Appendix 8

The 38th Session of the Joint Norwegian - Russian Fisheries Commission, Sochi, Russia, 5-9 October 2009

REPORT OF THE WORKING GROUP ON SEALS

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1. EXCHANGE OF INFORMATION AND SUMMARY OF SEAL CATCHES IN 2009

Norwegian catches in the Greenland Sea in 2009 were taken by three vessels, whereas no Russian seal vessels participated in the area. Due to the uncertain status for Greenland Sea hooded seals, no animals of the species were permitted taken in the ordinary hunt operations in 2009. Only a few animals were taken for scientific purposes. The 2009 TAC set for harp seals in the Greenland Sea was set at 40 000, i.e. very close to the removal level recommended by ICES (the level that

would stabilize the population at present level) for 2009 and coming years: 40,383 animals, assuming that the age structure of the removals is proportional to the age composition of the population (currently 14% pups) - a catch consisting of a higher proportion of pups would be more conservative.

A possible reduction in harp seal pup production in the White Sea may have prevailed after 2003. Due to concern over this, but also over the accuracy of the pup production estimates from 2004 - 2008, ICES recommended reductions in removals down to 21,881 animals in the White and Barents Sea in 2009. This assumes that the age structure of the removals is proportional to the age composition of the population (i.e. 14% pups). However, in order to continue the development of hunting activities in the White Sea, the Joint Norwegian-Russian Fisheries Commission suggested that the TAC for 2009 should be set higher: at 35 000 seals, of which 7 000 should be allocated to Norway. On this background, Russian sealing in 2009 was planned to be continued using the new boat-based approach introduced in the White Sea catch in 2008. This catch, using ice class vessels fitted with small catcher boats, would focus primarily on weaned pups (beaters), to a much less extent on adult seals. No white-coats would be taken. However, Russian authorities implemented a ban of all White Sea pup catches which was characterized as "a bloody catch". Despite considerable effort from PINRO specialists to explain that a sustainable harvest from the population would be perfectly possible, the Russian authorities concluded that all pup catches in the White Sea should be banned in 2009. Due to this, there were no Russian harp seal catches in the White Sea in 2009. Also, no Norwegian vessels operated in the southeastern Barents Sea in 2009.

Norwegian and Russian catches in 2009, including catches under permits for scientific purposes, are summarized in the table below:

Area/species	**Norway**	**Russia**	**Sum**
GREENLAND SEA			
Harp seals			
Pups	5117	0	5117
Older seals (1yr+)	2918	0	2918
Sum	8035	0	8035
Hooded seals			
Pups	396	0	396
Older seals (1yr+)	17	0	17
Sum	413[1]	0	413[1]
Area subtotal	8448	0	8448
BARENTS SEA / WHITE SEA			
Harp seals			
Sum	0	0	0
Area subtotal	0	0	0
TOTAL CATCHES	8448	0	8448

1 Animals taken under permit for scientific purposes in the Greenland Sea

2. EXCHANGE OF INFORMATION AND SUMMARY REPORTS OF RESEARCH ACTIVITIES IN 2009

2.1 Norwegian research

2.1.1 Estimation of harp and hooded seal pup production in the Greenland Sea

From 14 March to 3 April 2007, aerial surveys were carried out in the Greenland Sea pack-ice (the West Ice) to assess pup production for populations of both hooded and harp seals. All data are now analyzed, and the total estimate of hooded seal pup production was 16,140 (95% CV 11,950-20,380). For harp seals the estimated pup production was 110,330 (95% CV 56,080-164,580). Incorporating the recent survey estimates and reproductive data into the population model used previously produced current population estimates of 82,000 (95% CV 65,000-99,000) for hooded seals and 810,600 (95% CV 487,100-1,134,100) for harp seals.

A new method to estimate the pup production of seals from aerial surveys (e.g., harp and hooded seals) using generalized Additive Models (GAMs) based on thin plate regression splines has been developed. The spatial distribution of seal pups in a patch is modelled using GAMs, and the pup production is estimated by numerically integrating the model over a fine grid area of the patch. Closed form expression for estimation of the the standard error of the pup production estimate is derived. The results show that the obtained pup production estimator is comparable to the conventional pup production estimator. However, the bias of the standard error estimator of the proposed method is lower than the bias of the conventional standard error estimator. The decrease of standard error bias results in a considerably reduction of the Coefficient of Variation (CV) estimate using the proposed GAM based method.

2.1.2 Biological parameters in harp seals

Biological parameters (fertility, mortality, demography) are important in the population models used to assess status and catch potential in harp seals. For the Greenland Sea harp seal stock, new data were collected during the commercial hunt on the moulting grounds in 2009 on reproductive rates to supplement material collected in 2000-2008. Because these new data are available, ICES considers the stock to be data rich. Mean age of maturity (MAM) was estimated at 7.6 years for a sample of 231 Greenland Sea harp seals collected during the early moulting period in 2009. This is significantly higher than the long term average of 5.6 years estimated for the period 1964-1990, but not significantly different from estimates for 1991 (6.9 years) and 2000-2008 (7.0 years). The 2000-2008 sample was relatively small (N=84) and biased towards females with adult pelages, which may have caused a negative bias in MAM. However, the new estimate based on a larger and unbiased sample, indicates that there has been a general increase in MAM of Greenland Sea harp seals. This may indicate a significant reduction in per capita resource levels due to either increasing population size or extrinsic changes in food availability. If this is the case, the effect appears to target maturity as the post 2000 estimates of ovulation rates (96-99%) and pregnancy rates (80-81%) of mature females did not differ significantly from previous estimates for the period 1964-1991.

Comparisons with 2006 reproductive parameters for the Barents Sea/White Sea stock (BS/WS stock) show no significant difference between the two NEA stocks in MAM. 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). Average post partum pregnancy rate of multiparous females was estimated at 64% and average ovulation rate of parous females was 95%.

Samples of harp seal teeth (for ageing) from the Norwegian moulting catches in the southeastern Barents Sea have been collected since 1963, and the most recent data (from 1994-1998 and 2006) have now been analysed. Sampling periods have typically been from end of March until beginning of May. There are currently high mean ages in the samples both for males and females. In fact, the mean ages in the moulting samples have approximately doubled over the past 30 years. For the years 1994-1997 the distributions were dominated by the cohorts born from the late 1970s up to 1985, the latter cohort forming a prominent peak starting in 1995. Previous presentations of age samples from the Barents Sea harp seal population after the seal invasions along Norwegian coastlines in 1986-1989 (peak in 1987) indicated a nearly complete loss of cohorts from these years. Again, the 1987 cohort was barely found in the 1994-1997 samples. However, in the 1998 sample, the 1987 cohort starts to contribute to the age distribution and is still an important contributor in 2006, where in fact all the "seal invasion" cohorts are important contributors during the years with high total pup production in the White Sea. Thus one explanation of their reappearance may be that these cohorts chose another strategy than the assumed usual migration paths taken by the population. Observing that the 1987 animals showed up again after 10 years, may support non-permanent emigration, although there is no indication where they may have spent the intervening time. The available age distributions provide an indication of strong and weak year classes.

2.1.3 Barents Sea harp seal body condition

In previous studies of Barents Sea harp seals, observations have indicated that poor condition of juvenile and adult seals could be linked to reduced recruitment to the stock. In a Norwegian sampling program conducted during April/May in 1992-2006 onboard Norwegian sealers operating in the southeastern Barents Sea (the East Ice), body condition data were collected from a large number of juvenile and adult harp seals. The data were analyzed to determine if there are some year-to-year variations, in particular if there are some changes after 2003 when the possible decline in recruitment to the stock could have occurred. The mean body weight of pups showed a significant year-to-year variation in 1992 – 2006. However, no significant changes in body condition index or blubber thickness of pups were found throughout the study period. For mature adult seals (i.e. seals larger than 150 cm) and 1+ animals in general, a significant drop of body weight, condition index, and blubber thickness were observed in 2006 compared to previous years. Both the condition index and the blubber thickness showed an increasing trend in both adults and 1+ animals during the period 1992-2001. Although variations have occurred, it seems as if the availability of forage fishes may have improved in the Barents Sea in the 1990s as compared with the late 1980s; the period 1997-2001 was characterized by increased abundance in

all key prey species (capelin, herring, polar cod) in the Barents Sea. The current analyses suggest that this is also a period of stable or even improved, condition in harp seals. The period after 2001-2006 is characterized by a new collapse in the capelin stock, whereas the abundance of both polar cod and herring were good. Unfortunately, the 2006 data showing an apparent decline in condition, are the only available on Barents Sea harp seal condition in the period between 2001 and 2009. Currently, the polar cod population seems to be in good shape and the capelin stock size has improved substantially in the last two years. How these recent changes may have affected the general condition of harp seals in the area is not known. To address this question, new samples are required. Sampling from commercial catches in the southeastern Barents Sea in April-May 2010 is highly recommended.

2.1.4 Harp seal feeding during summer in the Barents Sea

In May/June 2004, in June/July 2005, and in May/June 2006, Norwegian surveys were conducted, aimed to study the feeding habits of harp seals occurring in the open waters of the Barents Sea. Very few seals were observed along the coast of Finnmark, and no seals were seen in the open, ice-free areas. In the nothwestern parts of the Barents Sea, however, very large numbers of seals were observed along the ice edge and 20-30 nautical miles south of this. Preliminary results from analyses of faeces and gastrointestinal tracts indicate that the summer consumption to a large extent was dominated by krill, whereas polar cod also contributed importantly. All sampling were performed in a period with low capelin abundance – this may have influenced the results.
The 2006 survey also included synoptic assessment of prey abundance (using acoustics and trawling) in the areas where the seals were captured – these data are now being analyzed to assess potential prey preferences of the seals. Furthermore, potential prey items from the trawl hauls are now being analyzed for fatty acid composition – this will be compared with results from similar analyses of blubber cores from the captured seals in order to see if this is a useful way to describe harp seal diets. All collected material is also being used to develop a revised model for annual harp seal consumption of food resources, fish resources such as capelin in particular, in the Barents Sea. Harp seal consumption is now implemented in the assessment model used for capelin (Bifrost) in the Barents Sea – preliminary results indicate a considerable influence from harp seals on the capelin stock.

2.2 Russian research

2.2.1 New data on pup production of harp seals in the White Sea

Pup production estimates based on data collected during traditional Russian multispectral aerial survey (infrared [IR] digital RGB imageries) carried out between 14-16 March 2009 are now available. The total pup production estimate was 157 000 (SE=17 000). This value is slightly higher than in 2005 and 2008, but still less than observed in 2004 and in 2000-2003.

Prior to the multispectral survey, reconnaissance flights were conducted in the entire White Sea area on 6 and 11 March. During these flights, observations were made of ice condition, localization of main breeding patches, and the progress in breeding activity. Very active whelping (determined by the presence of extensive blood on the floes) was observed on 6 March, while

little fresh blood was observed on the floes on 11 March. Thus, it was assumed that the starting date of the survey (14 March) was after the peak of pupping.

Highest pup density was recorded in the east-central region of the White Sea "Basin" close to the Kola Peninsula south coast. In other areas of the White Sea densities were much lower, and in adjacent southeastern areas of the Barents Sea (outside Cheshskaya Bay) only very scattered adults with pups were observed.

The ice conditions in 2009 were considered better for harp seal whelping than in 2008, and closer to the situation observed in 2003-2005 when reductions in total pup production were first recorded. The entire survey period was characterized with calm, stable winter weather which was very beneficial for the activities.

All track lines were flown along longitudes with a transect spacing of 7.5 km. It was started from the border between open water (no ice) or coastal line and finished in border between ice and open water or in coastal line. The most considerable whelping patches were observed in areas where ice concentrations were between 70-90%. No direct satellite monitoring of ice drift was conducted, but based on information from the Arkhangelsk Hydro-meteorological Center (AHMC) ice drift was assumed to be low.

As in 2008, walruses were observed in the harp seal whelping patches also in 2009, presumably feeding on pups. The icebreaker and vessels activity observed in the area in previous years which was considered to a potentially important source of mortality did not occur in 2009.The shipping route was changed as a result of efforts by PINRO, AHMC and the World Wildlife Fund so that ships passed to the south and around the harp seal whelping patches.

At the 2009 meeting the Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) has suggested that the remaining possibilities to account for the reduced pup production since 2004 include reduced adult recruitment due to past juvenile mortality, unobserved mortality of adults in recent years, or a shift in contemporary pupping to areas outside of the traditional areas. Also, the WGHARP was informed that during the late 1980s or early 1990s, some reports of harp seal pups being observed in Svalbard were received. Therefore, it appears very important that areas in the northern and south-eastern Barents Sea and Kara Sea be searched during future surveys.

2.2.2 Other issues

During late spring, summer and early autumn, several dedicated expeditions were carried out in the Kola Peninsula coastal zone, using small boats and vessels. In the Barents Sea open area and in the northern area of the Kara Sea, opportunistic sighting surveys onboard research and fisheries vessels, including the annual joint Russian-Norwegian ecosystem surveys, were carried out. During all surveys mentioned above, data on marine mammal distribution and numbers were collected, taking into account also environmental conditions and fish species distributions and biomass. The main aim was to attempt to estimate marine mammals and fisheries interactions on one side, and influence of current climatic changes and human activity on marine mammals on

the other.

2.3. Joint Norwegian-Russian work

2.3.1 Comparisons of photos from aerial pup surveys

A workshop to compare methods of reading aerial photos from harp seal pup surveys was held on 25-29 May 2009 at PINRO in Murmansk. Readers from IMR and PINRO exchanged photos and used their own methods on the other group's photos. IMR provided photos taken during a survey in the Greenland Sea in 2007, and PINRO provided photos taken from a survey carried out in the White Sea in March 2009.The photos used by IMR have very high resolution and are of good quality. This makes it easy to spot the white pups in general, although pups lying in shaded areas can still be difficult to spot. The photos used by PINRO had lower resolution than those used by IMR. However, in parallel with the digital photos, PINRO used full IR images, and this tool greatly enhanced the detection rate. IMR readers examined the photos using Adobe Photoshop, and the pup positions were recorded on a digital overlay. PINRO readers examined the photos using a special software module, prepared and developed by PINRO using the MATLAB software. The analysis demonstrated that PINRO readings of the IMR photos had a systematic underestimation of the number of pups. This may be due to the lack of features in the MATLAB software which would have allowed the PINRO readers to adjust of images (something which is done routinely by IMR readers using Photoshop). Also, the PINRO readers did not have access to IR images when reading the IMR photos. There were no significant differences between the IMR readings of the PINRO photos and the original (i.e. photos + IR imagery) PINRO readings. Thus, the IR imagery appear to compensate for the lack of tuning possibility in their software. It was concluded that both groups appear to have satisfactory, and comparable, methodologies for analyzing the aerial photos.

2.3.2 Joint studies of life history parameters

Historical Norwegian and Russian data which describe the trends in fertility rate and maturity at average age (MAM) for hooded seals in the Greenland Sea have recently been subjected to joint Russian-Norwegian analyses. Age at maturity was determined by fitting Richards' curves to age specific proportions of mature females in scientific samples taken by Russian scientists in the Greenland Sea pack ice in May-June in the years 1990-94. Samples from the Denmark Strait (1956-60) and South Greenland (1970-71) previously analysed by the back calculation method were also included in the present analyses. Although there were annual difference in MAM among the Greenland Sea samples a common MAM of 4.8 years could be fit to all years . Similarly, a common MAM of 3.1 year could be fit to the two Northwest Atlantic samples. This represents a temporal and a stock specific split in the sample and it cannot be concluded which factor is more important. Ovulation rates of mature females ranged from 0.68 in May 1990 to 0.99 in June 1991 and 1992, but the average ovulation rate of 0.88 was similar to previous estimates for Northwest Atlantic hooded seals. For breeding and moulting patch samples taken in the period 1986-1990, indirect measures of pregnancy rates derived from patterns of alternation in corpora formation between ovaries ranged from 0.74 to 0.97 and were significantly lower in 1987 and 1988 than in all other samples including the older data for the Northwest Atlantic stock

ranging from 0.94 to 0.97.

In 2007-2008, materials for a project on the evaluation of reproduction, contaminant loads and general health status of Greenland Sea hooded seals were collected, and the project is presently being evaluated for funding by the Norwegian Research Council. Further sampling will be conducted in July 2010 when a minimum of 200 adult hooded seals will be collected.

2.3.3 Joint studies of blueback condition

A scientific take of 396 bluebacks in 2009 (originally planned to be 200 weaned bluebacks early in the season and 200 new bluebacks late in the season) was performed to continue a time series, started in 1995, where condition of bluebacks (weights, measurements, blubber thickness) was measured at fixed time windows during the Greenland Sea hunt. Data are available from several subsequent years (all samples taken from the commercially hunted pups) - new samples in 2009 allowed extension this time series, and to assess if there are changes over time in pup condition. This is the sort of data that will enable analyses necessary to address previous recommendations from ICES: "Continue work on the relationship between hooded seal growth and condition, and environmental conditions". The sample size is chosen on the basis of previous samples sizes in the time series, and all samplings were performed by scientific personnel onboard two of the Greenland Sea sealers. In addition to the Norwegian samples, some Russian data on Greenland Sea hooded seal pup weights are available from 1991 and 1992.

3. STATUS OF STOCKS AND MANAGEMENT ADVICE FOR 2010

The Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) met at the Institute of Marine Research, Tromsø, Norway, 27-30 August 2008, to assess the stocks of Greenland Sea harp and hooded seals, White Sea / Barents Sea harp seals. The group also evaluated a proposed management strategy for harp seals in the Greenland Sea. Updated information was available for all stocks to enable WGHARP to perform modelling which provided ICES with sufficient information to give advice on status and to identify catch options that would sustain the populations at present levels within a 10 year period. However, low pup production estimates for harp seals in the White Sea in recent years was a concern, and WGHARP decided to meet again at the ICES HQ in Copenhagen, Denmark, 24-27August 2009 to reassess this stock based on Russian pup production surveys conducted in the White Sea in March 2009. At the 2009 meeting, also the Greenland Sea harp seal stock was reassessed since new (2009) data on reproduction had become available and lifted this stock from data-poor to data-rich according to criteria previously developed and accepted by ICES.

Management agencies have requested advice on “sustainable” yields for these stocks. ICES notes that the use of “sustainable” in this context is not identical to its interpretation of “sustainable” applied in advice on fish and invertebrate stocks. “Sustainable catch” as used in the yield estimates for seals means the catch that is risk neutral with regard to maintaining the population at its current size within the next 10 year period.

A Precautionary Approach framework is developed by ICES for the management of harp and hooded seals. Within this framework, conservation, precautionary and target reference points can be identified and linked to specific actions. The suggested conceptual framework requires that "data rich" and "data poor" stocks be treated differently when biological reference points are to be defined. Data rich stocks should have data available for estimating abundance where a time series of at least five abundance estimates should be available spanning a period of 10-15 years with surveys separated by 2-5 years, the most recent abundance estimates should be prepared from surveys and supporting data (e.g., birth and mortality estimates) that are no more than 5 years old, and the precision of abundance estimates should have a Coefficient of Variation about the estimate of about 30%. Stocks whose abundance estimates do not meet all these criteria are considered data poor.

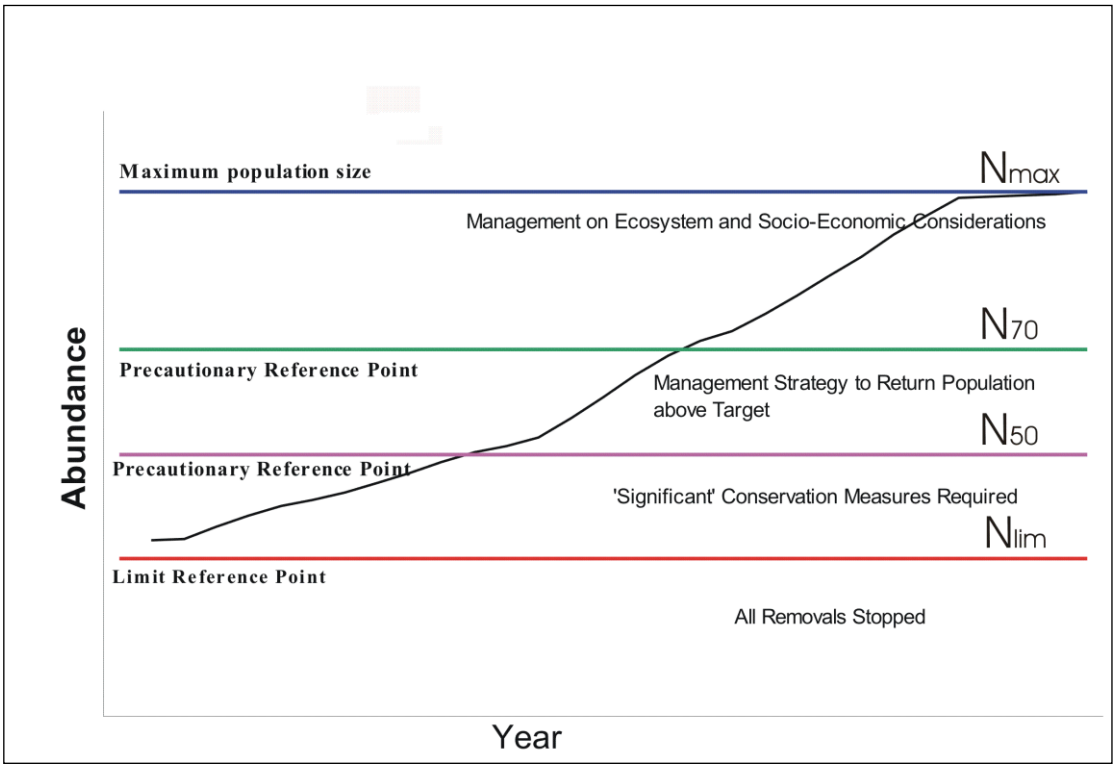

Figure 1 Reference points for a data rich seal stock.

For a data rich species, a framework including two precautionary and one conservation (limit) reference level are proposed (Fig. 1). All reference levels relate to the pristine population size, which is the population which would be present on average in the absence of exploitation, or a proxy of the pristine population (e.g. maximum population size historically observed, N_{max}). A conservation or lower limit reference point, N_{lim}, identifies the lowest population size which should be avoided with high probability. Between those points it is suggested that two precautionary reference points are used as decision signposts for increasingly restrictive

management to be introduced when the population approaches the conservation limit. In accordance with practices in the Western Atlantic ICES recommends that the limit reference point (N_{lim}) could be either 30% of the historical accurate maximum population estimates or should be set independently using IUCNs vulnerable criteria.

The first precautionary reference level could be established at 70% (N_{70}) of $N_{max.}$ When the population is between N_{70} and N_{max}, harvest levels may be decided that may stabilise, reduce or increase the population, so long as the population remains above the N_{70} level. When a population falls below the N_{70} level, conservation objectives are required to allow the population to recover to above the precautionary (N_{70}) reference level. N_{50} is a second precautionary reference point where more strict control rules must be implemented, whereas the N_{lim} reference point is the ultimate limit point at which all harvest must be stopped.

Population assessments were based on a population model that estimates the current total population size. These estimates are then projected into the future to provide a future population size for which statistical uncertainty is provided for each set of catch options. The 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 populations to which the model is applied there is not enough data to provide accurate estimates of M_{1+}, M_0 and F. 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 the parameter. The same population dynamic model was used for all three seal populations in question, but with stock specific values of prior distributions for M_0, M_{1+} and F.

The advice given by ICES in 2008 and the 2009 reassessments of the harp seal stocks by WGHARP was used by this Working Group on Seals to establish management advice for 2010 to the Joint Norwegian-Russian Fisheries Commission.

3.1. Greenland Sea

The Working Group **recommends** the opening dates for the 2010 catch season to be between 1 and 10 April for catches of both weaned harp seal pups and adult moulting harp seals. The Group recommends a closing date set at 30 June (2400 GMT) for harp seals. Exceptions on opening and closing terms may be made in case of unfavourable weather or ice conditions.

The Working Group agree that the ban on killing adult females in the breeding lairs should be maintained in 2010.

3.1.1 Hooded seals

The Working Group noted the conclusion from ICES that the adult population is at the lowest level estimated in the historical time series.

Results from a pup survey conducted in 2007 suggest that current pup production (16 140 pups,

CV = 0.13) remains low, and is significant lower than observed in the comparable 1997 survey (24 000 pups, CV = 0.28). Model explorations indicate a decrease in population abundance from the late 1940s and up to the early 1980s. In the most recent two decades, the stock appears to have stabilized at a low level which may be only 10-15% of the level observed 60 years ago. The modelling exercises included the three pup estimates as well as avialable information about age at maturity and estimates of natural mortality and natality. Incorporating these estimates into the population model produced a current total population estimate of 82 380 (95% C.I. 65 180-99 580) animals.

Catch estimation: ICES was requested to give options (with indication of medium term consequences) for three different catch scenarios:

- Current catch level (average of the catches in the period 2003 – 2007)
- Maintenance catches (defined as the fixed annual catches that stabilizes the future 1+ population)
- Two times the maintenance catches.

ICES still regard the Greenland Sea stock of hooded seals as data poor. Due to the restricted availability of data, ICES is not in the position to estimate future 1+ populations and can therefore not estimate sustainable catches. Instead, the concept of the Potential Biological Removal level (PBR) was used to calculate catch limits. The PBR approach identifies the maximum allowable removals that will ensure that the risk of the population falling below a certain lower limit is only 5% and that would allow a stock that dropped below this limit to recover. Using the PBR approach, the catch limit was calculated at 2 200 animals. However, ICES concludes that even harvesting at the PBR level could result in a continued stock decline or a lack of recovery. ICES therefore, concludes that the harvesting should still not be permitted with the exception of catches for scientific purposes.

The Working Group recommends that this ICES advice is implemented in future managenment of hooded seals in the Greenland Sea: Removals should still be prohibited until more information about current stock status becomes available.

3.1.2 Harp seals

The Working Group noted the conclusion by ICES (2008) and WGHARP (2009) that recent population size estimate is the largest observed to date.

In modelling the population, inputs to the model were pup production estimates from previous tag-recapture experiments (1983-1991) and from recent aerial surveys in 2002 and 2007:

YEAR	ESTIMATE	C. V.
1983	58,539	0.104
1984	103,250	0.147

1985	111,084	0.199
1987	49,970	0.076
1988	58,697	0.184
1989	110,614	0.077
1990	55,625	0.077
1991	67,271	0.082
2002	98,500	0.179
2007	110,530	0.250

As well as these pup estimates the model includes age at maturity and estimates of natural mortality and natality. Based on these inputs the model estimated a total population size for Greenland Sea harp seals in 2009 of 810 600 (95% C.I. 487 100-1 134 000) animals.

Catch estimation: Since this population is now considered to be data rich (updates of reproductive data in 2009), the usual population model was used to provide catch options. Options are given for various catch scenarios described below.

- Current catch level (average of the catches in the period 2005 – 2009).
- Sustainable catches.
- Two times the sustainable catches.

The sustainable catches are defined as the (fixed) annual catches that stabilize the future 1+ population under the estimated model. The catch options are further expanded using different proportions of pups and 1+ animals in the catches.

As a measure of the future development of the estimated population, the ratio between the size of the 1+ population in 2019 and 2009 (D1+) is used.

Option #	Catch level	Proportion of pups in catches	Pup catch	1+ catch	Total catch	Relative population size (D1+)		
						Lower CI	Point estimate	Upper CI
1	Current	72.7% (current level)	3,814	1,433	5,247	1.17	1.44	1.71
2	Sustainable	72.7%	36,205	13,596	49,801	0.61	1.00	1.40
3	Sustainable	0%	0	30,865	30,865	0.66	1.04	1.42
4	2 X Sustainable	72.7%	72,410	27,192	99,602	0.00	0.50	1.06
5	2 X sustainable	0%	0	61,730	61,730	0.06	0.60	1.13

Current catch level will likely result in an increase in population size of 44% over the next 10 years, whereas catches 2x sustainable catches will result in the population declining by

approximately 50% - 60%. According to WGHARP, a catch of 30 865 1+ animals (catch option 3), or an equivalent number of pups (where one 1+ seal is balanced by 2 pups), in 2010 and subsequent years would sustain the population at present level within a 10 year period.

Greenland Sea harp seals are currently classified as data rich. An implication is that ICES now find the Precautionary Approach framework developed for the management of harp and hooded seals (Fig. 1) appropriate for this particular population, given that the reference levels reflect the most recent estimate of total population size (810 600; 95% C.I. 487 100-1 134 000; the largest observed to date) ICES suggest that when the population is between N_{70} and N_{max}, harvest levels may be decided that may stabilise, reduce or increase the population, so long as the population remains above the N_{70} level. A TAC of twice the sustainable level when the population is above N_{70} will reduce the population to rapid to N_{70}, with a risk of the population falling below the first tier. A preferred option is to design the TAC for the first tier to satisfy specific risk criterion (e.g., 80% probability of remaining above N_{70} over a 10 year period). Using this approach, a modelled catch level of 42 400 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups), in 2010 and subsequent years is obtained. Any allowable catch should be contingent on an adequate monitoring scheme to detect adverse impacts before it is too late for them to be reversed, particularly if the TAC is set at a level where a decline is expected.

The Working Group recommend that the advice from ICES 2008 and conclusions from WGHARP 2009 be used as a basis for the determination of a TAC for harp seals in the Greenland Sea in 2010:

- *If the management objective is to maintain the population at current level, a TAC of 30 865 1+ animals or an equivalent number of pups, is recommended.*
- *If the management objective is to reduce the population towards N_{70} over a 10-year period, a TAC of 42 400 1+ animals, or an equivalent number of pups, is recommended.*

In both harvest scenarios, one 1+ seal should be balanced by 2 pups.

3.2 The Barents Sea / White Sea

The Working Group **recommends** the following terms concerning opening and closing dates and areas of the catches: From 28 February to 15 May for Russian coastal and vessel catches and from 23 March to 15 May for Norwegian sealing ships. Exceptions from opening and closing dates should be made, if necessary, for scientific purposes. The Norwegian participants in the Working Group suggest to prolong dates of harvesting to 1 July, and to determine the operational areas for the Norwegian catch activities to be the southeastern Barents Sea to the east of 20°E.

The Working Group agreed that the ban on killing adult harp seal females in the breeding lairs should be maintained in 2010.

3.2.1. Harp seal.

Russian aeroplane surveys of White Sea harp seal pups were conducted March 2004, 2005, 2008 and 2009 using traditional strip transect methodology and multiple sensors. The results obtained may indicate a reduction in pup production as compared with the results obtained in similar surveys in 1998-2003:

YEAR	ESTIMATE	C.V.
1998	286,260	.150
2000	322,474	.098
	339,710	.105
2002	330,000	.103
2003	327,000	.125
2004	231,811	.190
	234,000	.205
2005	122,400	.162
2008	123,104	.199
2009	157.000	.108

As a result of the 2009 survey, regarded to be very good by WGHARP, the Working Group feel that the reduced pup production observed since 2004 does not appear to be a result of poor survey timing, poor counting of imagery or the disappearance of pups from the survey areas prior to the survey. The remaining possibilities to account for the reduced pup production since 2004 include reduced adult recruitment due to past juvenile mortality, unobserved mortality of adults in recent years, or a shift in contemporary pupping to areas outside of the traditional areas. Therefore, the Working Group conclude that it is important that areas in the northern and southeastern Barents Sea and Kara Sea be searched during future surveys.

The population model usually applied by ICES was 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 1,099,000 was obtained. Given this size, WGHARP consider that the White Sea / Barents Sea harp seal stock is currently at a level which is somewhere between N_{30} and N_{50} .

Catch estimation: WGHARP had been requested to give options (with indication of medium term consequences) for three different catch scenarios:

- Current catch level (average of the catches in the period 2005 – 2009)
- Sustainable catches.
- Two times the sustainable catches.

However, the fit of the available population model for White Sea/Barents Sea harp seal

population was too poor to allow the impact of the three catch options to be reliably assessed. For this reason, WGHARP concluded that the only alternative available was to provide sustainable catch options based upon the Potential Biological Removals (PBR) approach. Using this approach, a PBR level of removal would be 30,062 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.

As suggested by WGHARP, the Working Group recommend that the PBR level (30, 062) be used as a basis for the determination of a TAC for harp seals in the White Sea / Barents Sea in 2010.

3.2.2 Other species

The Working Group agreed that commercial hunt of bearded seals should be banned in 2009, as in previous years, but it **recommend** to start catch under permit for scientific purposes to investigate results of long time protection.

4. RESEARCH PROGRAM FOR 2010+

4.1. Norwegian investigations

4.1.1 Estimation of harp and hooded seal pup production in the Greenland Sea

Data for pup production estimation were obtained from both harp and hooded seals in the Greenland Sea in March/April 2007. To meet the ICES request of data-richness, new surveys are planned in 2012 – planned cooperation with Canada and Russia may secure that all North Atlantic stocks are surveyed simultaneously. Preparations begin in 2010.

4.1.2 Collection of biological material from the commercial hunt and dedicated surveys

Biological material, to establish age distributions in catches as well as health, reproductive and nutritive status of the animals, will be collected from commercial catches of harp seals in the southeastern Barents Sea in April/May in 2010. In the Greenland Sea, hooded seals will be sampled for the same purposes in a dedicated survey in July 2010.

4.1.3 Population model improvements

The current population model used for northeast Atlantic seal stocks applies a constant reproductive rate for all years. Given the changes in reproductive rates observed for the populations, ICES recommends that the model be modified to allow for changes in reproductive rates over time. The impact of the selection of priors and associate variance should also be explored further. This work will be started in 2010, and will occur in close cooperation with Canadian scientists.

4.1.4 Seal physiology and tagging

On research cruises to the Greenland Sea in March/April 2010, various physiological parameters of harp and hooded seals will be studied. Also, data from satellite based tags, deployed on hooded seals in the area in 2007 and 2008, will be analysed.

4.1.5 Harp seals taken as by-catches in gillnets

Provided harp seals invade the coast of North Norway also during winter in 2008, biological samples will be secured from animals taken as bycatches in Norwegian gill net fisheries.

4.2.Russian investigations

4.2.1 Russian research on the White Sea/Barents Sea harp seal population

Russian scientists plan to carry out annual multispectral aerial survey, and aim to use these data for determination of harp seal population size by modelling. This information is very important for the Joint Norwegian-Russian Research Program on Harp Seal Ecology. This research will be carried out under recommendations from WGHARP 2009 and JRNFC 38 Session.

Research on harp seal reproductive biology is planned to be carried out in the White and the Barents Seas. The aim is to study harp seal biological data such as mortality, maturity, birth rate, and morphological and physiological indexes. During spring, work will be continued on pup mortality estimation in the White Sea. Plans include also continuation of research on harp seal feeding in the White and the Barents Sea during spring and summer. All these research activities will be carried out under the Harp Sea Ecology Programme and recommendations from WGHARP 2009 and JRNFC 38th Session.

Under recommendations of WGHARP 2009, work will be continued on the development and improvement of mathematical model design to estimate harp seal total population abundance and their pup production.

4.3. Joint Norwegian - Russian investigations

4.3.1 Feeding habits of harp seals in open waters of the Barents Sea

In 2001 and 2002, Norwegian and Russian scientists performed an aerial survey to assess whether there was an overlap in distribution, and thus potential predation, between harp seals and capelin in the Barents Sea. This experiment was followed with boat-based surveys aimed to study pelagic feeding by harp seals in the Barents Sea during summer and autum in (2004-2006), and the results from these investigations are now being analysed and prepared for presentation/publication.

4.3.2 Joint Research program on harp Seal Ecology

Harp seals are the most important marine mammal top predators in the Barents Sea. To be able to assess the ecological role of harp seals by estimation of the relative contribution of various prey items to their total food consumption in the Barents Sea, more knowledge both of the spatial distribution of the seals over time, and of their food choice in areas identified as hot-spot feeding areas is urgently needed. For this reason, the Joint Norwegian-Russian Fisheries Commission has decided to initiate a joint research program on harp seal ecology aimed to:

- assess the spatial distribution of harp seals throughout the year (experiments with satellite-based tags)
- assess and quantify overlap between harp seals and potential prey organisms (ecosystem surveys)
- identify relative composition of harp seal diets in areas and periods of particular intensive feeding (seal diet studies in selected areas)
- secure the availability of data necessary for abundance estimation
- estimate the total consumption by harp seals in the Barents Sea (modelling)
- implement harp seal predation in assessment models for other relevant resources (modelling)

The program was adopted by the Joint Norwegian-Russian Fisheries Commission in 2006. Although both ecosystem surveys and abundance estimation of harp seals are in progress, the core activities of the program have not yet been properly started. The parties had planned to deploy satellite transmitters on harp seals in the White Sea in late May in 2007-2009. However, the Federal Technical Committee has forbidden all satellite tagging in Russian waters in all years. Both parties strongly regret the decision made by the committee.

The Parties still agree that tagging seals in the White Sea is the most preferable approach, as it ensures that only seals from the White Sea stock are tagged, and because tagging of different sex and age groups can be balanced. Therefore, PINRO will apply for permission to tag seals in the White Sea also in 2010. In this process, PINRO scientists will use newly received information and contacts obtained at a seminar on tagging of animals in Moscow, February 2009. If permissions to tag are received, SevPINRO is responsible for organizing the logistics required for a vessel-based live catch of seals in May 2010, while IMR is responsible for the satellite tags, including providing all necessary technical details, as well as for providing experienced personnel and equipment for anaesthetizing seals and tag deployment.

As in previous years, IMR will apply for a survey to the Hopen area in June 2010 in case permission to tag seals in the White Sea is not obtained. To further secure the accomplishment of the harp seal tagging project a proposal for funding as sent to the Norwegian Research Council in June 2009.

4.3.3 Life history parameters in seals

Upon request, forwarded during meetings of the Joint Norwegian-Russian Fisheries Commission, one Russian scientist was invited to participate in scientific work on Norwegian sealers during March-April in 1997-1999 in the southeastern part of the Barents Sea, and in 2000 and 2009 in

the Greenland Sea. This Norwegian-Russian research cooperation is encouraged, e.g., by extending an invitation to Russian scientists to participate on Norwegian sealers in the southeastern Barents Sea and/or in the Greenland Sea also in the future. This would enable coordinated and joint sampling of new biological material. The Working Group **recommend** that Russian scientists are offered the possibility to participate in Norwegian research activities in 2010. If Russia can realize scientific or commercial vessel trips in the White, Barents and Greenland Seas, invitation for participation of Norwegian scientists is desirable.

4.3.4 Reconnaissance of possible new harp and hooded seal breeding patches in the Greenland Sea

A reduction in extent and concentration of drift ice has occurred in the Greenland Sea between Greenland and the Jan Mayen island. These changes must have resulted in substantial changes in breeding habitat for the Greenland Sea populations of harp and hooded seals. Could these changes in ice-conditions have triggered behavioral changes of such a magnitude as a relocation of breeding for at least parts of the populations? Recent low pup production in hooded seals, and new (2007) discoveries of breeding harp seals in areas outside those used historically by the species could both be indicative of such changes. The Working Group **recommends** that this is further examined by using aerial surveys to investigate whether a southward relocation of breeding has occurred for parts of the harp and hooded seal populations in the Greenland Sea. If new breeding patches are observed, this will have considerable implications for future research, management and hunting activities in the area.

4.3.5 Reconnaissance of possible new harp seal breeding patches outside the White Sea

Possibilities to account for the reduced harp seal pup production in the White Sea since 2004 include a shift in contemporary pupping to areas outside of the traditional areas. During the late 1980s or early 1990s, some reports of harp seal pups being observed in Svalbard were received. Therefore, the Working Group conclude that it is important that areas in the northern and southeastern Barents Sea and Kara Sea be searched during future aerial reconnaissance surveys.

4.4. Necessary research takes

For completion of the proposed Norwegian and Russian research programs, the following numbers of seals are planned to be caught under special permits for scientific purposes in 2010:

Area/species/category	Russia	Norway
Barents Sea / White Sea		
Whelping grounds		
Adult breeding harp seal females	500	0
Harp seal pups	500	0

Outside breeding period		
Harp seals of any age and sex	2300	200
Greenland Sea*		
Whelping grounds		
Adult breeding harp seal females	0	100
Harp seal pups	0	100
Adult breeding hooded seal females	0	100
Hooded seal pups	0	100
Outside breeding grounds		
Harp seals of any age and sex	0	100
Hooded seals of any age and sex	0	200

5. OTHER ISSUES

5.1 Bans on seal hunting and products

From a scientific point of view there is no doubt that harp and hooded seal stocks in the North Atlantic are well managed and sustainably harvested with acceptable hunting methods. This is acknowledged both by ICES and NAMMCO. For this reason the Working Group regrets the decision by Russian authorities to implement a ban on all hunting of weaned harp seal pups in the White Sea in 2009. Also, the Working Group strongly regrets the recent political and emotion-driven ban on all import of seal products in EU. As also concluded by NAMMCO, this is a non-scientific step backwards in relation to requested ecosystem based management of all marine resources, seals included. Excluding the possibilities to harvest at all levels in the ecosystem may in the long run have implications for harvest possibilities at other levels than those decided to be excluded. If the subsequent results are reduced harvest possibilities for some species, the Working Group suggest that it be discussed whether the costs of such reductions should be covered by EU itself (e.g., by quota reductions) since this organization implemented the ban.

5.2 Observations of marine mammals on the ecosystem surveys

Marine mammal observers have participated since 2003 in the ecosystem survey in the Barents Sea in August-September. Data from the ecosystem survey has provided significant insight into marine mammal distributions and the processes influencing their distributions, such as marine mammal-prey interactions, interspecific competition and selective habitat use. Knowledge of these processes is required for understanding the ecological role of marine mammals, as well as for evaluating the assessment methods currently used. Furthermore, the marine mammal distributions have been monitored through years with low and increasing capelin abundance. If continuing to monitoring through years with high capelin densities, we are in a perfect position to investigate how fluctuations in capelin abundance influence the capelin-marine mammal

interactions and interactions between marine mammals and alternative prey species. The Parties agreed that the aerial surveys, carried out supplementary to the vessel based surveys, provide valuable information and should be performed. The aerial survey is particularly valuable if covering areas north and east of the areas covered by the vessels.

5.3 Abundance estimation of grey seals

In Norway grey seal pup production surveys aimed to cover all the breeding colonies along the entire coast were conducted in 2006-2008 using boat based as well as aerial surveys. The Parties recommend that the Russian grey seal breeding colonies at the Murman Coast, last covered in 1991, should be covered again. The Ainov islands were partly surveyed in 2006. The Parties recommend that these surveys are completed, and that also the Seven Islands should be surveyed soon, preferably in 2010. Ideally each colony should be visited three times (minimum twice) during the breeding period. The Parties discussed possibilities of multispectral surveys carried out by PINRO using a smaller aircraft. Norwegian participation in the grey seal surveys in Russia is highly recommended by both Parties. Traditionally the Russian grey seal colonies have been surveyed by Murmansk Marine Biological Institute (MMBI), and continued cooperation with MMBI is encouraged.

5.4 Marine mammal sightings and observations in the coastal zone of the Barents and Kara Seas

During late spring, summer and early autumn, several dedicated expeditions will be continued in the Kola Peninsula coastal zone, using small boats and vessels. In the Barents Sea open area and in the northern area of the Kara Sea, opportunistic sighting surveys onboard research and fisheries vessels, including the annual joint Russian-Norwegian ecosystem surveys, will be carried out. During all surveys mentioned above, data on marine mammal distribution and numbers will be collected, taking into account also environmental conditions and fish species distributions and biomass. The main aim will be to attempt to estimate marine mammals and fisheries interactions on one side, and influence of current climatic changes and human activity on marine mammals on the other.

6. APPROVAL OF REPORT

The English version of the Working Group report was approved by the members on 7 October 2009.