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Background	Each NAMMCO party shall submit an annual a National Progress Report by March 1st the following year.

NORWAY - PROGRESS REPORT ON MARINE MAMMALS 2018

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I INTRODUCTION

This report summarises Norwegian research on pinnipeds and cetaceans conducted in 2018 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); https://www.hi.no/hi

The Norwegian Polar Institute (NP); http://www.npolar.no/no/

The Arctic University of Norway, Forskningsgruppe for arktisk marin systemøkologi (UiT-AMSE); https://uit.no/om/enhet/forsiden?p_dimension_id=88165

Norwegian Orca Survey, Andenes; https://www.norwegianorcasurvey.no/

II RESEARCH BY SPECIES 2018

PINNIPEDS

Aerial surveys were conducted in the period 18 - 31 March 2018 in the Greenland Sea pack-ice (the West Ice) to assess the pup production of the Greenland Sea populations of **harp** and **hooded seals**. Reconnaissance surveys were flown by helicopter (18 – 22 March) and a fixed-wing aircraft (18 - 31 March) in an area along the eastern ice edge between 68°40'and 74°47'N. Harp seal breeding was first observed from the fixed-wing on 18 March at approximately 74º00'N / 13º47'W, along with scattered hooded seal families further south. On 21 March, however, a large patch (considered to be the same patch as observed on 18 March) containing whelping harp and hooded seals was discovered in an area between 72º25'N and 72º35'N; 14º30'W and 16º00'W. Color markers and satellite-based GPS beacons were deployed on ice floes north, east and south of the patch. On 27 March, two photographic surveys were flown to cover the entire whelping patch area which was a little more than 60 nm in south-north direction. Due to fog in the northwest areas, these areas had to be re-visited with new transect surveys the following day (28 March). To define the transect lines for this second survey day, data from the ice-deployed GPS beacons were used to account for the ice drift between the two days. In total, 5104 photos were taken during the surveys (3016 photos on 27 March; 2088 photos on 28 March). Results from the aerial surveys will be used to estimate the 2018 harp and hooded seal pup production in the West Ice. Subsequently, the status of the stocks will be assessed by incorporating the pup production estimates into population models. (IMR).

As part of a collaboration with the Greenland Institute of Natural Resources, 26 newborn **harp seal** pups were tagged with satellite-linked dive recorders during the 2017 breeding season. In addition, two female adult harp seals were tagged with so-called Conductivity-Temperature-Depth Satellite Relay Data Loggers in summer 2018, part of a collaboration with the ArcticPRIZE and ARISE projects funded by the UK's Natural Environment Research Council. The 26 tags on pups provides the first description of the foraging migrations and diving behavior of young harp seals and show that these also move preferentially into the Barents Sea, where they spend several months feeding in areas also utilized by adult harp seals. Data from the two adult harp seals have shown remarkable migrations throughout the eastern and northern Barents Sea, and has also collected extremely valuable oceanographic data from regions where such data are otherwise difficult and expensive to obtain. Further tagging studies are planned for coming years to gradually build up a more comprehensive understanding of feeding migrations of this key Barents Sea predator, and additionally to build up a valuable oceanographic dataset to complement other oceanographic sampling activities in the region. (UiT, IMR).

Three wild-caught female **harp seals** from the Greenland Sea stock were brought into temporary captivity in connection with a controlled validation study on energetics. The two pups and one adult were kept in two indoor and outdoor experimental facilities. They were trained daily using operant conditioning to participate in experiments and husbandry and were regularly fed live fish. After 2.5 years, the harp seals were instrumented with satellite transmitters and released in the Barents Sea. The tags transmitted for 45, 67, and 162 days for the juveniles and adult, respectively. The two juveniles remained in the Barents Sea east of the Svalbard Archipelago, while the adult female migrated to the Greenland Sea following a pattern consistent with that observed in wild harp seals from the same stock. They all performed regular deep dives (>100 m) and exhibited signs of foraging comparable to wild harp seals. (UiT, IMR)

Harbor 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. Usually three independent surveys were conducted. In 2016, an electric drone (helicopter) was used to photograph harbor 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 harbor seals along the mainland Norwegian coast in 2011-2016. In western Finnmark, 395 harbor seals were counted in 2013. West Finnmark was not covered in the two previous surveys. The count of 7317 harbor 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. In 2017 and 2018, new counting surveys (drone and visual counts) were conducted from the southernmost peak (Lindesnes) in Norway and along the west coast, including the counties Vest-Agder, Rogaland, Sogn & Fjordane and Møre & Romsdal. The total numbers of harbour seals in each of the counties were approximately similar with the results in the previous counting period (2011-2015). (IMR).

A population model was 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 (2015), Troms (2016) and Rogaland (2017) pup production was approximately equal to the results in 2006-2008. Including all pup counts in 2014-2017 in the population model, the current total number of grey seals in Norway was estimated to 3850 animals (95% CI: 3504-4196). New surveys in 2018 showed that pup production still was at the same low level as in 2014-2015 in Trøndelag and Nordland. (IMR).

Walrus (*Odobenus rosmarus)*

Forty walruses were previously equipped with GPS loggers (20 in 2014 and 20 in 2015) on their tusks. These loggers log one GPS position per h and download these data to receiving stations that are places on different haul-out sites (in masts that were initially deployed for a camera surveillance project). The longevity of the batteries in the loggers should be minimum 5 years. The receiving stations were visited and serviced summer 2018 and GPS data from walruses were collected. This project is mainly funded by the Norwegian-Russian Environmental Commission. (NP).

An aerial survey of walruses was flown during August 2018. Eighty-six different haul-out sites were visited and pictures taken for counting on those that had animals present (NP).

Ringed seals (*Pusa hispida)*

Twenty-three ringed seals were collected from the Isfjorden area, Svalbard, to the Norwegian Environmental Specimen Bank. Data on morphometrics, age, sex and various tissue are delivered to this Specimen Bank. (NP).

CETACEANS

Minke whales (*Balaenoptera acutorostrata)*

During the period 26 June to 20 August 2018, a sighting surveys was conducted with the chartered vessel *Acc Mosby* in the North Sea and adjacent areas. The areas which were covered in 2018 were the IWC *Small Area EN* and the block EW4 in the *Small Area EW*. In addition, several fjord systems in western Norway received coverage as part of a feasibility study of surveying for harbour porpoises in inner coastal waters. This was the fifth year of the six-year survey period 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 3,137 c nautical miles was surveyed with independent double platforms on primary effort in the offshore blocks. During primary search effort, the number of observations from the primary platform (crow's nest) was 106 sightings of **minke whales**. Sightings of other cetacean species include **fin whales** (30 primary sightings), **sei whale** (1 primary sighting), h**arbour porpoises** (198 primary sightings), **Lagenorhynchus spp. (**30 primary sightings, of which 3 were **white-beaked dolphins**, 14 were **white-sided dolphins** and 13 were unidentified to species), **pilot whales** (7 primary sightings), **Northern bottlenose whales** (4 primary sightings), **sperm whales** (3 primary sightings)

and **killer whales** (1 primary sighting). In addition, 68 grey seals were recorded in offshore North Sea waters, especially off the England coast between 53°N and 55°N. (IMR).

Minke whale catch data for the 2018 season have been computerised and evaluated. (IMR).

In a joint Japanese-Norwegian cooperation, possible morphological differences of the white flipper patch between the North Atlantic and North Pacific common **minke whales** were studied. Morphological measurements were taken from left flippers of sexually mature animals caught in the two areas. The relative length between the tip of flipper to the distal border of white patch to the total flipper length showed no statistical differences between whales from the two areas. However, the relative length between the tip of flipper to the proximal border of white patch to the total flipper length was significantly larger in the North Atlantic (74.31 %) as compared to the North Pacific (63.62 %) common minke whales. Also, the mean angle between the proximal boundary line of white patch to the longitudinal axis of the flipper was significantly different between the North Atlantic (70.05 degree) and the North Pacific (92.29 degree) whales. The results showed that there are clear morphological differences in the white patch of the flipper between the two common minke whale subspecies. (IMR).

Food safety and development of PCB methodology: Norwegian and Icelandic authorities have since 2015 participated in trilateral meetings, at different levels, between Norway, Iceland and Japan regarding the regulations for import of whale products to Japan. The objective of the discussions regarding PCBs in the trilateral co-operation has been to improve the predictability of results obtained in Japan with those produced for whale products in Norway and Iceland. The need for increased predictability became evident due to different methodologies for PCB-analysis in Japan compared with that of EU, Iceland, and Norway. Japanese methodology determines total-PCB by way of industrial standard (Kanechlor), which is only used in Japan, while Norway, Iceland, and EU use methodology which determines an internationally established selection of congeners e.g. PCB_6 or PCB_7 using methods that are defined by quality criteria (including e.g. trueness, recovery, and measurement uncertainty). (IMR).

In 2018 the work and discussions in the trilateral meetings between Japan, Iceland and Norway have resulted in the agreement that there is a good correlation between PCB_7 and total-PCB and that a Japanese maximum limit for PCB_7 may be set as a proxy for total-PCB. Remaining topics to be agreed upon in the next trilateral meeting to be held in Tokyo medio February 2019 are: (i) Discussions regarding the underlying Japanese risk assessment and risk management for the proposed maximum limit of 0.2 mg/kg for PCB_7; (ii) Discussions regarding the use of measurement uncertainty in compliance assessment taking into account international recommendations of fairness towards both consumers and producers, evaluating decision risks and establishing decision rules; (iii) How uncertainty from sampling can be handled by e.g. harmonization of sampling protocols or by the use of a referee sample in order to be able to have an appropriate measurement uncertainty which is a prerequisite in order to compare analytical results before export with the analytical result from spot checks at import at a later stage. (IMR).

Other cetaceans

The *"weShare" project* examines the causes and consequences of the massive herring superabundance events that took place in the Kaldfjord/Vengsfjord system over 5 winter seasons between 2013 and 2017. The project has 1) carried out extensive and repeated echosounder surveys for herring

approximately monthly every season (Oct-Feb) to study the dynamics and estimate the biomass of herring, 2) used advanced electronic accelerometer/camera tags, attached with suction cups to ~25 **humpback whales**, to study in detail their foraging behavior, estimate their prey consumption rates, and estimate their body condition, 3) carried out a pilot study to evaluate the use of aerial drones to estimate whale abundance, and 4) supported the collection of photo IDs of humpback whales. The photo ID efforts have so far resulted in over 900 individual humpbacks having been identified in the region since 2010, and these represent the North Norwegian Humpback Whale Catalogue (NNHWC, www.hvalid.no). Photographs of most of these individuals have been submitted to the North Atlantic Humpback Whale Catalogue (NAHWC), and several matches have been discovered with whales from Iceland, Ireland, Cape Verde Islands and the Caribbean. In addition, weShare has partnered with two other Fram Centre funded projects focused on describing the ecosystem-wide effects of herring superabundance on the general fjord ecosystem, in terms of water mass characteristics and nutrient composition, oxygen depletion, sediment structure and composition. The weShare project also uses fisheries data provided by the Fisheries Directorate, as well as AIS (Automatic Identification System) data on general vessel traffic in the region, to evaluate the overlap between various human activities and whale presence. The project has so far produced one MSc thesis at the Arctic University of Tromsø, and data are actively worked up by research scientists at the UiT and IMR, and specifically by two PhD candidates at UiT. As part of weShare's other collaborations with researchers from Scotland, France and Japan, we are also involved with ongoing studies of the behavioural response of humpback whales to natural underwater sounds, specifically those of fish-eating and mammal-eating **killer whales**. Results from several of these projects have been presented at major international conferences. Since the disappearance of the whales from the Kaldfjord/Vengsfjord system, weShare has transitioned into an intensive data processing stage, and several publications are being prepared and will be published throughout the next year. (UiT – IMR).

Whaletrack/Whalefeast-project: The WHALETRACK-project was initiated in 2013 with the aim to map the **humpback and killer whale** behavior and migrations related to their winter aggregations in the North-Norwegian fjords. In 2018 the "Whalefeast-project" was also included under the Whaletrack framework (see link below). The UiT Arctic university of Norway is the project leading institution with close cooperation with the Institute for Marine Research (IMR, Tromsø and Bergen). The project also includes close cooperation with other Norwegian and international institutions and include several PhD-and Master candidates.

The main purpose of the project is to gain better knowledge about the behavior of humpback and killer whales before, during and after the period they feed on overwintering herring in the fjords or off the coast of Northern Norway. We also aim to investigate how the whales interact with fishing activity and tourist boats. The tagged whales also give us indirect information on herring movement over large areas at different times, which can be of management significance for both herring and whales. This information will be relevant to fishing and possibly petroleum activities offshore, which is a focus for one of one of the PhD candidates. The project includes satellite and archival tag tagging, biopsy and eDNA sampling and ID-picturing.

Since 2013, a total of almost 30 humpback and 40 killer whales have been tagged with transdermal satellite transmitters and about 40 humpbacks and 7 killer whales with archival tags (suction cup tags). The humpbacks have been satellite tagged in the fjords of Troms (Nov-Jan 2016-2019) in northern Norway and in the northern Barents Sea (Sept 2018), while the killer whales have been tagged in the same northern fjords (2015-2019) and at the herring spawning grounds of Møre (Western part of Norway, February 2019). A considerable number of biopsies have been collected during the same period, as well as eDNA samples during the 2018/19-season. Since 2010, more 900 different

humpbacks have been registered and catalogued in the area by the North Norwegian Humpback Whale Catalogue (NNHWC), in addition to several hundred in the Northern Barents Sea (IMR). In the last years, both humpback and killer whales have also been tagged with satellite transmitters in the Northern Atlantic to follow their migrations more closely.

Whilst the ***Whaletrack*** project since 2013 has focused on mapping the horizontal and vertical migration patterns of humpback and killer whales, the new *Whalefeast* project (2018-2021) will also include a closer cooperation with the fisheries and tourism industry, as well as using eDNA- techniques in addition to already collected data. It will include social science studies of the impact that the whale arrivals have had, and has, on the tourist and fisheries industries.

Some of the tracking results, project and contact information can be seen at https://en.uit.no/prosjekter/prosjekt?p_document_id=505966. (UiT, IMR, LKARTS-Norway, http://hvalid.no/)

As part of the long-term **killer whale** research project initiated in 2013, efforts were directed towards further data collection throughout the year in northern Norway. This included collection of ID-photographs, biopsy samples, behavioral observations, aerial (drone) imagery, sound recordings and prey remains. Data are being used for various studies based on individuals' recognition including mark-recapture analyses and investigations of group-specific foraging ecology. The Norwegian killer whale identification database is a work in constant progress and the latest version of the ID-catalogue was published in March 2018 (Jourdain & Karoliussen 2018). (ORCA).

A group of **killer whales** was naturally entrapped in the bay of Trælvikosen, off Brønnøysund (65°28'37.28"N, 12°14'3.79"E) in May 2017. To our knowledge, this was the fifth recorded case of natural killer whale entrapment in Norway since 1992. A rescue operation coordinated by scientists of Norwegian Orca Survey and colleagues successfully guided the whales back to open waters after 19 days of entrapment. Not only the successful operation promoted animal welfare, it also prevented inherent social controversy commonly associated to such events. Steps of both situation assessment and rescue operation were published (Jourdain et al. 2019) as baseline information should cetacean entrapment happen again in the future. (ORCA).

As ordered by NAMMCO, an extensive review of the literature aiming at assessing current status of **North Atlantic killer whale** populations was conducted. Future research priorities were discussed and summarized by an international working group in November 2018. (ORCA).

Studies of **harbor porpoise** ecology and population biology, based on samples obtained from bycatches, were initiated in 2016 and continued in 2017 and 2018. Some preliminary results are available: Saithe was by far the most important prey item (32-90%). Other fish species such as capelin, herring, Norway pout and blue whiting also contributed importantly to the porpoise diet, depending on area. The growth of the porpoises was analyzed by fitting von Bertalanffy growth models to the data. Females grow both faster and longer than the males; the asymptotic length in females and males were 166 cm and 149 cm, respectively. Results from analysis of reproductive status suggest that females become sexually mature between 4 and 5 years of age, whereas males become sexually mature at ca. 3 years of age. (IMR, UiT).

Bowhead whales (*Balaena mysticetus*)

Satellite tags were deployed on 9 bowhead whales in the Framstrait September 2018.Tags were deployed from a helicopter with FF Kronprins Haakon as a base ship. In addition, biopsies for genetic studies were collected from 2 individuals. (NP).

Seven acoustic recorders (AURALs) listening for bowhead whales, white whales and narwhals (but also other species- and anthropogenic sounds) were deployed autumn 2018. Many of these were redeployments where data from the previous year was downloaded and new batteries were installed before the AURALs were redeployed (NP).

White whales (*Delpinapterus leucas*)

The first-ever aerial survey for estimating the number of white whales in the Svalbard area was conducted July and August 2018 (NP).

Blue and fin whales (*Balaenoptera musculus and B. physalus*)

Satellite tags were deployed on blue whales (N=4) from a small boat and on fin whales (N=5) from a helicopter on the west coast of Svalbard. In addition, biopsies for various investigations (genetics, diet and pollution) were collected from 4 blue whales. (NP).

Other species

In August-October 2018 marine mammal observers were onboard the vessels participating in the Barents Sea ecosystem survey which is a joint effort with Russia. In total, 2119 individuals of nine species of marine mammals were observed. As in previous years, white-beaked dolphin (*Lagenorhynchus albirostris*) was the most common species (more than 70% of all individual registrations). This species was widely distributed in the survey area and expanded somewhat to the northeast compared to the 2017 survey. The highest densities of this species apparently overlap with the distributions of capelin, codfishes, herring and polar cod in the survey area. Although in modest numbers, the toothed whales were also represented by sperm whales (*Physeter macrocephalus*), harbour porpoises (*Phocoena phocoena*), and killer whales (*Orcinus orca*) besides the numerous white-beaked dolphins. The sperm whales were observed at deeper waters along the continental slope and other parts of the research area westward of 27^{o} E. The harbour porpoise and killer whale sightings were mainly made in the southern parts of the research area. The baleen whale species minke (*Balaenoptera acutorostrata*), humpback (*Megaptera novaeangliae*) and fin (*Balaenoptera physalus*) whale were quite abundant as 22 % of the total animals registered belonged to these species. There main concentrations were found east of Svalbard. There were fewer observations of minke whales in 2018 than in 2017, and although they are widely distributed over all the survey area, their highest concentrations were in the northern areas with spatial overlap with capelin and polar cod aggregations. The humpback whales were as usual recorded mainly in the waters to the east of the Svalbard Archipelago and in the area of the Great Bank. In 2018, more humpback whales were observed than in the previous year, and they were recorded in areas with aggregations of capelin, often with fin and minke whales in the same areas. In 2018, fewer fin whales were observed during the survey as compared to 2017. (IMR, in cooperation with PINRO).

Research vessels, coastguard vessels and other providers have collected incidental observations of marine mammals. Recorded data include date, position, species and numbers. During 2018 a total of 822 cetacean observation incidents have been reported. The most frequently observed species were **minke whales** (149 groups), **Lagenorhynchus dolphins** (184), **fin whales** (126), **humpback whales** (127), **killer whales** (99), **harbour porpoises** (36 groups), **blue whales** (4), **sperm whales** (8), **long-finned pilot whales** (17), **bottlenose dolphins** (4), **sei whales** (5), **common dolphins** (2 group) and **Northern bottlenose whales** (1 groups). (IMR).

During 2018 photo IDs have been collected from more than 300 **humpback whales** during field work and from incidental sources. In addition, biopsy samples have been collected from 33 humpback whales. (IMR).

III ONGOING (CURRENT) RESEARCH

PINNIPEDS

Data for assessment of biological parameters were collected from 170 **harp seal** females during commercial sealing in the East Ice in 2018 – analyses are in progress. In addition to the biological parameters, samples were also taken for studies of contaminants and ecology (stable isotopes) from some of the sampled females and 5 additional males. (IMR)

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)

Collect new data on biological parameters for **harp seals** in the West Ice during the commercial hunt 2019. (IMR)

In March 2018, 6 adult **harp seal** females were live captured in the West Ice immediately after the lactation period and brought back to Tromsø by a research vessel. In Tromsø the seals were kept in captivity during the entire moulting period. Subsequently, sattellite based tags were deployed on the seals which were subsequently transported by boat and released north of Bear Island in mid July. The experiment is in progress, and data are still being received from the transmitters. (IMR, UiT)

Tagging with satellite-based tags, **harp seals** in the White Sea - funding secured, will be attempted in April/May 2019. (IMR)

Ship based counting of **harbor seals**, using electronic helicopter drones with camera, will be conducted in mid Norway (Trøndelag and Nordland) in September. This will continue the work further south in 2018, aimed aimed to provide a new abundance estimate for the species along the entire Norwegian coast. (IMR)

Final analyses of historic **grey seal** diet data from the Norwegian coast have been done and an article was submitted. (IMR)

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

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, were conducted during 2014-2017. Visual observations of all **marine mammals** were conducted along all sampling transects, and publication of analyses of possible associations between **baleen whales** and their prey are in progress. (IMR)

CETACEANS

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

Year-round data collection at the Norwegian Orca Survey is to be maintained throughout 2019. A mark-recapture analysis spanning 1986-2018 and aiming at estimating population parameters is underway. Biopsy samples are being analyzed along with individuals' sighting histories and predation records to assess prey specializations and variations in foraging ecology of killer whale groups (Jourdain et al. 2017). (ORCA).

GENERAL

The collection of data on incidental observation of marine mammals will be continued. Participation of marine mammal observers on the annual ecosystem surveys in the Barents Sea has been established as part of the general survey procedure. (IMR).

The mosaic sighting survey program (*NILS*) for estimating abundance of minke whales in the period 2014-2019 is ongoing. Analyses to estimate the abundance of other cetacean species observed during these surveys are underway. (IMR).

IV ADVICE GIVEN AND MANAGEMENT MEASURES TAKEN

Sealing

Harp and hooded seals

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 2019.

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 stabilize, 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 2019 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.

Coastal seals

A new management system for coastal seals was introduced in 1996. Hunting quotas on **harbor** and **grey seals** were set based on best available information on seal abundance along the coast. The regulations also included catch reports. The new management regime required increased survey effort along the Norwegian coast to be able to give advice on catch levels. In 2003, quotas were increased substantially compared to the recommendations based on scientific advice, when they were set at 1186 grey seals (25% of the abundance estimate) and 949 harbor seals (13% of the abundance estimate). Also, compensation paid for shot seals, which included sampling of age and body condition data, were introduced and lasted until 2014 (except in 2011). In 2010, management plans for harbor and grey seals were implemented, aimed to ensure sustainable populations of both species 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 harbor 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. Target levels can be adjusted based on new knowledge on seal populations.

Seals in Svalbard

Since a main purpose of managing animal species in Svalbard is to protect naturally occurring species, hunting must not affect the stocks. Controlled and limited hunting is allowed for some species, including **ringed** and **bearded seals**. To hunt in Svalbard, documentation of an accepted big-game-proficiency test (annual rifle shooting test) is required. The two seal species cannot be hunted in national parks / nature reserves. They are also protected during the darkest period (December-January) and in the breeding period. Catch reports are mandatory.

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 was 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 2018 the total catch quota, including transfers, was set to 1278 minke whales. The catch quota for 2019 has been suggested to be the same as for 2018, but this has not been finally decided. The catching season opens April 1 and are closed medio September.

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VI APPENDIX 1 – CATCH DATA

Sealing

Harp and hooded seals

Norwegian catches in the Greenland Sea (West Ice) in 2018 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 2018. Only 14 animals (whereof 6 were pups) were taken for scientific purposes. In addition, 3 pups were taken in the ordinary hunt, presumably because they were misidentified (as harp seal beaters) before they were shot. The 2018 TAC for harp seals in the Greenland Sea was set at 26 000 1+ animals (where 2 pups balance one 1+ animal), i.e. the removal level that would reduce the population with 30% over the next 15 year's 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 10,090 1+ animals (where 2 pups balance one 1+ animal) in the White and Barents Sea in 2018. 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 2018. The total quotas given were not fulfilled in any area: In the West Ice, only 5% 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 2015-2018. However, one Norwegian vessel, hunting in the southeastern Barents Sea (the East Ice) in 2018, took a total of 2,241 harp seals. This represented 22%of the identified sustainable level.

Table VI.1. Norwegian catches of harp and hooded seals in 2018. 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	1,218	1,485	2,703	21	2,220	2,241
Hooded seals	9	8	17			

Coastal seals

In 2003-2009, total annual **harbor seal** hunting quotas ranged between 704 and 989 animals, while annual catches were 538-905 harbor seals. In 2010-2017, annual harbor seal quotas ranged between

425 and 485 animals, while annual catches were 159-511 harbor seals. In 2018, the quota was 460 harbor seals and 385 were taken in the hunt.

In 2003-2011, recommended quotas on **grey seals** were 355-460 animals but set annual quotas were 1040-1536. Annual catches ranged between 111 and 516 grey seals in that period. Set grey seals quotas were 460 animals in 2012-2014, but due to observations of declines in grey seal pup production the quotas were reduced to 315 grey seals in 2015, 210 animals in 2016-2017. Annual catches were 33-216 grey seals in 2012-2017. In 2018, the catch quota was 200 animals and 66 grey seals were taken.

Seals in Svalbard

In 2003-2017, total annual **ringed seal** catches in Svalbard ranged between 15 and 78 animals. In 2018, 46 ringed seals were taken in the hunt.

The number of **bearded seals** taken annually in Svalbard in 2003-2017 ranged between 2 and 34 animals, and the number taken in the 2018 hunt was 18 bearded seals.

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 Reviews 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, 11 vessels participated in the 2018 season of whaling and the catching period was 1 April to 20 September. Table VI.2 shows the number of minke whales taken by area in the 2018 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. Unused quotas can be transferred to the following year. The present quota period is 2016-2021. The calculated annual basic quota for this period is 710 animals within Medium Area E and 170 whales within the Small Area CM, giving a total of 880 minke whales. The total catch in the 2017 season was 432 whales and the quota for 2018 was set to 1278 minke whales, including transferred unused catches in the E area.

Table VI.2. Quotas and catches of minke whales in 2018 by management area as defined in RMP.

2018	Management area					
Small-type whaling	EB	EN	ES	EW	CM	Total
Catch	123	0	214	117	0	**454**
Quota	1108				170	1278
Stock area	Northeastern				Central	

VII APPENDIX 2 – BY-CATCH DATA (*Arne Bjørge, IMR*)

Bycatch of harbour porpoises, grey and harbour seals

Harbour porpoises, harbour and grey seals are incidentally caught in coastal gillnet fisheries, and the total annual bycatches of the three species are assumed to be in the order of 3000, 600 and 500 animals, respectively. Large-mesh, bottom-set gillnets for cod and monkfish in the Norwegian coastal zone constitute most of these bycatches. Data collection for monitoring marine mammal bycatches in these two fisheries continued in 2018. Revised estimates of harbour porpoise bycatch for the period 2006-2008 and new estimates for the entire period 2006-2017 are about to be submitted for *peer review* publication. The bycatches of harbour porpoises in the two gillnet fisheries (for cod and monkfish) have fluctuated around an annual average of about 2400 porpoises during the period 2006-2015 (Fig. 1). The decline in porpoise bycatch in the monkfish fishery is most likely driven by a decline in fishing effort during this period.

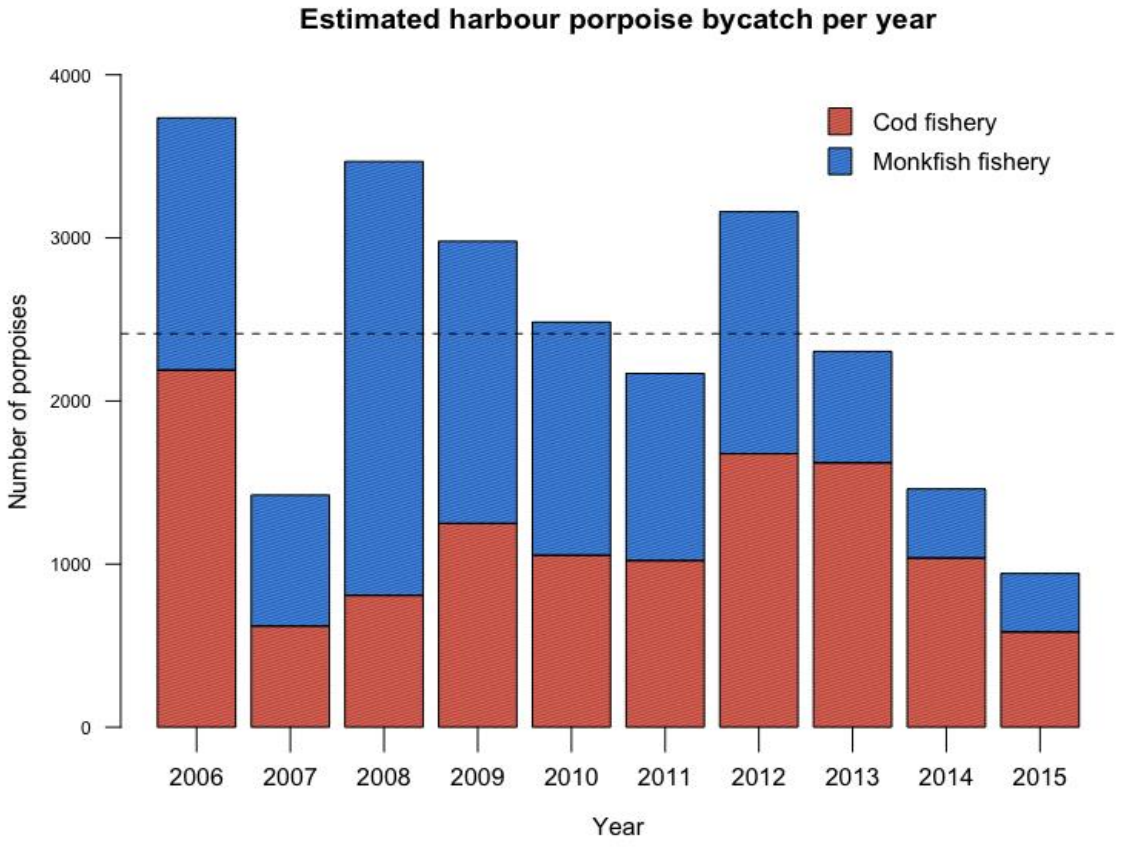

Figure 1. Estimated harbour porpoise bycatch in the Norwegian coastal gillnet fisheries targeting cod and monkfish. Estimates were derived using a stratified ratio estimator approach with data stratified by year, season and region. The dashed horizontal line represents average yearly bycatch across the ten-year period.

Harbour porpoise bycatch mitigation

Experiments with two types of Acoustic Deterrent Devices (ADDs), called pingers, were conducted on large-mesh gillnets in the coastal zone. The Future Oceans' porpoise pinger emits a 10kHz, 132 decibel signal every four seconds. The Fishtek Marine's banana pinger emits randomized signals with frequency between 50 to 120 kHz and 154dB every four to twelve seconds. Both pinger types were attached to the cork line at 200m intervals.

In the winter-spring cod fishery 2535 net-weeks without pingers were compared with 1723 net-weeks with pingers. Nets with and without pingers were used simultaneously. Nets without pingers caught nine porpoises, that is one porpoise per 282 net-weeks. Nets with pingers caught two porpoises, that is one porpoise per 861,5 net-weeks. The pingers resulted in a significant reduction of the risk of entanglement.

However, we cannot exclude the possibility that nets with pingers also influenced the risk of entanglement in neighboring nets without pingers in the first experiment. For the autumn of 2018 we therefore changed the experimental design. In paired week-numbers, the gillnets were set with pingers and in odd week-numbers, nets were set without pingers. Seven gillnet vessels participated in the experiment. The total fishing effort constituted 60 hauls with a total effort of 403 312 net-hours.

Six porpoises were caught by two vessels and all porpoises were taken in weeks without pingers. No porpoises were taken in nets with pingers, resulting in 100% reduction in the risk of bycatches.

The use of 10kHz pingers in the first experiment resulted in increased risk of entanglement of harbour seals. This is observed also in USA and called the 'dinner-bell' effect. 10kHz is in the audible range of seals, and seals can learn that the signals indicate nets with trapped fish and access to a cheap meal, but with enhanced risk of self being entangled. We therefore changed the frequency to 70kHz in the second experiment. The external shape of the Future Oceans' pingers were also modified to reduce the risk of entanglement in net meshes.

Table 1: Summary of results from the pinger experiment during autumn 2018. The column Gear type shows that these nets were nets for saithe and monkfish. The column Experimental design shows if active pingers were attached to the nets or not.

Gear type (gillnet)	Half mesh (mm)	Experimental design	Total catch target sp. (kg)	No. of hauls	Net-hours	No. of porpoises
Seithe	66	Control	6481	6	9600	1
Saithe	66	Pinger	786	1	1440	0
Monkfish	180	Control	5349	27	139984	5
Monkfish	180	Pinger	3496.5	26	82368	0

Entanglement of large whales

In the recent years there have been challenges with humpback and killer whale bycatch in the Norwegian herring fisheries in Troms, northern Norway, when the herring wintered in the Kaldfjorden. The herring was harvested by purse seines and there were many instances where whales got stuck in the seines. As a response to this the Norwegian Coastguard and the Norwegian Directorate of Fisheries' Sea Surveillance Service have been given special training in large whale entanglement response. Both the Coastguard and the Sea Surveillance Service monitor the fishing fleet so that whale bycatch mortality can be kept at the lowest level possible.

Specifically, for the 2017/2018 herring season the Coastguard and the Sea Surveillance Service recorded 26 incidences with whales. In 24 of these instances killer and humpback whales got caught in purse seines. Of these, 22 whales were released alive and two killer whales drowned. There was also one incidence where a whale got entangled in a cod/pollock net. This whale was cut loose by the Sea Surveillance Service and the Coastguard. The last incident during the season was a humpback whale which was found dead on a beach with remnants of a fishing net around its flukes. This whale was towed out to sea and sunken by the Coastguard. In summary, of all these 26 incidences there was recorded three whale mortalities: two killer whales and one humpback.

In other fisheries in 2018 there was only one reported incidence. This was reported by the Sea Surveillance Service and happened in the trawl fisheries for mackerel on the 3rd of October. This whale of unconfirmed species went into the trawl but escaped out on its own without any damages.