations showed that over the period 15 March to 20 March there were some changes in ice concentrations, the location and shape of open water areas. This indicates that ice drift did occur in the area. Although the survey lines cover the study area where seals were detected on 15-16 March-it is not clear if some animals might have been lost from the area before the 19-20 March lines were flown. One approach might be to analyse the data from 15-16 March.

During the discussion 4 major hypotheses were put forward as possible explanations for the dramatic decline in pup production estimates in the White Sea.

- Timing of survey to late – pups entered the water
- Pups may have been lost before the survey (either due to bad ice or drifting out of the survey area)
- Declining female reproductive rates
- Major increase in adult female mortality

The first two of these hypotheses would have resulted in an underestimate of total pup production, however if either of the latter two hypotheses were correct, then surveys would have accurately reflected pup production.

In future surveys, it would be useful to begin reconnaissance efforts earlier in the season and maintain them through the survey period. Stage determination studies (either by on-ice work, or low altitude, low cover widely distributed photo flights) should also be carried out to determine the evolution of the pupping ogive.

Population estimates

Due to WGHARP's concern over the accuracy of the pup production estimates from 2004 - 2008, the stock is considered data poor. The model was also unable to capture the sudden drop in pup production, and, therefore, was only used for obtaining a multiplier for scaling the pup production in order to obtain the population size. A multiplier of 7 was used; hence a population estimate of 861,728 was obtained.

Shafikov (SEA169) presented a method to estimate total population based upon estimates of pup production and estimates of mature and immature males and females. The result is a multiplier that can be applied to estimated pup production to produce an estimate of total population. Unfortunately, the author was not present to explain his approach in detail. However, based upon the working paper, WGHARP had some questions about the approach proposed. The method used to estimate the number of immature females appears to assume that the number of females in each age group is constant. As a result the proportion of the population considered immature appears to be unrealistically low. Also, there were some concerns about the meaning of the values (e.g. J_{min}) and the assumed values used in the paper. Also it was indicated that the WG has developed a number of models that require fewer assumptions, make more complete use of the available data, and take into account changes in the population structure. These models have provided general multipliers that can be applied to estimates of pup production to give an indication of the total population. Such multipliers have been used previously and owing to the possibility of changes in age structure of the population, they should be considered to provide only approximate abundance.

4.3.5 Catch Options

The White and Barents Sea harp seal stock was considered data poor, and the catch model was considered unreliable to estimates the impact of future catches. Therefore, catch options should be based on the use of the Potential Biological Removals (PBR) approach (ICES, 2006a).

R_{max} is set at a default of 0.12 for pinnipeds. It was regarded appropriate to set the recovery factor (F_r) to 0.5 given the unexplained sudden drop of the observed pup production. Using the CV = 0.20 obtained from the pup production estimate, a PBR level of removal would be 21,881 animals in the White and Barents Sea.

This assumes that the age structure of the removals is proportional to the age composition of the population (i.e. 14% pups). A catch consisting of a higher proportion of pups would be more conservative, but a multiplier to convert 1+ year-old animals to pups is inappropriate.

4.4 The Northwest Atlantic Stock

4.4.1 Information on recent catches and regulatory measures

A three-year management plan was implemented for the Canadian commercial seal hunt in 2003. The Total Allowable Catch (TAC) for harp seals was set at an average of 325,000 per year (total 975,000) with a maximum of 350,000 allowed in the first two years provided the TAC in the third was reduced so that the total for the three years was not exceeded (Annex 8 Table 3). As a result of catches in the first two years, the TAC in the final year of the plan (2005) was set at 319,517. In 2006, the total catch quota was set at 335,000. In order to ensure that the population was maintained above the Precautionary Reference Level of N_{70} and concerns about poor ice in the southern Gulf of St. Lawrence, the TAC was reduced in 2007 to 270,000. The TAC was raised slightly to 275,000 for the 2008 hunt, as a result of low catches the previous year.

Catches in 2005 totalled 323,826, which was slightly above the TAC (Annex 7 Table 5). As a result, catches for the 2003-05 year management plan were 979,309, which was 0.4% over the total allowable (975,000). In 2006, catches (354,867) exceeded the TAC by 6% although this assumes that 2,000 seals were taken in the Canadian Arctic which double the level assumed to occur by Stenson (2005). Catches were significantly reduced in 2007 (224,745, 83% of TAC) due to the lack of ice in the southern Gulf and heavy ice off Newfoundland. Poor ice, offshore distribution and low prices also resulted in lower catches in 2008 with preliminary catches figures indicating that only 75% (206,454) of the TAC was taken.

Prior to 1980, catches of harp seals from the Northwest Atlantic population in Greenland were consistently less than 20,000 animals (Annex 7 Table 5). Since 1980, Greenland catches increased relatively steadily to a peak of over 100,000 in 2000. From 2002 through 2004, catches decline to between 66,000 and 70,000. In 2005 and 2006, the last years for which data are available, reported catches were slightly over 90,000 seals. In recent years, the proportion of seals considered to be adults (i.e. showing some indication of a harp pattern) has declined.

Although limited data are available on catches in the Canadian Arctic, they appear to be relatively low (generally <5,000). A recent study indicates that current catches average less than 1,000 per year (Annex 7 Table 5).

Stenson (2005) estimated human induced mortality of harp seals in the northwest Atlantic. In addition to reported catches, he estimated the number of seals killed as bycatch in fishing gear (Newfoundland bycatch and US Atlantic fisheries) and seals killed but not landed or reported (i.e. 'struck and lost'). Using this approach, the average total removals from 1952 – 1982 was approximately 388,000, but declined to 176,000 per year between 1983 and 1995. Between 1996 and 2004, higher catches in Canada and Greenland resulted in average annual removals of 468,500. Owing primarily to the lower catches in Canada, total removals in 2008 was estimated to be approximately 389,000 (Annex 7 Table 5). Young of the year account for approximately 66% of the current removals.

Given the reduced level of catches in Canada during the past two years, the high level of hunting in Greenland (including struck and loss) and the relative ages of seals taken in the two hunts, the current Greenland hunt may be having as great, or possibly even greater, impact on the population dynamics of Northwest Atlantic harp seals than the hunt in Canada.

Rosing-Asvid (SEA179) described the catch history of harp seals in Greenland and attempted to relate this to changes in the size of the Northwest Atlantic harp seal population. The catch data consisted of skin purchase data (1800-1938) and official catch statistics (1939-2006). The data were divided into the catches along the Greenland coast north and south of the winter ice edge, which occurs at approximately 67°N. Catches in the south dropped in the mid nineteenth century, which is a period when the population is assumed to have declined and it remained low until the 1990s. In northern areas, catches were highly variable throughout the time series but did show a significant increase in the 1990s. The decline and increase in catches was much greater than would have been expected from the fluctuations in population size and these fluctuations were strongest south of the ice edge. There has been an increase in the duration of stay of harp seals in Greenland waters as indicated by an increase in the number of months with high catches. This suggests that while catches may be influenced by changes in abundance of the harp seal population, environmental conditions will also have an impact. In recent years, the number of pregnant seals remaining until late in the season (January/February) in west Greenland waters appears to have increased based on higher catches of these animals, and whelping has been observed several times along the cost (see section 4.1).

A reduction in the harp seal population from N_{max} (5.8 million) to N_{70} (4.1 million) would reduce the population to levels last seen in the early 1990's, when catches in Southwest Greenland were about 50% below current levels. The N_{50} level (2.7 millions) would bring the population back to the 1983 level, which was when the catches in Southwest Greenland were about 5% of current levels. Catches of harp seals in Canada can have an impact on numbers of animals available to Greenland hunters although it is not a clear relationship due to the impact of other factors in the physical and biological environment.

4.4.2 Current research

Visual and photographic surveys were carried out in March 2008 to estimate pup production of NW Atlantic harp seals. The results of this survey are expected to be available in May or June 2009.

Research on diet, reproductive rates, growth and habitat use are continuing.

4.4.3 Biological parameters

No new data were presented.

4.4.4 Population Assessment

No new estimates of pup production or population size of harp seals in the Northwest Atlantic were presented. However, Hammill and Stenson (SEA172) examined the impact of including a term for increased mortality of pups due to poor ice in the assessment model on estimates of abundance.

Harp seals use pack ice to haul out on, to give birth and nurse their young. After weaning the young of the year (YOY) remain with the ice, which they use as a resting platform. The harp seal population is assessed approximately every 4 years using a population model that relies upon independent estimates of pup production obtained from aerial surveys. Since the current harvest is focused on YOY animals, the impact of any unusual mortality will not be reflected in the assessment for at least two decades later. In the Gulf of St. Lawrence, poor ice conditions, which are thought to lead to increased mortality among young animals, have been observed in 6 of the last 10 years. A factor to account for increased mortality during poor ice years has been incorporated into the assessment model since 2004, but the impacts of this factor on model predictions has not been evaluated. Under scenarios of a constant harvest, an annual mortality of 30% or higher, due to ice, in a single year would result in significant changes in the population trajectory within a decade, but these changes would not be noticed as detectable changes in pup production for at least 20 years. Repeated ice-related mortality of 10% had limited impact unless it occurred in 6 or more winters within a decade. Changes in the population and pup production due to increased YOY mortality could not be detected until 15 or more years had passed even under high levels of mortality or variability among years, by which time significant changes in the population can occur. For management considerations, taking into account possible changes in natural mortality due to ice would not appear to be important in the short-term, but will have more important longer term implications.

The implications of the ice related mortality observed in the southern Gulf if St. Lawrence were discussed. If the overall extent of ice is limited, ice mortality may be density dependent. In Canada, however, the ice mortality observed in recent years appears to be density independent in that sufficient ice was available for pupping to occur but pup mortality was high due to ice disappearing.

Surveys of pup production provide data on the number of pups that are born. These data are important for estimating the current status of the population. However, estimating the number of pups that may not survive the nursing and post-weaning fast is critical for understanding future population dynamics. Although it would be extremely useful to have actual estimates of the proportion of young that die due to ice-related mortality, it is extremely difficult to obtain such data. Modelling studies indicate that including an approximate level of mortality will improve estimates of future populations.

5 Hooded seals (*Cystophora cristata*)

5.1 The Greenland Sea Stock

5.1.1 Information on recent catches and regulatory measures

The 2006 TAC given for Greenland Sea hooded seals was 4,000 animals of all ages. Concerns over low pup production estimates, however, resulted in a recommendation from ICES that no harvest of hooded seals should be permitted, with the exception of catches for scientific purposes, from 2007 on. This advice was immediately implemented. Total catches (all taken by Norway, Russian sealers did not operate in the Greenland Sea in the period) in 2006 were 3,647 (including 3,079 pups) (Annex 6, Table 1). In 2007 and 2008 the number of animals taken for scientific purposes amounted to 62 (including 27 pups) and 44 (including 9 pups), respectively.

5.1.2 Current research

The Norwegian Polar Institute and the IMR are involved in a satellite tagging study of Greenland Sea hooded seals, which is likely to contribute to our knowledge about habitat use and development of diving skills of juvenile hooded seals. The University of Tromsø has a separate project also involving satellite tagging of blue backs in the Greenland Sea.

A comparative study of hooded seal female reproductive rates in the Northwest and the Northeast Atlantic is ongoing and will be presented at a symposium in Dartmouth, Canada in September 2008.

In 2007-2008, materials for a project on the evaluation of contaminant loads and general health status were collected, and the project is presently being evaluated for funding by the Norwegian Research Council.

5.1.3 Biological parameters

There is no new information on biological parameters for this stock.

5.1.4 Population assessment

Pup production

Results from the Norwegian survey of the Greenland Sea carried out in 2007 were presented (Øigård *et al*., SEA166). No distinct hooded seal whelping concentrations were detected, only scattered hooded seal families and, subsequently, solitary bluebacks over a relatively large area which was denoted Patch A. Patch A was surveyed photographically using a low-density coverage method (transect spacing 5 nm, two photos shot per 1 nm along each transect). Patch B and C, both harp seal whelping concentrations which also included scattered bluebacks, were surveyed using high-density coverage methodology (transect spacing 2 nm, cameras operated to ensure about 80-90% coverage of the area along each transect line). Results from the staging flights suggest that the majority of hooded seal females whelped between 23 and 29 March, whereas harp seal births were primarily allocated to the period 15 to 21 March. The calculated temporal distribution of births were used to correct the abundance estimates obtained. The total estimate of hooded seal pup production was 15,370 (SE = 1,675). This estimate is not significantly different from the pup production estimate obtained with similar methodology in the Greenland Sea in 2005, and is considerably lower than in 1997.

Population estimates

The parameters used for the assessments of the Greenland Sea hooded seals can be found in Tables 5 and 6.

Table 5. Estimates of proportions of mature females (p) at ages 2-11 (ICES, 2006b).

AGE	2	3	4	5	6	7	8	9	10	11
p	0.05	0.27	0.54	0.75	0.87	0.93	0.97	0.98	0.99	1.00

Table 6. Estimates of Greenland Sea hooded seal pup production (ICES (2006b, Øigård et al. SEA166).

YEAR	ESTIMATE	C.V.
1997	24,000	0.28
2005	15,200	0.25
2007	15,370	0,11

The prior distributions for M_{1+}, M_0 and F (Table 7) are as in ICES (2006b). The mean of the prior for M_0 was taken to be approximately three times that of M_{1+}. The model runs shown in Fig. 2 seem to indicate a substantial decrease in population abundance from the late 1940s and up to the early 1980s. In the most recent two decades, the population size appears to have been relatively stable at a low level, but the current trajectory is uncertain. Using a prior value of M_{1+} of 0.11 (std 0.05), a 2007 abundance of 66,890 (std 8,645) is obtained for age 1+ seals, the estimated number of pups is 15490 (std 1,528) for a total of 82,380 (std 8,779).

Table 7. Estimated 2007 status of hooded seals in the Greenland Sea. The column "Estimate" shows the estimated parameters (point estimate and standard deviations), while the column "Prior" shows the prior distributions placed on parameters.

Parameter	Estimate		Prior	
	Est.	SD	Mean	SD
M_{1+}	0.157	0.034	0.11	0.05
M_0	0.334	0.050	0.33	0.05
F	0.869	0.093	0.88	0.1
$N_{1+}(2007)$	66 890	8 645		
$N_0(2007)$	15 490	1 528	15 370	1 675

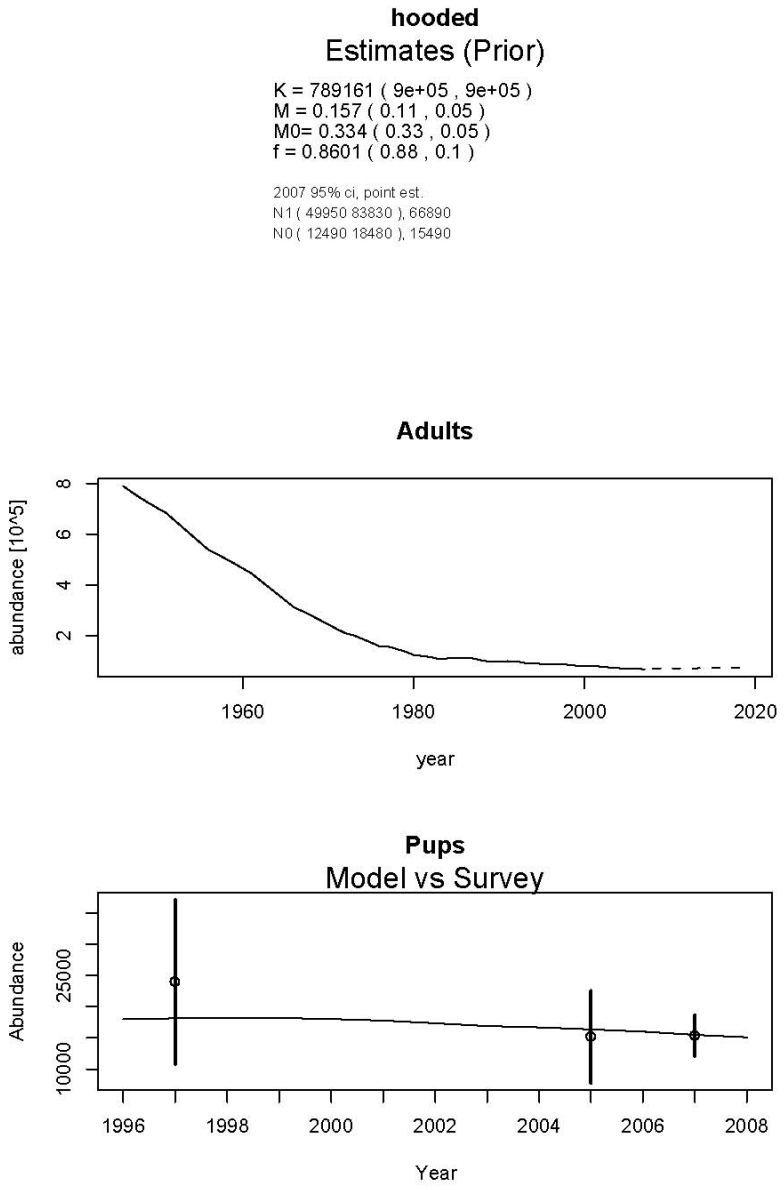

Figure 2. Fitted model and model diagnostics for hooded seals in the Greenland Sea. Estimated N_{1+} population trajectory (panel labelled Adult). The lower-right panel shows 95% intervals (vertical bars) for available pup production estimates, and modelled pup production (solid line).

5.1.5 Catch options

The Greenland Sea hooded seals are still regarded data poor (because of the age of the data on reproductive parameters), and if hunt is allowed, catch options should be based on the use of the Potential Biological Removals (PBR) approach (ICES, 2006b). However, as is apparent from Figure 2, the 2007 population was well below N_{lim} (30% of N_{max} ~ 789,000 animals). As such, WGHARP recommends that no harvest be allowed for Greenland Sea hooded seals at this time because the stock size is below N_{lim}. This follows the Precautionary harvest strategy developed by WGHARP in its 2003, 2005, and 2006 meetings.

5.2 The Northwest Atlantic Stock

5.2.1 Information on recent catches and regulatory measures

From 1998 – 2006, the TAC for hooded seals was set at 10,000 (Annex 8, Table 3). As a result of new data on the status of the population (Hammill and Stenson 2007) and the adoption of the precautionary approach under Objective Based Fisheries Management (OBFM), the quota was reduced to 8,200 in 2007 and 2008. The killing of bluebacks is prohibited in Canada. Catches of hooded seals (1+ only) have remained extremely low (Annex 8, Table 3). Since 2005, less than 50 hoods have been taken annually, with only 5 being reported, to date, in 2008.

Catches in Greenland were between 1,000 and 2,000 between the mid 1950s and 1972 (Annex 8, Table 3). Since then catches have ranged from 3,000 - 10,000, being in the 6,000 – 7,000 range in most years. The most recent data indicates that 4,128 and 4,747 hooded seals were taken in 2005 and 2006, respectively.

Currently, the vast majority of hooded seals are caught in Greenland. With the exceptions of 1963-1982, when Canadian catches accounted for over 70% of the annual catches, Greenland accounted for over 65% of the hooded seals killed. In recent years, they have accounted for almost 100% of the catches.

5.2.2 Current research

As part of an International Governance Programme, Canadian and Greenland Scientists have carried out a cooperative study of the movements and diving behaviour of hooded seals caught shortly after moulting. Together with a similar project in the NE Atlantic, these data are providing information on habitat use throughout the north Atlantic. The animals are also acting as oceanographic samplers, collecting data on sea temperature and salinity.

Canada is continuing research on diet, reproductive rates and growth and condition.

5.2.3 Biological parameters

No new data were presented.

5.2.4 Population assessment

No new data were presented.

6 Response to additional requests for advice

Is the proposed Norwegian Working Group strategy for managing Greenland Sea harp seals in accordance with the precautionary principle

WGHARP members evaluated the proposed Norwegian Greenland Sea harp seal management strategy with respect to the precautionary principle. To a certain degree, the request is moot because the stock is currently considered to be data poor. In this situation, the proposed Norwegian management framework is inappropriate because management of data poor stocks considers control rules only for above or below N_{lim}, where the TAC is set at PBR and zero (0), respectively.

The Norwegian management framework will, however, be relevant for stocks considered data rich. T basic framework proposed by Norway is appropriate and it aligns well with the four-tier precautionary management system WGHARP proposed to and was accepted by ACFM in 2006. The proposed annual TACs do not, however, appear to be precautionary. That is, they do not consider issues of uncertainty in the parameter (population) estimates, time to recovery above a threshold, or monitoring that are requisite to a precautionary management scheme. First, it should be recognized that the object of the precautionary management scheme adopted by ICES for harp and hooded seals has a goal of maintaining stock size with some probability at or above N_{70} (shown in the Norwegian request as 430,000 seals for Greenland Sea harps). If stock size is above N_{70}, then the management goal is to stay above the reference point, and if stock size is below N_{70}, the goal is to rapidly recover to the reference point. If stock size is above N_{70}, a consistent harvest of 2X Sustainable Catches would decrease the population to N_{70} over a very short time period. For example, if the stock was at N_{max}, 2X Sustainable Catch will likely reduce the population to N_{70} in 5-6 years; smaller populations would reach N_{70} sooner. As a result, catches would need to be significantly reduced every year from 2X the Sustainable Catch to ensure the population does not fall below N_{70}. Managers would need to begin reducing harvests immediately to smoothly transition to N_{70}.

For stocks above N_{lim} but below N_{50} or N_{70}, the proposed TACs conceptually match the idea of increased conservation at lower levels, and should allow population to increase (all other things remaining the same). However, recovery would be slow. For example, if harvesting at 0.5 of Sustainable Catch, it would take at least 10 years for a stock of 200,000 seals to increase by 50,000 (+25%), and perhaps 40+ years to return to N_{70}. Takes have to be lower than 0.5 or 0.75 Sustainable Catches, if the population is to recover in a reasonable time frame.

WGHARP recommends to Norway that in developing a seal management strategy that:

- Management should ensure that a given harvest has:
    - For stocks initially above N_{70} – an 0.80 probability that stock size will remain above N_{70} 10 years in the future
    - For stocks initially above N_{50} and below N_{70} - an 0.80 probability that stock size will be above N_{70} 10 years in the future
    - For stocks initially above N_{lim} and below N_{50} - an 0.80 probability that stock size will be above N_{50} 10 years in the future

- A model based approach would be useful to define the decreasing annual harvests to synchronize with N_{70}, when stocks are above N_{70}. Such an approach would be more precautionary if it started at less than 2X.

  Another consideration is that survey monitoring won't be able to identify the impact on pup production until 8-10 years after implementation. Significant changes can occur in the population before monitoring can distinguish changes. However, it is still useful to continue to survey the population so that the harvest strategy can be updated with new data.

  Assess the minimum size of a harp seal population that can be considered sustainable and that the same time can give a maximum continued yield

  The ideal level at which the population "should be" will depend primarily upon the management objective proposed. For example, if the objective is to maintain a harvest of a given level, the population required to provide this yield can be estimated using the population models developed for Greenland Sea harp and hood seals. The current situation in the White Sea/Barents Sea, however, is unclear and there are serious concerns about our understanding of the population dynamics that can account for the recent declines observed in the pup production estimates.

  If the management objective is to reduce the population to a minimum level, WGHARP has identified a critical limit (N_{lim}) below which a further reduction in the population may cause serious and irreversible harm. At this level, a sustainable catch of Greenland Sea harp seals may be in the order of 1,000 seals, although we recommend that, at this level, all catches should stop. It should also be pointed out that in many jurisdictions (e.g. Canada, IUCN, US), a population that is reduced to this level would be considered as Endangered and may not be maintaining its ecological role. Because ecosystem models indicate that harp seals maintain ecosystem stability in many areas, such a reduction would also likely have a severe impact biodiversity in the northeast Atlantic ecosystem. Also, given the possibility of catastrophic events and the uncertainty associated with current methods of estimating abundance, it may not be possible to monitor such a low population or maintain it at this level.

  A management objective to reduce predation on a specific prey species to aid in its recovery is more difficult to define. Current scientific knowledge on the population dynamics of the prey and mortality by seals (and other predators) is not sufficient to estimate this level for any population. To do so will require considerable additional research by fish and marine mammal scientists to understand the complex interactions that occur in marine ecosystems.

  The precautionary advice we have provided to ACFM is designed to maintain the population above the N70 level. This is in the range of the maximum sustainable yield estimated for many marine mammal populations. At this level, the sustainable harvest could be, for example, in the order of 20,000 harp seals in the Greenland Sea.

7 Advice for ACFM and NAFO

The chairman of WGHARP, with assistance from former Chairs, Haug and Stenson, will work with ACOM to prepare advice for ICES and NAFO, and circulate the advice to the WG for their final review.

8 Other business

None

9 Adoption of the report

The WG adopted the report on 30 August 2008, at the close of the meeting.

Annex 1: List of participants

Name	Address	Phone/Fax	Email
Richard Merrick (Chair)	National Marine Fisheries 166 Water Street Woods Hole, Maine 02543 USA	Phone: +1 508 495 2291 Fax:: +1 508 495 2066	richard.merrick@noaa.gov
Anne Kirstine Frie	Institute of Marine Research P.O. Box 6404 N-9294 Tomsø Norway	Phone: +47 776 09429 Fax:: +47 776 09701	anne.kirstine.frie@imr.no
Tore Haug	Institute of Marine Research P.O. Box 6404 N-9294 Tomsø Norway	Phone: +47 776 09722 Fax:: +47 776 09701	tore.haug@imr.no
Mike Hammill	Department of Fisheries and Oceasns P.O. Box 1000 Mont-Joli Québec G5H 3Z4 Canada	Phone: +1 418 775 0580 Fax:: +1 418 775 0740	hamillm@dfo-mpo.gc.ca
Kjell Tormod Nilssen	Institute of Marine Research P.O. Box 6404 N-9294 Tomsø Norway	Phone: +47 776 09724 Fax:: +47 776 09701	kjell.tormod.nilssen@imr.no
Victor Korzhev	Polar Research Institute of Marine Fisheries and Oceanography 6 Knipovich Street 183763 Murmansk Russia	Phone: +7 815 247 2469 Fax:: +7 815 247 3331	korgev@pinro.ru
Tor Arne Øigård	Institute of Marine Research P.O. Box 6404 N-9294 Tomsø Norway	Phone: +47 776 09730 Fax:: +47 776 09701	tor.arne.oeigaard@imr.no
Aqqalu Rosing-Asvid	Greenland Institute of Natural Resources Box 570, 3900 Nuuk Greenland	Phone: +299 361247 Fax:: +299 361212	aqro@natur.gl
Garry Stenson	Department of Fisheries and Oceans P.O. Box 5667 St. John's Newfoundland A1C 5X1 Canada	Phone: +1 709 722 5598 Fax:: +1 709 772 41050	Garry.stenson@dfo-mpo.gc.ca
Olga Svetocheva (Only in attendance on last day)	Murmansk Marine Biological Institute of the Kola Science Centre of the Russian Academy of Sciences Murmansk Russia	Phone: +7 818 264 6039 Fax:: +7 818 264 6039	svol@atnet.ru

Vladimir B. Zabavnikov	Polar Research Institute of Marine Fisheries and Oceanography 6 Knipovich Street 183763 Murmansk Russia	Phone: +7 815 247 2572 Fax:: +7 815 247 3331	ltei@pinro.ru

Annex 2: Agenda

Wednesday, 27 August

9:00am to 9:30am -- Introductory Comments (Merrick, Haug and Stenson)

9:30am to 10:00am – Discussion of Terms of Reference

10:00am to 10:15 am -- Harp Seals: Stock Identity, Distribution and Migration

10:15 am to noon – Harp Seals: Greenland Sea Stock

- Information on recent catches and regulatory measures (SEA165)
- Current Research
- Biological parameters (SEA176, SEA177)

Noon to 1:00pm – Lunch

1:00pm to 2:30pm – Harp Seals: Greenland Sea Stock

- Population assessments (SEA166. SEA168)
- Catch Options (SEA168)

2:30pm to 5:30pm – Harp Seals: White Sea and Barents Sea Stock

- Information on recent catches and regulatory measures (SEA165)
- Current Research(SEA171, SEA173, SE174)
- Biological parameters(SEA176, SEA177)
- Population assessments (SEA169, SEA175)
- Catch Options (SEA170)

5:30pm Break for Day

Thursday, 28 August

9:00am to 10:00am – Begin Work on Catch Options for Greenland Sea and White Sea/Barents Sea harp seals

- Decide on catch options
- Modelling working group begins work

10:00am to 10:30am -- Harp Seals: Northwest Atlantic Stock

- Information on recent catches and regulatory measures (SEA178)
- Current Research (SEA179)
- Biological parameters
- Population assessments (SEA172)

10:30am to 10:45 am—Hooded Seals: Stock Identity, Distribution and Migration

10:45 am to noon -- Hooded Seals: Greenland Sea Stock

- Information on recent catches and regulatory measures
- Current Research
- Biological parameters
- Population assessments (SEA165, SEA166, SEA167)
- Catch Options (SEA167)

Noon to 1:00pm – Lunch

1:00pm to 5:00pm—Hooded Seals: Northwest Atlantic Stock

- Information on recent catches and regulatory measures
- Current Research
- Biological parameters
- Population assessment
- Catch Options

5:00pm -- Break for day

Friday, 29 August

9:30am to 5:00 pm — Plenary discussions and writing

- Evaluation of the proposed Norwegian management strategy with respect to the precautionary principle.
- Assessment of the minimum size of a harp seal population that can be considered sustainable and that the same time can give a maximum continued yield

Saturday, 30 August

9:00am to noon – Conclude report writing

Annex 3: WGHARP terms of reference for the next meeting

The **Working Group on Harp and Hooded Seals (WGHARP)** (Chair: R. Merrick, USA) will meet in Copenhagen during August 2009 (or a location/date to be determined) to:

a) Review results of intersessional working groups deliberations;

b) Review White Sea/Barents Sea winter 2009 surveys results;

c) Update assessments for White Sea/Barents Sea harp seals based on new data collected in winter 2009 surveys;

d) Review results of Canada's winter 2008 survey results; and

e) Consider other requests from member states for scientific advice;

WGHARP will report by September 2009 to the attention of the ACOM.

Supporting Information

PRIORITY:	High priority as a tool for the assessment and management of harp and hooded seal in the North Atlantic Ocean. WGHARP receives requests for advice from member countries through **ACOM** and/or NAFO Scientific Council, incuding recognition of the need for a precautionary approach to mangement of seal populations.
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	Action Numbers 4.3 and 4.3 A number of North Atlantic nations currently harvest harp and hooded seal stocks, and there is a need for a relatively neutral forum for developing and vetting scientific advice on sustainable harvests of these stocks. The WGHARP provides this forum through the inclusion of ICES and NAFO member state scientists expert in pinniped biology and the quantiative techniques necessary for development of sound catch advice; members represent all harvesting nations as well as nations without seal harvests. The activities of WGHARP are particularly relevant to action plan goals 3 and 4
RESOURCE REQUIREMENTS:	None beyond the contributions from member states
PARTICIPANTS:	The Group is normally attended by some 10-15 members and guests.
SECRETARIAT FACILITIES:	None
FINANCIAL:	None
LINKAGES TO ADVISORY COMMITTEES:	ACOM is the parent advisory committee for WGHARP, NAFO Sc.C.
LINKAGES TO OTHER COMMITTEES OR GROUPS:	LRC, RMC, WGMME, WGNPBW.
LINKAGES TO OTHER ORGANIZATIONS:	NOAA/NMFS, NAMMCO, Joint Norwegian-Russian Fisheries Committee. The work of this group is closely aligned with harp and hooded seal research and management programs conducted by the governments of Canada, Greenland, Norway, Russia, and the United States
SECRETARIAT MARGINAL COST SHARE:	ICES 100%

Annex 4: Recommendations

RECOMMENDATION	ACTION
1. ESTABLISH INTERSESSIONAL WORKING GROUP TO: A. DESIGN WINTER 2009 WHITE SEA/BARENTS SEA HARP SEALS. SURVEY B. EVALUATE HYPOTHESES TO EXPLAIN DECLINE IN OBSERVED WHITE SEA PUPPING	CANADA, NORWAY, AND RUSSIA
2. CONDUCT WHITE SEA/BARENTS SEA HARP SEAL SURVEY IN WINTER 2009	RUSSIA
3. CONDUCT SATELLITE TAGGING OF WHITE SEA/ BARENTS SEA HARP SEALS	NORWAY AND RUSSIA
4. COLLECT ADDITIONAL REPRODUCTIVE DATA ON GREENLAND SEA AND WHITE SEA/BARENTS SEA HARP AND HOODED SEALS	GREENLAND, NORWAY AND RUSSIA
5. SUPPORT ADDITIONAL RESEARCH ON SEA ICE–SEAL WHELPING RELATIONSHIPS	CANADA, GREENLAND, RUSSIA, AND NORWAY
6. CONTINUE HARP SEAL GENETIC ANALYSES WITH LARGER SAMPLE SIZE	CANADA, GREENLAND, NORWAY, AND RUSSIA
7. CONDUCT RECONAISSANCE HARP AND HOODED SEAL SURVEYS OF SOUTHERN COASTAL GREENLAND OUTSIDE OF THE TRADITIONAL WHLEPING AREAS	GREENLAND AND NORWAY
8. CONDUCT EXPERIMENT TO DETERMINE COMPARABILITY OF SEAL SURVEYS CONDUCTED IN DIFFERENT AREAS	CANADA, NORWAY, AND RUSSIA
9. PEER REVIEW SHAFIKOV ABUNDANCE ESTIMATION METHODS MS (SEA169)	RUSSIA

Annex 5: References

Working Papers

Number	Author	Title
SEA165	T. Haug, V. Zabavnikov and A. Golikov	Norwegian and Russian catches of harp and hooded seals in the Greenland Sea and in the Barents Sea / White Sea in 2006–2008
SEA166	T. A. Øigård, T. Haug, K. T. Nilssen and A.-B. Salberg	Pup production estimates of hooded and harp seals in the Greenland Sea during the 2007 whelping season.
SEA167	T. A. Øigård, T. Haug, K. T. Nilssen, N. Øien and A.-B. Salberg	The 2007 abundance of hooded seals (*Cystophora cristata*) in the Greenland Sea.
SEA168	T. A. Øigård, T. Haug, K. T. Nilssen and A.-B. Salberg	The 2007 abundance of harp seals (*Pagophilus groenlandicus*) in the Greenland Sea.
SEA169	I. N. Shafikov	Estimation of abundance of the White Sea population of the harp seal (*Phoca groenlandica*) according of the data from the offspring calculation.
SEA170	V. A. Korzhev	Recommendations on the White Sea population harp seal biological reference points and hunting strategy.
SEA171	V. B. Zabavnikov, V. V. Asyutenko, E. I. Badanina, S. A. Egorov, S. V. Zyryanov, N. V. Isaeva and I. N. Shafikov.	Research of the White Sea harp seal population (*Phoca groenlandica*) which were carried out by PINRO in 2004–2008: estimation of current situation and possible perspectives.
SEA172	M. O. Hammill and G. B. Stenson	Possible Impacts of Ice Related Mortality on Trends in the Northwest Atlantic harp seals populations
SEA173	V. Svetochev and O. Svetocheva	Food habits of the Harp Seal (*Phoca groenlandica*) in the White Sea in spring
SEA174	V. Svetochev and O. Svetocheva.	Ecology of Harp Seal pups (*Phoca groenlandica*) during the ice period in the White Sea
SEA175	I. N. Shafikov.	Probabilistic approach to the estimation of marine biological objects by the data from area surveys.
SEA176	A. K. Frie and V. Svetochev	Population structure of Northeast Atlantic harp seals (*Pagophilus groenlandicus*)
SEA177	A. K. Frie	Age at maturity and fertility rates of Greenland Sea and Barents sea/White Sea harp seals (*Pagophilus groenlandicus*)
SEA178	G. Stenson	Total Allowable, and Reported, Catches of harp and hooded seals in Canada, 2005–2008
SEA179	A. Rosing-Asvid	Distribution Patterns of Northwest Atlantic Harp Seals in Relation to Population Size

Other References

Author	Year	Citation
Benjaminsen, T.	1979	Pup production and sustainable yield of White Sea harp seals. *Fiskeridirektoratets Skrifter, Serie Havundersøkelser* 16:551-559.
Hammill, M. O., and G. B. Stenson	2007	Application of the precautionary approach and conservation reference points to management of Atlantic seals. ICES Journal of Marine Science, 64.
Nordoy, E., L. P. Folkow. V. Potelov, V. Prischemikhin and A.S. Blix	2008	Seasonal distribution and dive behaviour of harp seals (*Pagophilus groenlandicus*) of the White Sea-Barents Sea stock. Pol. Biol. 31:1119-1135.
Rosing-Asvid, A.	2008	A new harp seal whelping ground near South Greenland. Mar. Mamm. Sci. 24: 730-736.
WGHARP	2006a	Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, 30 August - 3 September, 2005, St. John's, Newfoundland, Canada. ICES CM 2006/ACFM. 44 pp.
WGHARP	2006b	Report of the Working Group on ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP), 12-16 June 2006, ICES Headquarters. ICES CM 2006/ACFM:32. 28 pp.

Annex 6: Catches of hooded seals including catches taken according to scientific permits

Table 1. Catches of hooded seals in the Greenland Sea ("West Ice") from 1946 through 2008[a]. Totals include catches for scientific purposes.

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year and older	total	Pups	1 year and older	Total
1946–50	31152	10257	41409	-	-	-	31152	10257	41409
1951–55	37207	17222	54429	-	-	-[b]	37207	17222	54429
1956–60	26738	9601	36339	825	1063	1888[b]	27563	10664	38227
1961–65	27793	14074	41867	2143	2794	4937	29936	16868	46804
1966–70	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	-	-	-	368	565	933

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year and older	total	Pups	1 year and older	Total
1996	575	236	811	-	-	-	575	236	811
1997	2765	169	2934	-	-	-	2765	169	2934
1998	5597	754	6351	-	-	-	5597	754	6351
1999	3525	921	4446	-	-	-	3525	921	4446
2000	1346	590	1936	-	-	-	1346	590	1936
2001	3129	691	3820	-	-	-	3129	691	3820
2002	6456	735	7191	-	-	-	6456	735	7191
2003	5206	89	5295	-	-	-	5206	89	5295
2004	4217	664	4881	-	-	-	4217	664	4881
2005	3633	193	3826	-	-	-	3633	193	3826
2006	3079	568	3647				3079	568	3647
2007	27	35	62				27	35	62
2008	9	35	44				9	35	44

[a] For the period 1946–1970 only 5-year averages are given.

[b] For 1955, 1956 and 1957 Soviet catches of harp and hooded seals reported at 3,900, 11,600 and 12,900, respectively. These catches are not included.

[c] Including 1048 pups and 435 adults caught by one ship which was lost.

Table 2. Canadian catches of hooded seals off Newfoundland and in the Gulf of St. Lawrence, Canada ("Gulf" and "Front"), 1946-2008a,b. Catches from 1995 onward includes catches under personal use licences. YOY refers to Young of Year. Catches from 1990-1996 were not assigned to age classes. With the exception of 1996, all were assumed to be 1+.

	Large Vessel Catches				Landsmen Catches[c]				Total Catches			
Year	YOY	1+	Unk	Total	YOY	1+	Unk	Total	YOY	1+	Unk	Total
1946-50	4029	2221	0	6249	429	184	0	613	4458	2405	0	6863
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	12703	613	211	24	848	8096	5431	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	393[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[e]	636	41	53	636	730
1991	0	14	0	14[d]	0	0	6411[e]	6411	0	14	6411	6425
1992	35	60	0	95[d]	0	0	119[e]	119	35	60	119	214
1993	0	19	0	19[d]	0	0	19[e]	19	0	19	19	38
1994	19	53	0	72[d]	0	0	149[e]	149	19	53	149	221
1995	0	0	0	0	0	0	857[e]	857	0	0	857[e]	857
1996	0	0	0	0	0	0	25754[e]	25754	0	22,847[f]	2907	25754
1997	0	0	0	0	0	7058	0	7058	0	7058[e]	0	7058
1998	0	0	0	0	0	10148	0	10148	0	10148[e]	0	10148
1999[e]	0	0	0	0	0	201	0	201	0	201[e]		201
2000[e]	2	2	0	4[d]	0	10	0	10	2	12[e]	0	14
2001[e]	0	0	0	0	0	140	0	140	0	140[e]	0	140
2002[e]	0	0	0	0	0	150	0	150	0	150[e]	0	150
2003[e]	0	0	0	0	0	151	0	151	0	151[e]	0	151
2004[e]	0	0	0	0	0	389	0	389	0	389[e]	0	389

2005[e]	0	0	0	0	0	20	0	20	0	20[e]	0	20
2006[e]	0	0	0	0	0	40	0	40	0	40	0	40
2007[e]	0	0	0	0	0	17	0	17	0	17	0	17
2008[eg]	0	0	0	0	0	5	0	5	0	5	0	5

[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 in Newfoundland and may differ from NAFO values.
[e] Statistics no longer split by age; commercial catches of bluebacks are not allowed
[f] Number of YOY estimated from reported illegal catches
[g] Preliminary estimates

Table 3. Catches of hooded seals in West and East Greenland 1954–2003.

Year	West Atlantic Population				NE	All Greenland
	West	KGH[b]	Southeast	Total		
1954	1097	-	201	1298	-	1298
1955	972	-	343	1315	1	1316
1956	593	-	261	854	3	857
1957	797	-	410	1207	2	1209
1958	846	-	361	1207	4	1211
1959	780	414	312	1506	8	1514
1960	965	-	327	1292	4	1296
1961	673	803	346	1822	2	1824
1962	545	988	324	1857	2	1859
1963	892	813	314	2019	2	2021
1964	2185	366	550	3101	2	3103
1965	1822	-	308	2130	2	2132
1966	1821	748	304	2873	-	2873
1967	1608	371	357	2336	1	2337
1968	1392	20	640	2052	1	2053
1969	1822	-	410	2232	1	2233
1970	1412	-	704	2116	9	2125
1971	1634	-	744	2378	-	2378
1972	2383	-	1825	4208	2	4210
1973	2654	-	673	3327	4	3331
1974	2801	-	1205	4006	13	4019
1975	3679	-	1027	4706	58[a]	4764
1976	4230	-	811	5041	22[a]	5063
1977	3751	-	2226	5977	32[a]	6009
1978	3635	-	2752	6387	17	6404
1979	3612	-	2289	5901	15	5916
1980	3779	-	2616	6395	21	6416
1981	3745	-	2424	6169	28[a]	6197
1982	4398	-	2035	6433	16[a]	6449
1983	4155	-	1321	5476	9[a]	5485
1984	3364	-	1328	4692	17	4709
1985	3188	-	3689	6877	6	6883
1986	2796[a]	-	3050[a]	5846[a]	-[a]	5846[a]
1987	2333[a]	-	2472[a]	4805[a]	3[a]	4808[a]
1988–92[c]						
1993	4983	-	1967	6950	32	6982
1994	5060	-	3048	8108	34	8142
1995	4429		2702	7131	48	7179

Year	West Atlantic Population				NE	All Greenland
	West	KGH[b]	Southeast	Total		
1996	6066	-	3801	9867	24	9891
1997	5250		2175	7425	67	7492
1998	5051		1270	6321	14	6335
1999	4852	-	2587	7439	16	7455
2000	3769	-	2046	5815	29	5844
2001	5010	-	1496	6506	8	6514
2002	3606	-	1189	4795	11	4806
2003	4351	-	1992	6343	10	6353
2004	4133		1690	5823	20	5843
2005	3092		1022	4114	14	4128
2006	4194		550	4744	3	4747

[a] Provisional figures: do not include estimates for non-reported catches as for the previous years.

[b] Royal Greenland Trade Department special vessel catch expeditions in the Denmark Strait 1959–68.

[c] For 1988 to 1992 catch statistics are not available.

Annex 7: Catches of harp seals including catches taken according to scientific permits

Table 1. Catches of harp seals in the Greenland Sea ("West Ice") from 1946 through 2008[a]. Totals include catches for scientific purposes.

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	pups	1 year and older	Total	Pups	1 year and older	Total
1946–50	26606	9464	36070	-	-	-	26606	9464	36070
1951–55	30465	9125	39590	-	-	-b	30465	9125	39590
1956–60	18887	6171	25058	1148	1217	2365b	20035	7388	27423
1961–65	15477	3143	18620	2752	1898	4650	18229	5041	23270
1966–70	16817	1641	18458	1	47	48	16818	1688	18506
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	7961	6783	14744
1988	4493	5170	9663c	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

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	pups	1 year and older	Total	Pups	1 year and older	Total
1995	317	7889	8206	-	-	-	317	7889	8206
1996	5649	778	6427	-	-	-	5649	778	6427
1997	1962	199	2161	-	-	-	1962	199	2161
1998	1707	177	1884	-	-	-	1707	177	1884
1999	608	195	803	-	-	-	608	195	803
2000	6328	6015	12343	-	-	-	6328	6015	12343
2001	2267	725	2992	-	-	-	2267	725	2992
2002	1118	114	1232	-	-	-	1118	114	1232
2003	161	2116	2277				161	2116	2277
2004	8288	1607	9895				8288	1607	9895
2005	4680	2525	7205				4680	2525	7205
2006	2343	961	3304				2343	961	3304
2007	6188	1640	7828				6188	1640	7828
2008	744	519	1263				744	519	1263

[a] For the period 1946–1970 only 5-year averages are given.

[b] For 1955, 1956 and 1957 Soviet catches of harp and hooded seals reported at 3,900, 11,600 and 12,900, respectively (Sov. Rep. 1975). These catches are not included.

[c] Including 1431 pups and one adult caught by a ship which was lost.

Table 2. Catches of harp seals in the White and Barents Seas ("East Ice"), 1946–2008[a,b].

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and Older	Total	Pups	1 year and Older	Total	Pups	1 year and Older	Total
1946–50			25057	90031	55285	145316			170373
1951–55			19590	59190	65463	124653			144243
1956–60	2278	14093	16371	58824	34605	93429	61102	48698	109800
1961–65	2456	8311	10767	46293	22875	69168	48749	31186	79935
1966–70			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[e]	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[f]	8758	31000	500	31500	31000	9258	40258
1994	0	9500	9500	30500	2000	32500	30500	11500	42000
1995	260	6582	6842	29144	500	29644	29404	7082	36486
1996	2910	6611	9521	31000	528	31528	33910	7139	41049

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and Older	Total	Pups	1 year and Older	Total	Pups	1 year and Older	Total
1997	15	5004	5019	31319	61	31380	31334	5065	36399
1998	18	814	832	13350	20	13370	13368	834	14202
1999	173	977	1150	34850	0	34850	35023	977	36000
2000	2253	4104	6357	38302	111	38413	40555	4215	44770
2001	330	4870	5200	39111	5	39116	39441	4875	44316
2002	411	1937	2348	34187	0	34187	34598	1937	36535
2003	2343	2955	5298	37936	0	37936	40279	2955	43234
2004	0	33	33	0	0	0	0	33	33
2005	1162	7035	8197	14258	19	14277	15488	9405	22474
2006	147	9939	10086	7005	102	7107	7152	10041	17193
2007	242	5911	6153	5276	200	5476	5518	6111	11629
2008 [g]	0	0	0	13331	0	13331	13331	0	13331

[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] Russian catches of 1+ animals after 1987 selected by scientific sampling protocols.
[f] Included 717 seals caught to the south of Spitsbergen, east of 14o E, by one ship which mainly operated in the Greenland Sea.

Table 3. Reported catches of harp seals in the northwest Atlantic. Estimated catches are indicated by shading.

Year	Front & Gulf	Canadian Arctic	Greenland	NW Atlantic Total
1952	307,108	1,784	16,400	325,292
1953	272,886	1,784	16,400	291,070
1954	264,416	1,784	19,150	285,350
1955	333,369	1,784	15,534	350,687
1956	389,410	1,784	10,973	402,167
1957	245,480	1,784	12,884	260,148
1958	297,786	1,784	16,885	316,455
1959	320,134	1,784	8,928	330,846
1960	277,350	1,784	16,154	295,288
1961	187,866	1,784	11,996	201,646
1962	319,989	1,784	8,500	330,273
1963	342,042	1,784	10,111	353,937
1964	341,663	1,784	9,203	352,650
1965	234,253	1,784	9,289	245,326
1966	323,139	1,784	7,057	331,980
1967	334,356	1,784	4,242	340,382
1968	192,696	1,784	7,116	201,596
1969	288,812	1,784	6,438	297,034
1970	257,495	1,784	6,269	265,548
1971	230,966	1,784	5,572	238,322
1972	129,883	1,784	5,994	137,661
1973	123,832	1,784	9,212	134,828
1974	147,635	1,784	7,145	156,564
1975	174,363	1,784	6,752	182,899
1976	165,002	1,784	11,956	178,742
1977	155,143	1,784	12,866	169,793
1978	161,723	2,129	16,638	180,490
1979	160,541	3,620	17,545	181,706
1980	169,526	6,350	15,255	191,131
1981	202,169	4,672	22,974	229,815
1982	166,739	4,881	26,927	198,547
1983	57,889	4,881	24,785	87,555
1984	31,544	4,881	25,829	62,254
1985	19,035	4,881	20,785	44,701
1986	25,934	4,881	26,099	56,914
1987	46,796	4,881	37,859	89,536
1988	94,046	4,881	40,415	139,342
1989	65,304	4,881	42,971	113,156
1990	60,162	4,881	45,526	110,569
1991	52,588	4,881	48,082	105,551
1992	68,668	4,881	50,638	124,187
1993	27,003	4,881	56,319	88,203
1994	61,379	4,881	59,684	125,944
1995	65,767	4,881	66,298	136,946
1996	242,906	4,881	73,947	321,734
1997	264,210	2,500[a]	68,816	335,526

Year	Front & Gulf	Canadian Arctic	Greenland	NW Atlantic Total
1998	282,624	1,000[a]	81,272	364,896
1999	244,552	500[a]	93,117	338,169
2000	92,055	400[a]	98,459	190,914
2001	226,493	600[a]	85,428	312,521
2002	312,367	1,000	66,735	380,102
2003	289,512	1,000	66,149	356,661
2004	365,971	1,000	70,586	437,557
2005	323,826	1,000	91,696	416,522
2006	354,867	1,000	92,210	448,077
2007	224,745	1,000	81,447[b]	307,192
2008	206,436	1,000	81,447[b]	288,883

[a] Rounded
[b] Average of catches 1997-2006

Table 4. Harp seal catches off Newfoundland and in the Gulf of St. Lawrence, Canada ("Gulf" and "Front"), 1946–2005[a,b]. Catches from 1995 onward include catches under the personal use licences.

Year	Large Vessel Catch				Landsmen Catch				Total Catches			
	Pups	1+	Unk	Total	Pups	1+	Unk	Total	Pups	1+	Unk	Total
1946-50	108256	53763	0	162019	44724	11232	0	55956	152980	64995	0	217975
1951-55	184857	87576	0	272433	43542	10697	0	54239	228399	98273	0	326672
1956-50	175351	89617	0	264968	33227	7848	0	41075	208578	97466	0	306044
1961-65	171643	52776	0	224419	47450	13293	0	60743	219093	66069	0	285162
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	95	549	0	644[e]	23827	7073	0	30900	23922	7622	0	31544
1985	0	1	0	1[e]	13334	5700	0	19034	13334	5701	0	19035
1986	0	0	0	0	21888	4046	0	25934	21888	4046	0	25934
1987	2671	90	0	2761	33657	10356	22	44035	36350	10446	0	46796
1988	0	0	0	0	66972	13493	13581	94046	66972	27074	0	94046
1989	1	231	0	232[e]	56345	5691	3036	65072	56346	8958	0	65304
1990	48	74	0	122[e]	34354	23725	1961	60040	34402	25760	0	60162
1991	3	20	0	23[e]	42379	5746	4440	52565	42382	10206	0	52588
1992	99	846	0	945[e]	43767	21520	2436	67723	43866	24802	0	68668
1993	8	111	0	119[e]	16393	9714	777	26884	16401	10602	0	27003
1994	43	152	0	195[e]	25180	34939	1065	61184	25223	36156	0	61379
1995	21	355	0	376[e]	33615	31306	470	65391	34106	31661	0	65767
1996	3	186	0	189[e]	184853	57864	0	242717	184856	58050	0	242906
1997	0	6	0	6[e]	220476	43728	0	264204	220476	43734	0	264210
1998	7	547	0	554[e]	0	0	282070	282070	7	547	282070	282624
1999	26	25	0	51[e]	221001	6769	16782	244552	221027	6794	16782	244603
2000	16	450	0	466[e]	85035	6567	0	91602	85485	6583	0	92068
2001	0	0	0	0	214754	11739	0	226493	214754	11739	0	226493
2002	0	0	0	0	297764	14603	0	312367	297764	14603	0	312367
2003	0	0	0	0	280174	9338	0	289512	280174	9338	0	289512
2004	0	0	0	0	353553	12418	0	365971	353553	12418	0	365971
2005[f]	0	0	0	0	319127	4699	0	323820	319127	4699	0	323820
2006	0	0	0	0	346426	8441	0	354867	346426	811	0	354867
2007	0	0	0	0	221488	3257	0	224745	221488	3257	0	224745
2008[f]	0	0	0	0	206171	285	0	296456	206171	285	0	296456

[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)

[e] Large vessel catches represent research catches in Newfoundland and may differ from NAFO values

[f] Preliminary estimates

Table 5. Catches of harp seals in Greenland, 1954–1987 (List-of-Game), and 1993–2006 (Piniarneq), and % adults[a] according to the hunters' reports.

Year	West Greenland		South East Greenland		North East Greenland		All Greenland
	Catch num-bers	% adults	Catch num-bers	% adults	Catch num-bers	% adults	Catch num-bers
1954	18,912		475		32		19,419
1955	15,445		178		45		15,668
1956	10,883		180		5		11,068
1957	12,817		133		40		12,990
1958	16,705		360		30		17,095
1959	8,844		168		7		9,019
1960	15,979		350		16		16,345
1961	11,886		219		13		12,118
1962	8,394		211		10		8,615
1963	10,003	21	215	28	20	50	10,238
1964	9,140	26	125	40	7	86	9,272
1965	9,251	25	76	65	2	100	9,329
1966	7,029	29	55	55	6		7,090
1967	4,215	38	54	35	10		4,279
1968	7,026	30	180	47	4		7,210
1969	6,383	21	110	62	9		6,502
1970	6,178	26	182	70	15	100	6,375
1971	5,540	24	63	48	5		5,608
1972	5,952	16	84	48	6	100	6,042
1973	9,162	19	100	20	38	79	9,300
1974	7,073	21	144	29	27	95	7,244
1975	5,953	13	125	20	68	72	6,146
1976	7,787	12	260	48	27	55	8,074
1977	9,938	15	72	16	21	81	10,031
1978	10,540	16	408	14	30	36	10,978
1979	12,774	20	171	19	18	25	12,963
1980	12,270	17	308	14	45		12,623
1981	13,605	21	427	15	49		14,081
1982	17,244	16	267	20	50	60	17,561
1983	18,739	19	357	56	57	30	19,153
1984	17,667	16	525	19	61		18,253
1985	18,445	2	534	0	56	52	19,035
1986	13,932[b]	10	533[b]	18	37[b]	65	14,502[b]

Year	West Greenland		South East Greenland		North East Greenland		All Greenland
	Catch num-bers	% adults	Catch num-bers	% adults	Catch num-bers	% adults	Catch num-bers
1987	16,053[b]	21	1060[b]	24	15[b]	60	17,128[b]
1988							
1989							
1990	For 1988 to 1992 comparable catch statistics are not available.						
1991							
1992							
1993	55,792	50	1,054	30	40	93	56,886
1994	56,941	50	864	30	88	65	57,893
1995	62,296	53	906	36	61	52	63,263
1996	73,287	52	1,320	35	69	59	74,676
1997	68,241	49	1,149	28	201	58	69,591
1998	80,437	51	1,670	30	110	73	82,217
1999	91,321	50	3,592	12	104	65	95,017
2000	97,229	44	2,459	15	113	76	99,801
2001	84,165	42	2,525	18	73	68	86,763
2002	65,810	46	1,849	19	66	86	67,725
2003	64,735	44	2,828	24	44	77	67,607
2004	69,273	41	2,625	27	207	29	72,105
2005	90,308	35	2,775	18	38	58	93,121
2006	91,191	33	2,038	16	89	78	93,318

[a] Seals exhibiting some form of a harp.

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

Table 6. Estimated catches of harp seals in Greenland, 1975–1987 and 1993–1995. Figures in bold are non-corrected figures from Table 5.

Year	West Greenland	South East Greenland	North East Greenland	Total Greenland
1975	6,689	**125**	**68**	6,882
1976	11,826	**260**	50	12,136
1977	12,830	**72**	50	12,952
1978	16,434	**408**	50	16,892
1979	17,459	**171**	50	17,680
1980	15,101	**308**	**45**	15,454
1981	22,760	**427**	**49**	23,236
1982	26,793	**267**	**50**	27,110
1983	24,606	**357**	**57**	25,020
1984	25,566	**525**	**61**	26,152
1985	20,518	**534**	**56**	21,108
1986	25,832	**533**[a]	50	26,415
1987	37,329	**1060**[a]	50	38,439
1993	**55,792**	1,335	**40**	57,167
1994	58,811	1,746	**88**	60,645
1995	65,533	1,529	**61**	67,123

[a] Provisional figures; do not include estimates for non-reported catches.

Table 7. Estimated total removals of harp seals in the northwest Atlantic

Year	Reported	Bycatch	Struck and Lost	Total
1952	325,292	0	129,230	454,522
1953	291,070	0	95,095	386,165
1954	285,350	0	112,084	397,434
1955	350,687	0	100,938	451,625
1956	402,167	0	64,218	466,385
1957	260,148	0	96,381	356,529
1958	316,455	0	176,883	493,338
1959	330,846	0	94,426	425,272
1960	295,288	0	140,697	435,985
1961	201,646	0	34,532	236,178
1962	330,273	0	125,277	455,550
1963	353,937	0	86,250	440,187
1964	352,650	0	88,959	441,609
1965	245,326	0	64,414	309,740
1966	331,980	0	83,382	415,362
1967	340,382	0	65,438	405,820
1968	201,596	0	46,718	248,314
1969	297,034	0	66,051	363,085
1970	265,548	68	50,313	315,929
1971	238,322	490	29,870	268,682
1972	137,661	621	22,031	160,313
1973	134,828	465	37,486	172,779
1974	156,564	182	42,899	199,645
1975	182,899	285	43,681	226,865
1976	178,742	1092	47,991	227,825
1977	169,793	1577	44,094	215,464
1978	180,490	2919	65,474	248,883
1979	181,706	3310	50,585	235,601
1980	191,131	2717	60,048	253,896
1981	229,815	3921	53,222	286,958
1982	198,547	3785	54,740	257,071
1983	87,555	4962	40,131	132,648
1984	62,254	4108	39,591	105,952
1985	44,701	4857	32,069	81,627
1986	56,914	8178	36,178	101,269
1987	89,536	13096	55,099	157,731
1988	139,342	8545	75,895	223,781
1989	113,156	10256	59,775	183,187
1990	110,569	3621	77,978	192,168
1991	105,551	9689	65,400	180,640
1992	124,187	25476	82,629	232,292
1993	88,203	26472	72,665	187,340
1994	125,944	47255	102,049	275,248
1995	136,946	20395	104,635	261,975
1996	321,734	29201	146,607	497,542
1997	335,526	18869	126,654	481,048
1998	364,896	4641	126,725	496,262
1999	338,169	16111	113,033	467,313

Year	Reported	Bycatch	Struck and Lost	Total
2000	190,914	11347	110,354	312,615
2001	312,521	19475	109,069	441,065
2002	380,102	9329	98,009	487,440
2003	356,661	5367	91,233	453,261
2004	437,557	12330.4	102,612	552,498
2005	416,522	12330.4	114,191	543,043
2006	448,077	12330.4	119,884	580,291
2007	307,192	12330.4	97,361	416,883
2008	288,883	12330.4	93,563	394,776

Annex 8: Summary of harp and hooded sealing regulations

Table 1. Summaries of Norwegian harp and hooded sealing regulations for the Greenland Sea ("West Ice"), 1985–2008.

Year	Opening Date	Closing Date	Quotas				Allocations	
			Total	Pups	Female	Male	Norway	Soviet & Russian
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	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
1992-94	26 March	30 June	9,000	0	0	Incl.	1,700	7,300
1995	26 March	10 July	9,000	0	0	Incl.	1,700[7]	7,300
1996	22 March	10 July	9,000[8]				1,700	7,300
1997	26 March	10 July	9,000[9]				6,200	2,800[11]
1998	22 March	10 July	5,000[10]				2,200	2,800[11]
1999-00	22 March	10 July	11,200[12]				8,400	2,800[11]
2001-03	22 March	10 July	10,300[12]				10,300	
2004-05	22 March	10 July	5,600[12]				5,600	
2006	22 March	10 July	4,000				4,000	
2007-08[14]			0	0	0	0	0	0
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
1992-93	10 April	31 May	10,900	0	0[5]	0[5]	8,400	2,500
1994	10 April	31 May	13,100	0	0[5]	0[5]	10,600	2,500
1995	10 April	31 May	13,100	0	0[5]	0[5]	10,600[7]	2,500
1996	10 April	31 Ma[8]	13,100[9]				10,600	2,500[11]
1997-98	10 April	31 May	13,100[10]				10,600	2,500[11]
1999-00	10 April	31 May	17,500[13]				15,000	2,500[11]

Year	Opening Date	Closing Date	Quotas				Allocations	
			Total	Pups	Female	Male	Norway	Soviet & Russian
2001-05	10 April	31 May	15,000[13]				15,000	0
2006-07	10 April	31 May	31,200				31,200	0
2008	5 April	31 May	31,200				31,200	0

[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.
[7] Included 750 weaned pups under permit for scientific purposes.
[8] Pups allowed to be taken from 26 March to 5 May.
[9] Half the quota could be taken as weaned pups, where two pups equalled one 1+ animal.
[10] The whole quota could be taken as weaned pups, where two pups equalled one 1+ animal.
[11] Russian allocation reverted to Norway.
[12] Quota given in 1+ animals, parts of or the whole quota could be taken as weaned pups, where 1,5 pups equalled one 1+ animal.
[13] Quota given in 1+ animals, parts of or the whole quota could be taken as weaned pups, where 2 pups equalled one 1+ animal.
[14] Hooded seals protected, only small takes for scientific purposes allowed.

Table 2. Summary of sealing regulations for the White and Barents Seas ("East Ice"), 1979–2008.[1]

Year	Opening Dates		Closing Date	Quota-Allocation		
	Soviet/Rus.	Norway		Total	Soviet/Rus.	Norway
1979–80	1 March	23 March	30 April3	50,0004	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 April3	80,000	61,000	19,000
1988	-	-	-	70,000	53,400	16,600
1989–94	-	-	-	40,000	30,500	9,500
1995	-	-	-	40,000	31,250	8,7505
1996	-	-	-	40,000	30,500	9,500
1997-98	-	-	-	40,000	35,000	5,000
1999	-	-	-	21,400[6]	16,400	5,000
2000	27 Febr	-	-	27,700[6]	22,700	5,000
2001-02	-	-	-	53,000[6]	48,000	5,000
2003	-	-	-	53,000[6]	43,000	10,000
2004-05				45,100[6]	35,100	10,000
2006	-	-	-	78,200[6]	68,200	10,000
2007	-	-	-	78,200[6]	63,200	15,000
2008	-	-	-	55,100[6]	45,100	10,000

[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.
[6] Quotas given in 1+ animals, parts of or the whole quota could be taken as pups, where 2,5 pups equalled one 1+ animal

Table 3. Major management measures implemented for harp seals in Canadian waters, 1960–2008.

Year	Management Measure
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.
1987	Change in Seal Management Policy to prohibit the commercial hunting of whitecoats and hunting from large (>65 ft) vessels (effective 1988). Changes implemented by a condition of licence.
1992	First Seal Management Plan implemented.
1993	Seal Protection Regulations updated and incorporated in the Marine Mammal Regulations. The commercial sale of whitecoats prohibited under the Regulations. Netting of seals south of 54°N prohibited. Other changes to define killing methods, control interference with the hunt and remove old restrictions.
1995	Personal sealing licences allowed. TAC remained at 186,000 including personal catches. Quota divided among Gulf, Front and unallocated reserve.
1996	TAC increased to 250,000 including allocations of 2,000 for personal use and 2,000 for Canadian Arctic.
1997	TAC increased to 275,000 for Canadian waters.
2000	Taking of whitecoats prohibited by condition of license
2003	Implementation of 3 year management plan allowing a total harvest of 975,000 over 3 years with a maximum of 350,000 in any one year.
2005	TAC reduced to 319,517 in final year of 3 year management plan
2006	TAC increased to 335,000 including a 325,000 commercial quota, 6,000 original initiative, and 2,000 allocation each for Personal Use and Arctic catches
2007	TAC reduced to 270,000 including 263,140 for commercial, 4,860 for Aboriginal, and 2,000 for Personal Use catches
2008	TAC increased to 275,000 including a 268,050 for commercial, 4,950 for Aboriginal and 2,000 for Personal Use catches Implementation of requirement to bleed before skinning as a condition of licence

Table 4. Major management measures implemented for hooded seals in Canadian waters (1960–2007).

Year	Management Measure
1964	Hunting of hooded seals banned in the Gulf area (below 50oN), 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.
1984–1990	TAC reduced to 2,340 for Canadian waters.
1987	Change in Seal Management Policy to prohibit the commercial hunting of bluebacks and hunting from large (>65 ft) vessels (effective 1988). Changes implemented by a condition of licence.
1991–1992	TAC raised to 15,000.
1992	First Seal Management Plan implemented.
1993	TAC reduced to 8,000. Seal Protection Regulations updated and incorporated in the Marine Mammal Regulations. The commercial sale of bluebacks prohibited under the Regulations.
1995	Personal sealing licences allowed (adult pelage only).
1998	TAC increased to 10,000
2000	Taking of bluebacks prohibited by condition of license.

Annex 9: Technical Minutes

Report from the Review Group on WGHARP

The review group for Harp and Hooded seals (RGHARP) have been asked to review the report from WGHARP 27-30 of August 2008. The group met by correspondence on 8-12 of September 2008. The Group was chaired by Dr. Olle Karlsson, Swedish Museum of Natural History, Sweden and participated by Dr. Dave Thompson, Sea Mammal Research Unit, University of St Andrews, Scotland and Ivar Jussi, State Nature Conservation Centre, Estonia.

General Comments

The group was asked to put special emphasis on the request made by Norway on the long term stock size aim of 430.000 animals for the harp seals in the Greenland Sea, but has also to look at the other terms of reference for the working group i.e. the impact on seal stocks in the area of harvest at current levels, sustainable catches and twice the sustainable catches, and also to define the minimum size of the harp seal population that can be sustainable.

Most of the stocks are considered data poor which makes it difficult for WGHARP to meet the terms of reference, and hence also for the review group. The review will follow the outline of the report.

4 Harp seal

4.1 Stock Identity, distribution and management

General Comments

This section is based on a study by Frie and Svetochev on genetic population structure of Harp seals in the North West Atlantic. The study seems to be based on a very small number of sampled animals, it would therefore have been preferable to get information regarding the total number of samples used in the analyses. Even if it the material is large enough to reject panmixia, it is probably not large enough to give a thorough picture of the genetic population structure. The report also suggests that a more complicated population structure might be present. More effort would be need in this area if genetic data should be used to define the correct management units.

4.2 The Greenland Sea Stock

General Comments

The studies made and models used to estimate stock seems to be technically correct, and the scope and depth of the science is appropriate to the request, given the limitation of the old reproductive data. With the different catch options to evaluate (present level, PBR and 2*PBR), we agree with WGHARP that harvest at the current level probably should pose no threats to population. We also agree with WGHARP that catches at PBR level or twice the PBR level would likely decrease the population. One issue that might have been worth to discuss a bit further are possible effects on pup mortality and adult survival of a reduced ice cover. Changes in ice conditions are likely to have an effect on most ice breeding seal species.

However there are certain aspects of the model that would need some more clarification and there are some minor editorial suggestions.

4.2.3 in the text two values for fecundity are given 0,79 and 0,833 with discussion of wether the change is biologically significant. However, the fitted value is lower at 0.69. Some comment on the implications of this difference should be included.

4.2.4 *page 10 line 12* Would it be possible to give area covered by each shot to get an idea of actual coverage?

Page 10 line 36. I should be i.

Figure 1. The fit shown in the figure is not very convincing. For 3 out of the 8 surveys from '83 to '92 the pup production projected by the model is below the lower 95% c.i. of the survey estimate while the five lower estimates all lie close to the fitted pup production trajectory (with a fitted fecundity of 0.69).

The '83 to '92 surveys would seem to indicate that the fecundity rate was varying dramatically between years. Mean pup prod for the three highest years was almost double that of the other 5 years estimates. If the lower pup counts are consistent with a population model with fecundity rates of 0.69 the higher counts around the same time would require fecundity>1.

The fit is presumably achieved because the survey results are in some way inverse weighted by their CVs. Has any sort of analysis been done on the effects of changing the intensity of this weighting?

The combination of a small pup production data set and the fact that the posterior mortality estimates are close to the priors may indicate that there is little useful information in the pup production data to fit these parameters. This would imply that the behaviour of the models is more or less determined by the choice of the prior means. In this case a more precautionary approach would be advisable when setting catch limits (see 4.2.5 below)

As the WGHARP report is a summary report, it can't contain a detailed description of the model, but it does need to include some discussion of this lack of fit to the early pup estimates and why the model is still accepted.

The third sentence in the figure text seems to refer to a figure in a previous report.

4.2.5 If the model fit is poor and you define this as a data poor population, it might be more appropriate to use a precautionary recovery factor. E.g. set Fr = 0.5 (or some other "precautionary" figure less than 1). At present, your prediction is that a value of 2X PBR would lead to a major population decline. If you set the PBR at half the level, then it would be seen as erring on the side of precaution, but given that recent historical takes have always been massively below the quota it should have no effect on the industry.

We noticed that the plot of average pregnancy rate for mature females has been dropped since WGHARP 2006a. It suggested that the proportion of immature females has increased through the model runs. Would this have any major implications if it turns out to be incorrect?

4.3 The White Sea and the Barents Sea Stock

General Comments

Also the White Sea and the Barents Sea Stock are treated as data poor by WGHARP due to concerns over the accuracy of the pup production estimate and concern over the model used to derive the population estimate. Population size was estimated using a multiplier of 7 derived from the model. Due to the data situation WGHARP was unable to estimate the impact of future catches, and therefore suggests catch options based on the PBR approach and we agree with the WG. But also here we have some minor suggestions for clarification.

4.3.3 *Page 16 line 15* The sentences starting "This pregnancy rate was…." is ambiguous. Is it the new value or the old value that was based on directly observed implantation rates. The next sentence needs a statement to explain why observed decrease in fecundity is not related to the observed drop in pup production. It is not clear which of the estimates the working group believe is more realistic.

4.3.4 *Page 17 line 16*. We suggest expanding to state something like "Therefore using the observed pup production and the previously derived multiplier produces a conservative/ precautionary all age population estimate on which to base PBR."

Page *17 line 28*. The value of 7 for the multiplier was presumably based on something like an average from previous years where the model did predict pup production reasonably well, it would be good to state what it was.

Page *17 line 43*. This section seems a bit too detailed compared with the rest of the report. We suggest to trim it down to something along the lines of

" However, the WG felt that certain assumptions led to an under-estimation of immature age class sizes. Until further clarification of the methods the WG based its advice on previously described, better supported models."

4.3.5 *Page 18 line 8*. Would it be worth including another comment about the conservative nature of the population estimate?

4.4 The Northwest Atlantic Stock

General Comments

The North West Atlantic Stock is the biggest stock with the largest catches. Catches for some years even slightly over TAC. The population is considered data poor and no new data or pup production estimates are presented. But for other populations also considered data poor, catch limit and its implications are given. This was also done in the same section in the 2005 WG HARP report, therefore it seems a bit strange to us that catch limits are excluded in this report or at least an explanation why it is not included.

5 Hooded seals

5.1 The Greenland Sea Stock

General Comments

The Greenland Sea Stock is considered data poor, due to the age of the data on reproductive parameters. Population size is below N_{lim} and WGHARP recommends no

harvest on the population. The review group agrees with WGHARPs recommendation no harvest given the data situation and the size of the population.

5.2 The Northwest Atlantic Stock

General Comments

No new data or estimates were presented

6 Response to additional requests for advice

Is the management strategy proposed by Norway in accordance with the precautionary principle?

WGHARP suggests that the management strategy proposed by Norway is inappropriate at present, since the Greenland Sea Harp seals is considered data poor. However WGHARP suggests that the management principle would be appropriate for populations considered data rich, even if the proposed TAC is far from precautious. A harvest set at twice PBR will lead to a rapidly declining population and even more so if catches where not be changed with more than 25% between years, if the population is above N_{70}. For RGHARP a precautious management principle should not deplete a population rapidly. The management principle proposed by Norway would also likely decrease the long-term yield from the population. Therefore RGHARP agrees with the WGHARP that a precautious management principle should address also a depleted stock's possibility to recover, preferably within a defined time period.

Assess the minimum size of a harp seal population that could be considered sustainable and that the same time can give a maximum continued yield?

RGHARP agrees with WGHARP that minimum sustainable population size is very much dependent on the management objectives. However if the population at the same time should give a maximum continued yield, interpreted as the size of where the population is at maximum productivity i.e. maximal numerical growth. Theoretically this point is typically interpreted as about 50% of the carrying capacity (K) for the logistic function. However since K is variable and 50% of K can only be detected in retrospect so from a management perspective less useful.