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Action requested:

- For Information

NORWAY - PROGRESS REPORT ON MARINE MAMMALS 2016

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I INTRODUCTION

This report summarises Norwegian research on pinnipeds and cetaceans conducted in 2016 and conveyed to the compilators. The research presented here was conducted at, or by representatives and associated groups of,

The Institute of Marine Research (IMR);
University of Tromsø (UiT);
The Norwegian Polar Institute (NP);
University of Tromsø – The Arctic University of Norway/ Department of Arctic and Marine Biology (UIT-AMB);
University of Tromsø – Research group Arctic Animal Physiology (UIT-ADF);
Norges Arktiske Universitet, Forskningsgruppe for arktisk infeksjonsbiologi (AIB);
The Arctic University of Norway, Forskningsgruppe for arktisk marin systemøkologi (UiT-AMSE).

II RESEARCH BY SPECIES 2016

PINNIPEDS

Harp seals (*Phoca groenlandica)*
Studies of **harp seals** and **hooded seals** from the Greenland Sea stock were conducted during a research cruise with *R/V "Helmer Hanssen"* to the Greenland Sea between 15 and 31 March 2016. Altogether 8 adults and 10 new-born hooded seals, and 2 adults and 5 new-born harp seals, were culled for various scientific purposes:
i) sample collections, for studies of mechanisms underlying neuronal tolerance to lack of oxygen (hypoxia) (in collaboration with Dr. T. Burmester, Zoologisches Institut und Museum, Universität Hamburg, Germany);
ii) studies of adaptations to fasting in hooded seal pups (the role of the liver as an energy store from birth via weaning and throughout the post-weaning fast);
iii) onboard physiological and anatomical studies of the nasal cavity/upper respiratory tract of hooded seals, for assessment of the role of the complex nasal turbinate structures during deep diving and their role in body heat and water conservation;
iv) collection of further data for anatomical studies of the nasal cavity/upper respiratory tract and lungs of harp seals, for quantification of lung capacity and dead space, for assessment of buoyancy in relation to diving energetics and of their role in heat and water conservation.

The described field research was combined with research-based teaching given to 19 students that participated on the cruise, which represents a mandatory part of the course "Arctic Biology" (BIO-2310) at the University of Tromsø -The Arctic University of Norway (UIT-AMB-ADF).

Additionally, studies were conducted using three captive **harp seals** in conjunction with the project COEXIST which has the overall objective of improving methodology for quantification of energy expenditure in free-living harp seals by telemetry, using data on dive depth and duration, swimming speed and three-dimensional accelerometery. Studies were conducted both in indoor sea water pools at UiT-AMB, in which the feeding behaviour of the seals when presented with fish of different dimensions was studied as part of a M.Sc. project, and in a large sea pen located in a fiord near Tromsø, the latter to allow studies of semi-natural diving behaviour by the animals. To obtain data on the diving behaviour of freely

diving seals, for comparison with data collected in the pen, all three animals were equipped with satellite-linked dive recorders and released in the Barents Sea during a cruise with *R/V "Helmer Hanssen"* in November 2016 (Akvaplan NIVA/UIT-AMB-ADF).

Hooded seals (*Cystophora cristata)*
Studies of **hooded seals** and **harp seals** from the Greenland Sea stock were conducted during a research cruise with R/V "Helmer Hanssen" to the Greenland Sea, between 15 and 31 March 2016, as detailed above (UIT-AMB-ADF).

The use of traditional photo aircrafts to assess seal populations in remote areas, such as the West Ice, is expensive, and has also become more difficult to operate during recent years. With funding from the Norwegian Research Council (NRC), IMR has now started experiments with alternative (and cheaper) methods to perform photo-based aerial surveys of **harp** and **hooded seals** in the West Ice, including the use of UAVs (Unmanned Aerial Vehicles) or drones. Manual analysis of images obtained in aerial photographic surveys is extremely time consuming and costly, and involves subjective human interpretation by trained experts. For this reason, the UAV project, also aims at developing methodology for automating the process of counting seals from aerial images. This will be achieved through the development of new image analysis and pattern recognition techniques tailored to detect seals in digital color images. Techniques including machine learning and deep neural networks are applied, and the preliminary results are very promising. This part of the work occurs in close cooperation with the Norwegian Computing Center, Oslo (IMR).

Morphometric data for adult female Greenland Sea **hooded seals** collected over the period 1958-64 to 2008-10 showed a reduction in length at age in samples collected in the 1970s and 1990s and a small increase in the most recent sample from 2008-10. Throughout the period, however, length-at-age was lower in Greenland Sea hooded seals than in Northwest Atlantic hooded seals collected over the period 1956-1976. Ventral blubber thickness of breeding females was also significantly lower in all Greenland Sea breeding samples (1958-1999) compared to a breeding sample from the Northwest Atlantic in 1967-1972. (IMR).

Data on age at maturity and fertility in Greenland Sea **harp seal** females were collected from the commercially hunted seals in the West Ice in 2014. Preliminary results from the analyses seems to indicate that conditions must have improved for the stock. Age at maturity has decreased significantly from 7.6 years in 2009 to 6.15 years, whereas fertility rate has increased to 91 %. (IMR).

Trophic levels and possible diet overlap between **harp seals** and common **minke whales** in the Barents Sea have been explored using stable isotopes of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) and fatty acid analysis. Blubber and muscle samples from 93 harp seals and 20 minke whales were collected in the southern Barents Sea in May 2011. The study showed that harp seals were at a higher trophic level than minke whales during spring. This supported previous diet studies suggesting a more fish-dominant diet for seals, as compared with the whales, during this time of the year. The stable isotopes and fatty acids indicated niche separation between the seals and the whales, and between different age groups of the harp seals. Older seals had fatty acid profiles more equal to minke whales as compared with younger seals. Furthermore, while the fatty acid profiles suggested that krill was particularly important for the young seals, the profiles from older seals and whales suggested that fish dominated their diets. (IMR).

Harbour seals were counted along the entire mainland Norwegian coast at known haul-out sites during the molting period from mid-August to early September 2011-2016. In 2011 and 2012, molting areas from Rogaland to Finnmark counties and in Østfold county were covered by aerial photo surveys flown at altitudes of approximately 245-275 m during low tide (± 2 hours). Surveys in Østfold county were flown at approximately 90 m. The small tidal amplitudes in Østfold permitted counts to be carried out during day time irrespective of the tidal cycle. Usually three independent surveys were conducted. In 2016, also an electric drone (helicopter) was used to photograph harbour seal colonies along the Norwegian Skagerrak coast. Visual counts using binoculars from small boats and land were

also carried out in areas not covered by aerial surveys, or where results from the aerial surveys seemed to be incomplete. The surveys revealed a total minimum population of 7712 harbour seals along the mainland Norwegian coast in 2011-2016. In western Finnmark, 395 harbour seals were counted in 2013. West Finnmark was not covered in the two previous surveys. The count of 7317 harbour seals (not including West Finnmark) seems to be a small increase compared to 6938 in 2003-2006, but slightly lower than 7465 in 1996-1999. (IMR).

A population model is used to describe the dynamics of the Norwegian **grey seal** population based on data from pup counts covering the entire grey seal distributional area in 1996-2008. The model also requires estimates of natural mortality and female reproductive rates, but since empirical data on these parameters were outdated or absent, they were estimated by the model using a Bayesian approach. Model runs indicated an increase in abundance of the total Norwegian grey seal population in the 30 most recent years, suggesting a total of 7120 (5710 - 8540) animals (1+) in 2011. Including an estimated pup production of 1620 (95% CI 1410-3050), it was estimated a total number of 8740 (95% CI 7320-10170) grey seals in 2011. However, new boat based surveys carried out in the entire area from Froan in Sør-Trøndelag to Lofoten in Nordland in 2014-2015 showed a significant decrease in pup production and yielded numbers ranging between 34.8% and 47.5% of the counts in 2007-2008. In Finnmark and Troms the pup production in 2015 and 2016 was approximately equal to the results in 2006. Including these new pup counts in the population model, and assuming the same population size in 2016 as in 2006-2008 for Rogaland county, the current total number of grey seals in Norway was estimated to 3850 animals (95% CI: 3504-4196). (IMR).

Walrus (*Odobenus rosmarus)*
The camera surveillance of **walrus** haul-out sites continued. Digital cameras taking pictures hourly were deployed on 5 different walrus haul-out sites during the period late June - early October to study haul-out behaviour and potential impact of visiting tourists to these sites. In addition, each of the 5 camera masts have a logging station to down log GPS data from walruses (N=40) that have GPS loggers attached to their tusks. The log a GPS position each h, and data from 27 individuals were collected during 2016 (NP).

Ringed seals (*Pusa hispida)*
6 ringed seals were equipped with GPS-CTD Satellite Relay Data Loggers for detailed studies of space use, and especially their affiliation with glacier fronts. The hydrographic data collected by the seals are parts of a Norwegian Research Council funded project in geophysics (TIGRIF: Tidewater Glacier Retreat Impact on Fjord circulation and ecosystems") (NP).

CETACEANS

Minke whales (*Balaenoptera acutorostrata)*
During the periods 27 June to 15 August 2016, a sighting surveys was conducted with the chartered vessel M/S *Fisktrans* in the Jan Mayen area. The areas which was covered was the IWC *Small Area CM* (Norwegian Sea and coastal Norway) and parts of *CM* as a contribution to the extension surveys of NASS-2015. This was the third year of the six-year program 2014-2019 to cover the northeast Atlantic to provide a new abundance estimate of **minke whales** every sixth year as part of the management scheme established for this species. A total of 2,556 nautical miles was surveyed with independent double platforms on primary effort. During primary search effort, the number of observations from the primary platform was 106 sightings of **minke whales**. Sightings of other cetacean species include **fin whales** (26 primary sightings), **humpback whales** (12 primary sightings), **killer whale** (11 primary sightings), **blue whale** (5 primary sightings), **Northern bottlenose whales** (23 primary sightings), and **sperm whale** (21 sightings) (IMR).

Minke whale catch data for the 2016 season have been computerised and evaluated. (IMR).

Other species

Research vessels, coastguard vessels and other providers have collected incidental observations of marine mammals. Recorded data include date, position, species and numbers. During 2016 a total of 2169 cetacean observation incidents have been reported. The most frequently observed species were **minke whales** (527 groups), **Lagenorhynchus dolphins** (146), **fin whales** (116), **humpback whales** (307), **killer whales** (200), **harbour porpoises** (356 groups), **blue whales** (19), **sperm whales** (38), **long-finned pilot whales** (65), **bottlenose dolphins** (3), **sei whales** (3), **common dolphins** (10 groups) and **Northern bottlenose whales** (161). (IMR)

During 2016 photo IDs have been collected from more than 500 **humpback whales** during field work and from incidental sources. In addition, biopsy samples have been collected from 40 humpback whales. (IMR).

During the commercial catch operations on feeding grounds in Norwegian waters, body condition data (blubber thickness and girth) have been collected from 10,556 **minke whales** caught from 1993 to 2013. To investigate temporal and geographical variations in minke whale condition, the following three models have been applied: 1. Multiple regression models with covariates; sex, year, latitude and longitude to find significant coefficients of the covariate; 2. Random effect models involving the random effects of variations by year or area and with sex as a fixed variable; 3. Varying coefficients models (VCMs) which were applied to investigate variation with year/area and to interpret covariate effects by visualizations. The significance of the estimated coefficients can be assessed by statistical tests. In conclusion, the total trend over the two decades of data available suggests a decrease in minke whale condition. However, this trend was most pronounced during the high summer season when the seasonal effect over the annual sampling periods from April to September was considered. (IMR).

Recent atypical migrations of **minke whales** from the southern to the northern hemisphere have been documented and fertile hybrids and back-crossed individuals between both species have also been identified. However, it is not known whether this represents a contemporary event, potentially driven by ecosystem changes in the Antarctic, or a sporadic occurrence happening over an evolutionary time-scale. Whole genome resequencing has now been used to identify a panel of diagnostic SNPs to enable to address this evolutionary question. Many SNPs displaying fixed or nearly fixed allele frequency differences among the minke whale species (Antarctic and common) were identified from the sequence data. Five panels of putatively diagnostic markers were established on a genotyping platform for validation of allele frequencies; two panels (26 and 24 SNPs) separating the two species of minke whale, and three panels (22, 23, and 24 SNPs) differentiating the three subspecies of common minke whale. The panels were validated against a set of reference samples, demonstrating the ability to accurately identify back-crossed whales up to three generations. This work has resulted in the development of a panel of novel diagnostic genetic markers to address inter-oceanic and global contact among the genetically isolated minke whale species and sub-species. These markers, including a globally relevant genetic reference data set for this species complex, are now openly available for researchers interested in identifying other potential whale hybrids in the world's oceans. (IMR).

The **white whale** programme continued in 2016. The purpose of this programme was 1. Determine space use (satellite telemetry) over the entire annual cycle - to discern how these whales move in relation to sea ice, bathymetry, glacier fronts and oceanographic conditions; 2. Assess diet via stable isotope and fatty acid analyses bases on blood and blubber samples from live-captured whales; 3. Update the general health status of Svalbard's white whales based on screening of serum samples; 4. Conduct a screening of levels of various pollutants based on blood and blubber samples from live-

captured whales. Five more animals were instrumented and sampled for blood and blubber for the various aspects of this programme, bringing the total number of animals up to 18 so far (NP).

Four acoustic recorders (AURALs) listening for **bowhead whales** *Balaena mysticetus***, white whales (***Delphinapterus leucas)* **and narwhals (***Monodon Monoceros)* (but also other species- and anthropogenic sounds) were deployed autumn 2015 and was retrieved during autumn 2016. Data was downloaded, new batteries installed and the AURALs were redeployed (NP).

Biopsies for various investigations (genetics, diet and pollution) were collected from blue, fin and humpback whales in the Svalbard area. Some **blue** and **fin whales** were in addition equipped with satellite tags to track their movement patterns (NP).

Long-finned pilot whale (*Globicephala melas*)
Brain samples were collected from 7 **long-finned pilot whales** that were culled for subsistence on the Faroe islands. The samples will be analysed in relation to ongoing studies into mechanisms underlying the high tolerance towards hypoxic insult in diving mammals in a collaboration between AMB-UiT, Bjarni Mikkelsen at the Natural History Museum of the Faroe Islands and Dr. T. Burmester, Zoologisches Institut und Museum, Universität Hamburg, Germany. (UIT-AMB-ADF)

The WhaleTrack project studies whale behavior and fishery interactions during extreme winter arrivals of herring into northern fjord systems: The recent winter arrivals of herring into fjords in northern Norway have been followed by an extreme aggregation of top-predators feeding on this superabundant resource, including predatory fish, birds and whales. The Whaletrack project is a sub-project under the WeShare project that include several institutions working on different issues related to the overwintering of herring in the northern fjords. The Whaletrack project has been focusing on measuring the behaviour of **humpback** and **killer whales** using different electronic tracking methods, ID-photo and genetic identification in the area. Since 2013, a total of about 40 humpbacks and 7 killer whales have been tagged with different data storage tags lasting from an hour to one week. In addition, 15 killer whales and 10 humpback whales (https://en.uit.no/prosjekter/prosjekt?p_document_id=505966) have been tagged with transdermal satellite tags during 2014-2017 giving us valuable data of the behaviour of the humpback and killer whales during their feeding period in winter in the northern fjords and during spring after leaving the fjords. These data will be compared with fishery statistics form the same area and former history of the whales obtained from photo identification (UiU-AMSE).

III ONGOING (CURRENT) RESEARCH

PINNIPEDS

Publication of **hooded seal** demographic and reproduction data (historical as well as new, sampled in 2008 and 2010) from the Greenland Sea are in the last phase of completion. (IMR)

Analyses of historical and new data on demography and reproduction of **harp seals** in the Greenland Sea and Barents Sea / White Sea are in progress. (IMR)

Collection of material to assess efficiency and animal welfare issues in the Norwegian commercial sealing of **harp seals** in the Greenland Sea in April/May was conducted in 2013 and 2014 – analyses and publication are in progress. (IMR)

During autumn (August-September) surveys to assess the oceanographic and ecological conditions in the Arctic Ocean (between Svalbard and the ice edge further north; the SI_ARCTIC project at IMR, running during 2014-2018), visual observations of all marine mammals are conducted along all sampling transects. In 2016 special attention was paid to **harp seals** feeding along the ice edge, and 26

animals were shot for scientific sampling. Sampling included parameters such as weight and length, blubber thickness, teeth taken for ageing, stomach/intestines for diet studies and muscle, blubber, liver and whiskers for studies of contaminants and stable isotopes. For comparison, also samples of relevant prey (krill, amphipods, squid and some fish species, all taken from trawl samples) were secured for the stable isotope analyses. Similar sampling will be conducted in August 2017.

Ship based registrations of **grey seal** pups, including tagging, counting and staging of pups, will be conducted in Rogaland during the period November-December 2017. This will complete the 2013-2017 program aimed to provide a new abundance estimate for the species along the entire Norwegian coast. (IMR)

Tagging of **harbor seals** with GSM tags will be conducted in southern Norway (Skagerrak) in August. The project will occur in cooperation with Swedish scientists. (IMR)

Ship based counting of **harbour seals**, using electronic helicopter drones with camera, will be conducted in western Norway in September. This will continue the work further south in 2016, aimed to provide a new abundance estimate for the species along the entire Norwegian coast. (IMR)

Final analyses of **grey seal** diet data from the Norwegian coast are in progress, an article will be submitted. (IMR)

Publication of results from genetic and population studies of **harbour** and **grey seals** is in progress. (IMR)

Previous studies in **hooded seals** have shown that their brain is unusually tolerant to lack of oxygen (hypoxia). Biochemical studies have been continued using sampled brain tissue from **hooded seals**, preserved in either paraformaldehyde, RNAlater or liquid N_2, as part of ongoing collaborative studies with Dr. T. Burmester, University of Hamburg, Germany on the mechanisms underlying tolerance to hypoxia and to reactive oxygen species in the brain of diving mammals. Current focus of investigations is towards the roles, and the labour division between, brain neurons vs. glia cells, which in previous studies have been shown to be differently organized in the brain of seals compared to non-diving mammals. (UIT-AMB-ADF)

Studies of the role of the liver during the post weaning fast of **hooded seal** pups were completed and compiled into a M.Sc. thesis that was defended in 2016. (UIT-AMB-ADF)

Analyses of experiments and samples that were collected from **hooded seals** during a research cruise with *R/V "Helmer Hanssen"* to the Greenland Sea in 2015, in order to study the functional anatomy of the large aortic arch of pinnipeds and the vascular supply to its thick walls, were completed and published in 2016. (UIT-AMB-ADF)

One adult and two yearling (b. 2014) **harp seal** that were captured in 2014 in the Greenland Sea have been trained intensively to perform various tasks on command, which is a necessity for studying various aspects of their energetics, with the ultimate goal of obtaining more precise assessments of food requirements of harp seal populations. The studies involved parallel accelerometer and respirometer studies in a large net pen with a respirometer dome installed, established in nearby Kaldfjorden as part of the COEXIST project (funded by the Norwegian Research Council). Here and at the research animal facility at UIT-AMB, studies of the buoyancy, feeding, diving and swimming behaviour of harp seals are also made, in part carried out by two M. Sc. students as part of their theses work. Collected data are currently being analysed. In order to obtain data on the diving behaviour of freely diving seals, for comparison with data collected in the pen, all three animals were equipped with satellite-linked dive recorders and released in the Barents Sea during a cruise with *R/V "Helmer Hanssen"*in November 2016. The studies of the animals in the indoor sea water pools at UiT-AMB have addressed the feeding behaviour of the seals when presented with fish of different dimensions and were conducted as part of a M.Sc. project that was completed in 2016. (Akvaplan NIVA/UIT-AMB-ADF)

Blood and other tissue samples, collected from harp and hooded seals during a research cruise with *R/V "Helmer Hanssen"* to the Greenland Sea in 2015. These samples have been further processed with regard to contaminant analyses, histopathological examinations and disease surveillance, by Dr. R. Dietz and PhD-student Jean-Pierre Desforges at Aarhus University, Denmark. The work is collaboration between Department of Bioscience at Aarhus University, Denmark, and UIT-AMB-ADF.

CETACEANS

Sampling of **minke whale** stomach contents and life history parameters will be performed during the commercial hunt in June. (IMR)

Studies of **harbor porpoise** ecology and population biology were initiated in 2016 and continues in 2017. Samples are obtained from bycatches. (IMR, UiT)

Long-finned pilot whale *(Globicephala melas)*
Biochemical studies are conducted with brain tissue sampled from **long-finned pilot whales**, preserved in either paraformaldehyde, RNAlater or liquid N_2, as part of ongoing collaborative studies between AMB-UiT, Bjarni Mikkelsen at the Natural History Museum of the Faroe Islands and Dr. T. Burmester, Zoologisches Institut und Museum, Universität Hamburg, Germany. (UIT-AMB-ADF)

IV ADVICE GIVEN AND MANAGEMENT MEASURES TAKEN

Sealing

Advice on the management of harp and hooded seals is based on deliberations in the ICES / NAFO / NAMMCO Working Group on Harp and Hooded Seals (WGHARP). WGHARP met during 26-30 September 2016 at the ICES HQ in Copenhagen, Denmark, to assess the status and harvest potential of stocks of Greenland Sea harp and hooded seals and harp seals in the White Sea. The advice given subsequently by ICES, were used by the Joint Norwegian-Russian Fisheries Commission to establish management advice for 2017.

The basis for the advice was a request from Norway in October 2015 where ICES was requested to assess the status and harvest potential of harp seal stocks in the Greenland Sea and White Sea/Barents Sea and of the hooded seal stocks in the Greenland Sea, and to assess the impact on the harp seal stocks in the Greenland Sea and the White Sea/Barents Sea of an annual harvest of: 1) Current harvest levels; 2) Sustainable catches (defined as the fixed annual catches that stabilizes the future 1+ population); 3) Catches that would reduce the population over a 10-year period in such a manner that it would remain above a level of 70% of current level with 80% probability.

ICES have developed a Precautionary harvest strategy for the management of harp and hooded seals. The strategy includes two precautionary and one conservation (limit) reference levels. The reference levels relate to the pristine population size, which is the population that would be present on average in the absence of exploitation, or a proxy of the pristine population (which in practical terms is referred to as the 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. The first precautionary reference level is established at 70% (N_{70}) of N_{max}.When the population is between N_{70} and N_{max}, harvest levels may be decided that stabilise, reduce or increase the population, so long as the population remains above the N_{70} level. ICES has suggested that this could be done by designing the TAC to satisfy a specific risk criterion which implicate 80% probability of remaining above N_{70} over a 15-year period. 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 strictly control rules must be implemented, whereas the N_{lim} reference point (set by ICES at 30% (N_{30}) of N_{max}) is the ultimate limit point at which all harvest must be stopped.

The ICES management of harp and hooded seals require that the populations in question are defined as "data rich". Data rich stocks should have data available for estimating abundance where a time series of at least three 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. Stocks whose abundance estimates do not meet all these criteria are considered "data poor", and should be managed more conservatively.

Population assessments were based on a population model that estimates the current total population size, incorporating historical catch data, estimates of pup production and historical values of reproductive rates. The modelled abundance is projected into the future to provide a future population size for which statistical uncertainty is provided for various sets of catch options. In case of "data poor" populations, catch limits are estimated using the more conservative Potential Biological Removal (PBR) approach.

Using the population assessment model, the size of the **Greenland Sea harp seal** population was estimated as 676 500 (95% C.I. 490 190 – 862 810) animals in 2017. ICES consider this population to be data rich, and above the N_{70} level (i.e., more than 70% of known maximum abundance measured). Thus, it is appropriate to provide catch advice using the assessment model and to apply the Precautionary harvest strategy. Current catch level will likely result in an increase in population size of 76% over the 15-year's period 2017-2032, whereas a catch of 21 500 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups) per year would sustain the population at present level over the same period. Catches that would reduce the population over a 15-year period in such a manner that it would remain above a level of 70% of current level with 80% probability are 26 000 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups), in 2017 and subsequent years. 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.

Recent Russian aerial surveys of the **White Sea/Barents Sea harp** seal stock suggest that there may have been a sudden reduction in pup production after 2003. ICES have suggested that the reduced pup production does not appear to be a result of poor survey timing, poor counting of imagery, disappearance or mortality of pups prior to the survey or increased adult mortality. The most likely explanation for the change in pup production seems to be a decline in the reproductive state of females.

The population assessment model used for the White Sea/Barents Sea harp seal population provided a poor fit to the pup production survey data. Nevertheless, ICES has decided to continue to use the model which estimated a total 2017 abundance of 1 408 200 (95% C.I. 1 251 680 – 1 564 320). The modelled total population indicates that the abundance decreased from 1946 to the early 1960s, increased from the early 1960s to the early 1980s, but then declined again until around 2007. The model suggests an increase in population size after 2007. Based on current data availability, this population is considered "data poor". The equilibrium catch level is 10 090 1+ animals, or an equivalent number of pups (where one 1+ seal is balanced by 2 pups), in 2017 and subsequent years. Using the traditional PBR approach, removals were estimated to be 39 985 seals (irrespective of age). However, this catch option indicates a 33% reduction of the 1+ population over the next 15 years. More conservative PBR approaches (but still within the defined framework of the method) were attempted as well, but they also resulted in population reductions (of 10-25%) over the next 15 years. Despite that this population is now classified as data poor, ICES expressed concerns over the high removals and declining population resulting from the PBR estimations, and concluded that the estimated equilibrium catches were the most preferred option.

Results from the most recent (2012) pup survey suggest that current **Greenland Sea hooded seal** pup production remains very low, and lower than observed in comparable surveys in 1997, 2005 and 2007. Due to some uncertainty regarding the historical data on pregnancy rates, the population model was run for a range of pregnancy rates (assuming 50%, 70% or 90% of the mature females produced offspring, respectively). All model runs indicated a population currently well below N_{30} (30% of largest observed population size). Recent analyses have indicated that pregnancy rates have remained rather constant around 70% in the period 1958 – 1999. Using this scenario, the model estimates a 2017 total population of 80 460 (95% C.I. 59 020 – 101 900). Following the Precautionary harvest strategy and the fact that the population is below N_{lim}, ICES recommend that no harvest be allowed for Greenland Sea hooded seals at this time.

Traditionally, both Russia and Norway have participated in the sealing operations in the West Ice and the East Ice and have, therefore, allocated quotas on a bilateral basis in negotiations in the Joint Norwegian-Russian Fisheries Commission. However, the Russians cancelled their sealing operations in the West Ice in 2001. The Norwegian shares of the 2017 quotas would be the total TAC of harp seals in the West Ice. In the East Ice, the Norwegian quota was set at 7,000 harp seals.

In 1996 new regulations for the **coastal seal hunt**, including catch reports, were introduced. Quotas were set based on the available information on seal abundance along the coast. In 2003, quotas were increased substantially compared to the recommendations based on scientific advice, when they were set at 1186 grey seals (25% of abundance estimate) and 949 harbour seals (13% of abundance estimate). In 2003-2010, annual catches varied between 302-516 grey seals and 457-905 harbour seals. In 2010, new management plans for harbour and grey seals were implemented. The goal is to ensure sustainable populations of grey and harbour seals within their natural distribution areas. Regulating measures should be designed to ensure that they have the greatest impact in areas where there is documented significant damage to the fishing industry caused by seals. Target population sizes were decided to be 7000 harbour seals counted during moult and a grey seal population producing 1200 pups annually along the Norwegian coast. Hunting quotas should be set to regulate the seal populations in relation to the target levels. For 2011, quota for harbour seals was set to 460 and 230 seals were taken. For grey seals recommended quota was 460, set quota was 1040 but only 111 grey seals were taken. Compensations paid for shot seals were stopped for 2011. For 2012, 2013, 2014, 2015 and 2016, recommended and set quotas were 460, 482, 425, 455 and 455 harbour seals, respectively. For grey seals quotas were 460 animals in 2012-2014, but due to observations of declines in pup production the quotas were reduced to 315 in 2015 and further down to 210 in 2016. Compensations paid for shot seals were again introduced in 2012 (250 NOK/seal): 355 harbour seals and 64 grey seals were taken in 2012; 483 harbour seals and 177 grey seals in 2013; 406 harbour seals and 213 grey seals in 2014; 297 harbour seals and 82 grey seals in 2015, and 362 harbor seals and 33 grey seals in 2016.

Whaling

At the IWC Annual Meeting in 1992 Norway stated that it intended to reopen the traditional **minke** whaling in 1993. So far, IWC has accepted the RMP developed by its Scientific Committee as a basis for future management decisions but has not implemented the procedure. The Norwegian Government therefore decided to set quotas for the 1993 and following seasons based on RMP, with parameters tuned to the cautious approach level as expressed by the Commission and using the best current abundance estimates as judged by the IWC Scientific Committee. In recent years research has been conducted on modification and retuning of the procedure to other target levels than the original 0.72, chosen by the Commission.

At, in principle, regular intervals an *Implementation Review* of the RMP for a specific species and management area is conducted. During such reviews, the input data as well as biological information including genetics are critically evaluated and conditioned for simulation trials of management

scenarios. The most recent review for North Atlantic common minke whales has been conducted over the period 2014-2017. It has been concluded that there is a single panmictic minke whale population in the Northeast Atlantic and new abundance estimates have been approved for use in RMP. From the 2008-2013 period, the total estimate for the surveyed areas is 100 615 (cv 0.17), of which 89 623 (cv 0.18) animals are in the Eastern area. (IMR).

Starting in 2016, a new six-year block quota 2016-2021, was set with an annual total catch quota of 880 animals of which 710 could be taken within the Northeastern stock area (the E Small Areas, i.e. the EW, EN, ES and EB Small Areas) and 170 within the CM area of the Central **minke whale** stock. The catch quotas are set for each of the five management areas, and untaken quotas may be transferred to following years within the period which the block quota is set for.

For 2016 the total catch quota was set to 880 **minke whales.** For 2017 the total catch quota, including transfers, was 999 minke whales. The catching season opens April 1 and are closed medio September.

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VI APPENDIX 1 – CATCH DATA

Sealing

Norwegian catches in the Greenland Sea (West Ice) in 2016 was taken by one vessel, 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 2016. Only a few animals were taken for scientific purposes. The 2016 TAC for harp seals in the Greenland Sea was set at 21 270 1+ animals (where 2 pups balance one 1+ animal), i.e. the removal level that would reduce the population with 30% over the next 10-year period.

A possible reduction in harp seal pup production in the White Sea may have prevailed after 2003. Due to concern over this, ICES recommended that removals be restricted to the estimated sustainable equilibrium level of 19,200 1+ animals (where 2 pups balance one 1+ animal) in the White and

Barents Sea in 2016. The Joint Norwegian-Russian Fisheries Commission has followed this request and allocated 7,000 seals of this TAC to Norway.

Table VI.I shows the Norwegian catches of harp and hooded seals in 2016. The total quotas given were not fulfilled in any area: In the West Ice, only 6% of the given harp seal quota was taken. A ban implemented on all pup catches prevented Russian hunt in the White Sea during the period 2009-2013. This ban was removed before the 2014 season. Unfortunately, however, the availability of ice was too restricted to permit sealing, resulting in no commercial Russian harp seal catches in the White Sea in 2015 and 2016. Also, no Norwegian vessels aimed for the hunting area in the southeastern Barents Sea (the East Ice) in 2016. In September 2016, 28 harp seals (1+ animals) were taken for scientific purposes north of Svalbard – presumably from the White Sea / Barents Sea population.

Table VI.1. Norwegian catches of harp and hooded seals in 2016. 1+ means one year old or older seals.

Catching area:	*The West Ice*			*The East Ice*		
Species	Pups	1+	Total	Pups	1+	Total
Harp seals	426	1,016	1,442	0	28	28
Hooded seals	10	8	18			

Whaling

After a temporary suspension, the traditional small type Norwegian **minke whaling** was again permitted in 1993 and quotas were implemented based on the Revised Management Procedure (RMP) developed by the International Whaling Commission's (IWC) Scientific Committee. The RMP allocates catch quotas to specific management areas. There are five such management areas within the region of interest to Norwegian whalers. The present areas are a revision of the original implementation and introduced by the IWC/SC at their Implementation Review of North Atlantic minke whales conducted at the 2003 Annual Meeting and later kept at the Implementation Review made in 2008 and 2014-2017. The areas are (1) the Svalbard-Bear Island area (coded ES), (2) the eastern Barents Sea (EB), (3) the Norwegian Sea and coastal zones off North Norway, including the Lofoten area (EW), (4) the North Sea (EN) and (5) the western Norwegian Sea-Jan Mayen area (CM).

In total, 16 vessels participated in the 2016 season of whaling and the catching period was 1 April to mid September. Table VI.2 shows the number of minke whales taken by area in the 2016 season. The quotas are given as six-year block quotas but is not fully utilised in all areas. There are several reasons for that, including problems with processing the catches and accessing remote areas like the Jan Mayen area and the eastern Barents Sea. The present quota period is 2016-2021. The calculated basic quota for 2016 is 710 animals within Medium Area E and 170 whales within the Small Area CM, giving a total of 880 minke whales for the 2016 season.

Table VI.2. Quotas and catches of minke whales in 2016 by management area as defined in RMP.

2016	Management area					
Small-type whaling	EB	EN	ES	EW	CM	Total
Catch	60	15	424	92	0	**591**
Quota						880
Stock area	Northeastern				Central	

VII APPENDIX 2 – BY-CATCH DATA

Harbour porpoises, grey and **harbour** seals are incidentally caught in coastal gillnet fisheries. The bycatch rate of harbour porpoises in gillnet fisheries for cod and monkfish is estimated by General Additive Models from data collected by a monitored segment (the Coastal Reference Fleet, CRF) of the fleet of small vessels (less than 15 meter total length) operating in the coastal zone. The landings statistics provided by the Directorate of Fisheries are used to extrapolate to entire fisheries with the same gear types. The annual estimate for the period 2006-2015 is about 3000 porpoises (bootstrap-generated CV 0.20) in the gillnet fisheries for cod and monkfish.

The data on grey and harbor seals from the CRF are not sufficient to obtain estimates of bycatch with satisfactory accuracy and precision. However, the bycatch of grey and harbour seals can be estimated from mark-recapture data. The total harvests of grey and harbour seals are known since 1997. We assume equal proportions of tagged animals among harvested seals and bycaught seals. Therefore:

Total bycatch = Tagged bycatch x Total harvest / Tagged harvest.

For grey seals, this resulted in a total bycatch of 8,379 for the period 1997-2014, with an average annual bycatch of 466 seals. The total bycatch of harbour seals for the period 1997-2014 was 9,989 resulting in an average annual bycatch of 555 seals. For comparison, the harvest of grey seals the last five years averaged 133 seals, and the harvest of harbour seals averaged 360 seals.