NORWAY - PROGRESS REPORT ON MARINE MAMMALS 2021

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I INTRODUCTION

This report summarises Norwegian research on pinnipeds and cetaceans conducted in 2021 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); www.hi.no
The Norwegian Polar Institute (NP); www.npolar.no
University of Tromsø – The Arctic University of Norway, Department of Arctic and Marine Biology, Research group Arctic Chronobiology & Physiology (UiT-AMB-ACP)
http://arcticchronobiologyandphysiology.blogspot.com/
University of Tromsø – The Arctic University of Norway, Department of Arctic and Marine Biology (UiT) www.uit.no
Norwegian University of Science and Technology (NTNU) www.ntnu.no
University of Oslo (UiO) www.uio.no
Directorate of Fisheries, Sea Surveillance Unit (SSU) www.fiskeridir.no
Norwegian Orca Survey (NOS) www.norwegianorcasurvey.com

II RESEARCH BY SPECIES 2021

PINNIPEDS

The assessment model currently in use for **harp** and **hooded seals** is a deterministic, age-structured population model. It uses historical catch data, reproductive data, and estimates of pup production to estimate the current total population. Development of these models was initiated when pup production estimates becoming available in the 1980s – subsequently the availability of data has increased, and the time series now spans more than 30 years. The deterministic model treats several of the input data as exactly known (e.g. reproductive parameters) and interpolates these data linearly across periods when no data are available. In addition, it only estimates three parameters: initial population size and pup and adult mortalities. The model is therefore very inflexible, and unable to adequately account for rapid changes in e.g. pup production. While the model appears to give a relatively reliable reflection of current population status, it obviously fails to generate reliable future population trajectories over time. ICES and NAMMCO have recommended that further model development should be undertaken to improve its performance. A first modelling workshop, including seal scientists form the entire North Atlantic, was held in the autumn of 2020 to discuss current models and suggest ways of improvements. One way forward considered was to link the seal models more tightly to other ecological variables, for example variations in important prey species (such as capelin) and competitors (such as cod). The work with model development continued by correspondence in 2021, progress and results will be discussed in digital meetings throughout 2022. In addition, ICES has facilitated the establishment of a benchmark process for harp seals. This process was formally started during a kick-off meeting, which was held online on December 8, 2021. This meeting laid out the agenda for a full year of preparatory work that will lead up to a face-to-face benchmark meeting to be held in December 2022. The envisaged outcome of this benchmark meeting will be an improved assessment approach centred around a modified version of the existing population model. Based on this improved assessment model, the research team will then meet to discuss the validity of existing reference points and harvest control rules, and the potential need to update these. Finally, the Joint ICES/NAFO/NAMMCO Working Group of Harp and Hooded Seals (WGHARP) will meet during autumn in 2023 to implement the new management tools, to discuss and include new data, and to develop new advice for the management of harp and hooded seals. (IMR)

In a study aimed to reconstruct trophic ecology, **harp seal** teeth collected in the 1990s from the Northwest Atlantic were analyzed for bulk stable carbon and nitrogen isotopes ($\delta^{13}C_{bulk}$ and $\delta^{15}N_{bulk}$), and compound-specific stable nitrogen isotopes of amino acids ($\delta^{15}N_{AA}$) for the first time. A fine-scale, annual growth layer group (GLG) dentine sub-sampling method corresponding to the second and third year of life was developed. In accordance with previous diet studies, while there was individual variability in $\delta^{15}N_{bulk}$, $\delta^{13}C_{bulk}$ and $\delta^{15}N_{AA}$ measurements, no significant differences in isotopic niche widths between males and females, or between GLGs were detected. Relative trophic position was calculated as the baseline-corrected $\delta^{15}N_{AA}$ values using trophic (glutamic acid) and source (phenylalanine and glycine) amino acids. Variability was measured between individuals in their relative trophic position, but within individual variability was low, suggesting that they fed at the same trophic level over these two years of life. These novel $\delta^{15}N_{AA}$ data may therefore suggest individual, specialist harp seal foraging behavior in sub-adults. These results show that compound-specific stable isotope signatures of archived, inert predator tissues can be used as tools for the retrospective reconstruction of trophic interactions on broad spatiotemporal scales. (IMR, UiT)

Sea-ice declines in the European Arctic have led to substantial changes in marine food webs. To better understand the biological implications of these changes, a study was conducted where the contributions of ice-associated and pelagic carbon sources to the diets of **harp** and **ringed seals** were quantified using compound-specific stable isotope ratios of fatty acids in specific primary producer biomarkers derived from sea-ice algae and phytoplankton. Comparison of fatty acid patterns between these two seal species indicated clear dietary separation, while the compound-specific stable isotope ratios of the same fatty acids showed partial overlap. These findings suggest that harp and ringed seals target different prey sources, yet their prey rely on ice and pelagic primary production in similar ways. From Bayesian stable isotope mixing models, it was estimated that relative contributions of sympagic and pelagic carbon in seal blubber was an average of 69% and 31% for harp seals, and 72% and 28% for ringed seals, respectively. The similarity in the Bayesian estimations also indicates overlapping carbon sourcing by these 2 species. These findings demonstrate that the seasonal ice- associated carbon pathway contributes substantially to the diets of both harp and ringed seals. (UiT, IMR, NP)

In a study addressing animal welfare issues in the Norwegian seal hunt, the relative effectiveness of a rapidly expanding Bonded hunting bullet and an explosively expanding Varmint bullet were investigated in the young **harp seal** hunt. The study was conducted as an open, controlled and randomized parallel group designed field trial. The animals were pre-randomized (1:1) into one explosively expanding (Varmint) and one expanding (Bonded) bullet type group, with 75 animals in each. The study sample consisted of young, weaned harp seals, 2–7 weeks of age, of both sexes, from the Greenland Sea harp seal population. The study was conducted during the regular hunt. Instantaneous death rate (IDR) and time to death (TTD) were the main variables. The observed IDR was 84% in both bullet groups. Correcting for Weather Condition Index, the IDR for the Varmint bullet was significantly higher compared to the Bonded. The mean TTD was shortest in the Varmint group, but the difference did not reach significance. Compared to the Bonded, a significantly higher total cranial damage score and bleeding intensity, and significantly lower frequencies of bullet exit wounds were detected in the Varmint group. The *post mortem* reflex movements caused by the Varmint bullet were significantly more powerful with longer duration and higher frequencies of clonic contractions. In conclusion, the results indicate a higher effectiveness of the Varmint bullet relative to the Bonded. The Varmint bullet may thus improve animal welfare in the hunt of young harp seals. (IMR)

During the 2021 annual UiT-AMB-ACP research cruise with *R/V "Helmer Hanssen"* physiological studies of **harp seals** and **hooded seals** from the Greenland Sea stocks were conducted. (UiT):

- **Harp seal** studies involved the capture of 5 adult females that were used in a MSc-project dealing with validation of the tritiated water technique for determination of body composition. Live-captured animals were injected with a tritiated water dose and blood samples collected and analysed according to established procedures. The animals were thereafter culled and dissected, for comparison of indirect (calculated) vs. direct (weighing) determinations of body composition. The results of this validation study are important in any future use of non-terminal, tritiated-water-based studies of body composition in this or related species.
- Four adult **hooded seals** were culled and used for further studies of mechanisms underlying cerebral hypoxia tolerance in this species. Samples of their visual cortex were incubated *in vitro* under normoxic and hypoxic conditions, also including re-oxygenation of hypoxia-incubated samples (thus, simulating non-diving, diving, and recovery-after-diving states, respectively). They were subsequently shock-frozen, to be used for metabolomic studies of differences in the use of metabolic pathways in the three different oxygenation states, in a collaboration between the University of Hamburg, Germany, and UIT-AMB-ACP.
- Brain samples from the same **hooded seals** were also used for cell dissociation, for development of techniques for the culturing of glia cells (astrocytes) and neurons. These activities aim to allow future detailed genetic/molecular studies of different brain cell types and their functional characteristics, without the need to cull additional seals to access fresh brain tissue every time. Cell-specific studies are important in disentangling the metabolic roles of two key neural cell types and by what mechanisms they contribute to the high cerebral hypoxia tolerance that is typical of diving mammals.
- **Hooded seal** pups were also culled for detailed studies of the thermogenic role of skeletal muscle in early life. Skeletal muscle samples were collected from three different muscles and preserved by different techniques (frozen in liquid N_2, preserved in RNAlater and in paraformaldehyde (PFA), for later genetic and molecular analyses. Similar samples were collected from 4 newborn pups, four weaned pups and from the four adult hooded seals, mentioned above. Additional samples were collected for comparative purposes from harp seal pups (i.e., pups of the above-mentioned adult female harp seals). This is a MSc project conducted in collaboration between the University of Veterinary Medicine, Vienna, Austria, and UiT-AMB-ACP.
- Additionally, 6 weaned **hooded seal** pups were live-captured and used in further studies of physiological adaptations to the post-weaning fast, with regard to both metabolic and osmoregulatory functions, in a MSc-project that was completed in the research animal facilities at UiT.

Harbor seals assessments were carried out along the entire mainland Norwegian coast during molt in 1996-1999, 2003-2006 and 2008-2015. In 2016, new harbor seal counts along the coast started in south, Norwegian Skagerrak, and were continued along the coast north to Finnmark in August 2021. Results show that numbers of harbor seals in Norwegian Skagerrak have increased to approximately the levels before the PDV-outbreak in 2002. At the west coast south of Stad (62°N) the numbers are slightly lower than in the first counting period 1996-1999. North of Stad, harbor seals have decreased in numbers in the counties Møre and Romsdal, Trøndelag and Nordland compared with results in 1996-1999. In Troms, the numbers increased from ca 560 in 1996-1999 to ca 990 in 2008-2015 but was reduced to 760 in 2020. In Finnmark, the total harbor seal numbers increased by 14% since 2008-2015 to ca 1120 in 2021. The total minimum numbers of harbor seals were ca 6960 along the Norwegian coast in 2016-2021, which is close to the Target Level of 7000 harbor seals.(IMR)

Grey seal pup production was estimated in Troms and Finnmark in November-December 2021, which finished the grey seal pup counts along the Norwegian coast in the period 2017-2021. Preliminary results showed a reduction of pups born in Troms by ca 25% from 65 pups in 2016 to 49 pups in 2021. The pup production in Finnmark increased by ca 9.7% from 206 pups in 2015 to 226 pups in 2021. Total grey seal abundance modelling will be carried out in 2022. (IMR)

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 autumn 2021 and GPS data from walruses were collected. This project is mainly funded by the Norwegian-Russian Environmental Commission in addition to internal funding. (NP)

As part of a new Norwegian Research Council funded project entitled: Arctic marine mammals in a time of climate change: a Kongsfjorden Case Study (ARK) **ringed**, **bearded** and **harbor seals** are equipped with biologging instruments in Kongsfjorden to study space use and potential competition in this fjord where it seems like the more temperate species (harbour seals) are taking over the area from the more Arctic species (ringed and bearded seals). SMRU tags are used that record and transmit (via UHF to a station on a mountain in the fiord) a GPS position every time a seal is at the surface and also transmits data from every dive, which provides a spatial and temporal resolution of the data that is necessary for this study. Six ringed, one bearded and 10 harbour seals were captured and instrumented. From all animals, samples of blood and blubber were also collected for studies of diet, pollution and health. (NP)

In addition, nineteen **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).

Environmental change and increasing levels of human activity are threats to marine mammals in the Arctic. Identifying marine mammal hot-spots and areas of high species richness are essential to help guide management and conservation efforts. Herein, space use based on biotelemetric tracking devices deployed on 13 species (**ringed seal, bearded seal, harbour seal, walrus, harp seal, hooded seal, polar bear, bowhead whale, narwhal, white whale, blue whale, fin whale and humpback whale,** total = 585 individuals) in the Greenland and northern Barents Seas between 2005 and 2018 is reported. Getis−Ord *Gi** hotspots were calculated for each species as well as all species combined, and areas of high species richness were identified for summer/autumn (Jun−Dec), winter/ spring (Jan−May) and the entire year. The marginal ice zone (MIZ) of the Greenland Sea and northern Barents Sea, the waters surrounding the Svalbard Archipelago and a few Northeast Greenland coastal sites were identified as key marine mammal hotspots and areas of high species richness in this region. Individual hotspots identified areas important for most of the tagged animals, such as common resting, nursing, moulting and foraging areas. Location hotspots identified areas heavily used by segments of the tagged populations, including denning areas for polar bears and foraging areas. The hotspots identified herein are also important habitats for seabirds and fishes, and thus conservation and management measures targeting these regions would benefit multiple groups of Arctic animals. (IMR, NP, UiT, UiO)

CETACEANS

During the period 8 June to 2 August 2021, a sighting survey was conducted with the chartered vessel *M/S Stålbas* in the Jan Mayen area - the IWC *Small Area CM*. In addition, Hardangerfjorden in western Norway received coverage as part of a feasibility study of surveying for harbour porpoises in inner coastal waters. This was the second year of the six-year survey period 2020-2025 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 about 2,640 nautical miles was surveyed with independent double platforms on primary effort in the three blocks CM1-CM3. During primary search effort, the number of observations from the primary platform (crow's nest) was 55 sightings of **minke whales**. Sightings of other cetacean species include **fin whales** (18 primary sightings), **humpback whales** (13 primary sighting), **blue whales** (5 sightings), **sei whale** (1 sighting), **Northern bottlenose whales** (35 sightings), **sperm whales** (11 sightings), **white-beaked dolphins** (5 sightings), **killer whales** (9 primary sightings), **pilot whale** (1 sighting) and h**arbour porpoise** (1 primary sighting). (IMR).

Minke whale catch data for the 2021 season have been computerised and evaluated. (IMR)

A study on measurement errors for the Norwegian **minke whale** survey has been published. The results indicate that the abundance estimates obtained by taking measurement error into account are consistently larger than the abundance estimates without measurement error corrections. Furthermore, some insights into the effect of measurement errors are provided by a theoretical analysis. (IMR)

A new abundance estimates of Northeast Atlantic **minke whales** based on the survey cycle 2014-2019 has been provided. For the Medium Area E an increase in abundance of about 20% compared to earlier survey cycles was found. An increase during the period was also seen in the Jan Mayen area, making the total abundance estimate for the surveyed areas about 50% higher than for the earlier survey cycles. (IMR).

Based on the new estimates new **minke whale** catch quotas have been calculated for the upcoming quota period, however, the authorities have not published final quotas for 2022 yet. (IMR).

In August-October 2021 marine mammal observers were onboard the vessels participating in the Barents Sea ecosystem survey which is a joint effort with Russia. In total, 2168 individuals of ten species of marine mammals were observed. As in previous years, **white-beaked dolphin** was one of the most common species (about 63% of all individual registrations). In 2021 higher numbers of white-beaked dolphins were recorded north of 74°N than in earlier years. Although in modest numbers, the toothed whales were also represented by **sperm whales**, **harbour porpoises**, and **killer whales** besides the numerous white-beaked dolphins. The sperm whales were observed in the western areas of the Barents Sea, west of 30°E, and in the deeper waters off the continental slope. The harbour porpoises were mainly recorded in the southeastern coastal waters. The baleen whale species **minke**, **humpback**, **fin** and **sei whales** as well as **blue whale** were abundant in the Barents Sea. These species were often found together in aggregations and overlapping with capelin. (IMR).

Research vessels, coastguard vessels and other providers have collected incidental observations of marine mammals. Recorded data include date, position, species and numbers. We are working with an app-based system for recording these types of observations. (IMR).

Recent warming in the Barents Sea has led to changes in the spatial distribution of both zooplankton and fish, with boreal communities expanding northwards. A similar northward expansion has been observed in several rorqual species that migrate into northern waters to take advantage of high summer productivity, hence feeding opportunities. Based on ecosystem surveys conducted during August–September in 2014–2017, a study investigated the spatial associations among the three rorqual species of **blue**, **fin**, and **common minke whales**, the predatory fish Atlantic cod, and their main prey groups (zooplankton, 0-group fish, Atlantic cod, and capelin) in Arctic Ocean waters to the west and north of Svalbard. During the surveys, whale sightings were recorded by dedicated whale observers on the bridge of the vessel, whereas the distribution and abundance of cod and prey species were assessed using trawling and acoustic methods. Based on existing knowledge on the dive habits of these rorquals, we divided our analyses into two depth regions: the upper 200 m of the water column and waters below 200 m. Since humpback whales were absent in the area in 2016 and 2017, they were not included in the subsequent analyses of spatial association. No association or spatial overlap between fin and blue whales and any of the prey species investigated was found, while associations and overlaps were found between minke whales and zooplankton/0-group fish in the upper 200 m and between minke whales and Atlantic cod at depths below 200 m. A prey detection range of more than 10 km was suggested for minke whales in the upper water layers. (IMR)

Another study show that aerial photogrammetry and tag-derived tissue density can reveal patterns of lipid-store body condition of **humpback whales** on their feeding grounds. Monitoring the body condition of free-ranging marine mammals at different life-history stages is essential to understand their ecology as they must accumulate sufficient energy reserves for survival and reproduction. However, assessing body condition in free-ranging marine mammals is challenging. Here, two independent approaches to estimate the body condition of humpback whales at two feeding grounds in Canada and Norway were cross-validated: animal-borne tags (n = 59) and aerial photogrammetry (n = 55). Whales that had a large length-standardized projected area in overhead images (i.e. whales looked fatter) had lower estimated tissue body density (TBD) (greater lipid stores) from tag data. Linking both measurements in a Bayesian hierarchical model to estimate the true underlying (hidden) tissue body density (uTBD), it was found that uTBD was lower (−3.5 kg m−3) in pregnant females compared to adult males and resting females, while in lactating females it was higher (+6.0 kg m−3). Whales were more negatively buoyant (+5.0 kg m−3) in Norway than Canada during the early feeding season, possibly owing to a longer migration from breeding areas. While uTBD decreased over the feeding season across life-history traits, whale tissues remained negatively buoyant (1035.3 ± 3.8 kg m−3) in the late feeding season. This study adds confidence to the effectiveness of these independent methods to estimate the body condition of free-ranging whales. (IMR)

One study shows indications that the behavioral responses of **humpback whales** to **killer whale** sounds are influenced by trophic relationships. Eavesdropping, the detection of communication signals by unintended receivers, can be beneficial in predator−prey interactions, competition, and cooperation. The cosmopolitan killer whale has diverged into several ecotypes which exhibit specialized diets and different vocal behaviors. These ecotypes have diverse ecological relationships with other marine mammal species, and sound could be a reliable sensory modality for eavesdroppers to discriminate between ecotypes and thereby respond adaptively. Here, it was tested whether humpback whales in the Northeast Atlantic responded differently to playback of the sounds of two killer whale ecotypes, Northeast Atlantic herring-feeding killer whales representing food competitors and Northeast Pacific mammal-eating killer whales simulating potential predators. Animal-borne tags and surface visual observations were used to monitor the behavior of humpback whales throughout the playback experiments. Humpback whales clearly approached the source of herring-feeding killer whale sounds (5 of 6 cases), suggesting a 'dinner-bell' attraction effect. Responses to mammal-eating killer whale sounds varied with the context of presentation: playback elicited strong avoidance responses by humpback whales in offshore waters during summer (7 of 8 cases), whereas the whales either approached (2 of 4 cases) or avoided (2 of 4 cases) the sound source in inshore waters during winter. These results indicate that humpback whales may be able to functionally discriminate between the sounds of different killer whale ecotypes. Acoustic discrimination of heterospecific sounds may be widespread among marine mammals, suggesting that marine mammals could rely on eavesdropping as a primary source of information to make decisions during heterospecific encounters. (IMR, UiT)

Another **humpback whale** study used an omnidirectional video logger to observe the resting behaviour of the whales. Animal-borne video loggers are powerful tools for investigating animal behavior because they directly record immediate and extended peripheral animal activities; however, typical video loggers capture only a limited area on one side of an animal being monitored owing to their narrow field of view. Here, the resting behavior of humpback whales using an animal-borne omnidirectional video camera combined with a behavioral data logger was investigated. In the video logger footage, two non-tagged resting individuals, which did not spread their flippers or move their flukes, were observed above a tagged animal, representing an apparent bout of group resting. During the video logger recording, the swim speed was relatively slow (0.75 m s^{-1}), and the tagged animal made only a few strokes of very low amplitude during drift diving. The drift dives were reported as resting behavior specific to baleen whales as same as seals, sperm whales and loggerhead turtles. Overall, this study shows that an omnidirectional video logger is a valuable tool for interpreting animal ecology with improved accuracy owing to its ability to record a wide field of view. (IMR, UiT)

Humpback whale songs on feeding grounds in North Norway has also been studied. Male humpback whales are known to produce long complex sequences of structured vocalizations called song. Singing behavior has traditionally been associated with low latitude breeding grounds but is increasingly reported outside these areas. This study provides the first report of humpback whale songs in the subarctic waters of Northern Norway using a long-term bottom-moored hydrophone. Data processed included the months January–June 2018 and December 2018–January 2019. Out of 189 days with recordings, humpback whale singing was heard on 79 days. Singing was first detected beginning of January 2018 with a peak in February and was heard until mid-April. No singing activity was found during the summer months and was heard again in December 2018, continuing over January 2019. A total of 131 song sessions, including 35 full sessions, were identified throughout the study period. The longest and shortest complete sessions lasted 815 and 13 min, respectively. The results confirm that singing can be heard over several months in winter and spring on a high latitude feeding ground. This provides additional evidence to the growing literature that singing is not an explicit behavior confined to low latitude breeding grounds. The peak of song occurrence in February appears to coincide with the reproductive cycle of humpback whales. Finally, this study indicates that song occurrence on a subarctic feeding ground likely aids the cultural transmission for the North Atlantic humpback whale population. (IMR, UiT)

How **killer whale** movements on the Norwegian shelf are associated with herring density was studied. Killer whales have a cosmopolitan distribution with a broad diet ranging from fish to marine mammals. In Norway, killer whales are regularly observed feeding on overwintering Norwegian spring-spawning (NSS) herring inside the fjords. However, their offshore foraging behavior and distribution are less well understood. In particular, it is not known to what degree they rely on the NSS herring stock when the herring move to deeper offshore waters. Satellite telemetry data from 29 male killer whales were analyzed to assess whether their offshore foraging behavior is linked to herring distribution. Unlike most marine predator−prey studies that use indirect proxies for prey abundance and distribution, our study utilized 2 herring density estimates based on (1) direct observations from acoustic trawl survey data and (2) simulations from a fully coupled ecosystem model. Mixed effects models were used to infer the effect of herring density and light intensity on whale movement patterns. These results suggest that killer whales follow NSS herring over long distances along the coast from their inshore overwintering areas to offshore spawning grounds. All whales changed from fast, directed, to slow, non-directed movement when herring density increased, although individuals had different propensities towards movement. The data indicated that whales continue to feed on herring along the Norwegian shelf. It is concluded that NSS herring constitute an important prey resource for at least some killer whales in the northeastern Atlantic, not only during the herring overwintering period, but also subsequently throughout the herring spawning migration. (IMR, UiT)

Following the cessation of whaling, South Atlantic populations of **humpback** and some other baleen whale species are recovering, but there has been limited monitoring of their recovery in the Scotia Arc, a former whaling epicentre and a hotspot for Antarctic krill. To inform the management of krill fisheries, up-to-date assessment of whale biomass and prey consumption is essential. Using a model-based approach, a new study provide the first estimates of whale abundance and krill consumption for South Georgia and the South Sandwich Islands and total abundance of humpback whales across their southwestern tlantic feeding grounds, using data collected during a survey in 2019. Humpback whale abundance was estimated at 24 543 (coefficient of variation, CV = 0.26; 95% CI = 14 863−40 528), similar to that measured in Brazil on the main wintering ground for this population. The abundance of baleen whales in South Georgia and the South Sandwich Islands, including those not identified to species level, was estimated at 43 824 (CV = 0.15, 95% CI = 33 509−59 077). Based on the proportion of humpback whales identified during the surveys (83%), the majority of these are likely to be humpback whales. Annual krill consumption by baleen whales was estimated to be in the range 4.8 to 7.2 million tons, representing 7 to 10% of the estimated krill biomass in the region. However, there is a need to better understand feeding rates in baleen whales, and further research into this field should be a priority to improve the accuracy and precision of prey consumption rate estimation. (IMR)

Due to little prior knowledge, a study was conducted, aimed to investigate the health status of bycaught **harbour porpoises** from the northernmost Arctic Norwegian coastline. Gross, histopathological and parasitological investigations were conducted on 61 harbour porpoise accidentally captured in fishing gear from February to April 2017 along the coast of Northern Norway. Most animals displayed a good nutritional status, none were emaciated. Pulmonary nematodiasis (*Pseudalius inflexus, Halocercus invaginatus* and *Torynurus convolutus*) was found in 77% and associated with severe bronchopneumonia in 33% of the animals. The majority (92%) had parasites in the stomach and intestine (*Anisakis simplex* sensu stricto (s. s.), *Pholeter gastrophilus, Diphyllobothrium stemmacephalum*, *Hysterothylacium aduncum* and *Pseudoterranova decipiens* s. s.). The prevalence of gastric nematodiasis was 69%. In the 1st stomach compartment *A. simplex* s. s. was found in 30% of the animals, causing severe chronic ulcerative gastritis in 23%. *Campula oblonga* infected the liver and pancreas of 90% and 10% of the animals, respectively, causing severe cholangitis/pericholangitis/hepatitis in 67% and moderate pancreatitis in 10% of the animals. Mesenteric and pulmonary lymphadenitis was detected in 82% and 7% of the animals, respectively. In conclusion, the major pathological findings in the investigated Arctic porpoises were parasitoses in multiple organs with associated severe lesions, particularly in the lung, liver and stomach. The animals were generally well nourished and most showed freshly ingested prey in their stomachs. The present study indicates that the harbour porpoises were able to tolerate the detected parasitic burden and associated lesions without significant health problems. (IMR)

The 2016 and 2017 sampling program using **harbour porpoise** by-catches for scientific sampling in Norway has resulted in several other studies as well. One study used tissues from 134 porpoises to assess the genetic population structure of the species by SNP-genotyping at 78 loci. The results of genetic clustering obtained for these individuals failed to identify more than one genetic group. Likewise, the individually based F did not meet an Isolation-by-Distance pattern, thus supporting the conclusion that harbour porpoise in Norway probably belongs to a single genetic group or population. Phtalate is a synthetic organic chemical that impact flexibility and elasticity to plastics (plasticizer), and in a baseline study (based on liver samples) of phthalate metabolites in porpoises it was concluded that levels were higher in porpoises taken in waters adjacent to areas with higher human activity and populations. For some reason the occurrence profile of phtalate metabolites in porpoise liver demonstrated some similarities with human urine (piss). The authors suggested that harbour porpoises can be potentially used as tracers for plasticizers in the marine environment. Furthermore a risk assessment was made of the effects of mercury in a various of marine taxa, including also harbour porpoises. The main focus was on the Baltic Sea, comparisons with other areas were done when samples were available. Mercury concentrations in muscle of porpoises from the Baltic were classified in the no risk category. All porpoises from the Norwegian coast were in the no risk category. (IMR)

Concentrations of per- and polyfluoroalkyl substances (PFAS) were analyzed in livers of 20 **harbour porpoises** from the coast of Norway using a novel rapid method. The animals were from the by-catches in fisheries, collected and sampled by IMR in 2016 and 2017. The highest detection rates were reported for PFOS (detected in 100% of the samples), PFOSA (100%), PFDA (95%), PFUnA (95%) and PFNA (90%). The reank order of the median concentrations for those substances that were detected in most of the **harbor seals** livers were: PFOS (60.1 ng/g wet weight[ww]) > PFUnA (3.03 ng/g ww) >PFDA (2.02 ng/g ww) > PFNA (0.76 ng/g ww) > PFOSA (0.53 ng/g ww). In general, concentrations were in the same order of magnitude as reported in harbour seals sampled in 1992 and 1997 in west Iceland However, for some substances levels were lower in the Norwegian porpoises as compared to those from Iceland. (NTNU, IMR)

Norwegian shipborne line-transect surveys have revealed very high density of **harbour porpoises** in the Hardangerfjord during summer. Five CPODs (electronic listening devices designed to record porpoise vocalisations) were deployed in the Hardangerfjord from October 2020 to October 2021. Preliminary analyses indicate high vocal activity throughout the year, in particular in middle and inner parts of the fjord, and with peak activity during night. (IMR)

As part of the Arctic 2030 project on Stranded whales, UiO have analysed legacy and emerging pollutants in **humpback whales**, **sperm whale**, **harbour porpoise**, **harbour seal**, **fin whale**, **pilot whale**, **bottlenose whale**, **white beaked dolphin**, **minke whales** and **killer whales**. All animals were stranded, except minke whales that were subsampled from the hunt by IMR. The data are currently being treated and prepared for publications. So far, the results on the stranded killer whales are published. Analyses of 8 stranded killer whales revealed that 65% had high PCB concentrations, exceeding the threshold for health effects (10ug/g lipid weight). 7 of the 8 whales, including one neonate, exceeded PCB threshold for immune effects (9 ug/g lipid weight). The PCB levels in the neonate (approximately 10 days old) was comparable to adult individuals. The emerging brominated flame-retardants PBT and HBB were for the first time found in marine mammal offspring, indicating maternal transfer. Protein associated pollutants (Hg and PFAS) were low in the neonate, indicating low maternal transfer, as also seen for other marine mammals. The spread in PCB concentrations overlapped the levels previously measured in biopsies from free-ranging individuals of the same populations, meaning that there was no bias to higher pollution loads in the stranded individuals. (UiO, IMR)

One study investigated survival and abundance of **killer whales** in Norway in 1988–2019 using capture–recapture models of photo-identification data. We merged two datasets collected in a restricted fjord system in 1988–2008 (Period 1) with a third, collected after their preferred herring prey shifted its wintering grounds to more exposed coastal waters in 2012–2019 (Period 2), and investigated any differences between these two periods. The resulting dataset, spanning 32 years, comprised 3284 captures of 1236 whales, including 148 individuals seen in both periods. The best-supported models of survival included the effects of sex and time period, and the presence of transients (whales seen only once). Period 2 had a much larger percentage of transients compared to Period 1 (mean = 30% vs. 5%) and the identification of two groups of whales with different residency patterns revealed heterogeneity in recapture probabilities. This caused estimates of survival rates to be biased downward (females: 0.955 ± 0.027 SE, males: 0.864 ± 0.038 SE) compared to Period 1 (females: 0.998 ± 0.002 SE, males: 0.985 ± 0.009 SE). Accounting for this heterogeneity resulted in estimates of apparent survival close to unity for regularly seen whales in Period 2. A robust design model for Period 2 further supported random temporary emigration at an estimated annual probability of 0.148 (± 0.095 SE). This same model estimated a peak in annual abundance in 2015 at 1061 individuals (95% CI 999–1127), compared to a maximum of 731 (95% CI 505–1059) previously estimated in Period 1, and dropped to 513 (95% CI 488–540) in 2018. Our results indicate variations in the proportion of killer whales present of an undefined population (or populations) in a larger geographical region. Killer whales have adjusted their distribution to shifts in key prey resources, indicating potential to adapt to rapidly changing marine ecosystems. (NOS, UiO, NP)

Identifying mortality sources and mitigation solutions is crucial in species management and conservation. In **killer whales**, mortality events may pose a serious concern for the conservation of small discrete populations, especially if they involve entire groups. This study investigated 19 incidents involving 116 killer whales from a minimum of five populations becoming naturally entrapped in inshore areas of the North Pacific (n = 12) and North Atlantic (n = 7) oceans between 1949 and 2019. The aim was to provide an assessment of possible causal factors, lethality and human responses to these events. Site characteristics and group size identified three categories of entrapments. In *Category 1*, nine cases involved small groups of killer whales (median = 5, range: 1–9) at sites characterized by severe geographic and food constraints. Four cases in *Category 2* included larger groups (median= 14, range: 6–

19) and entrapment sites with no obvious geographic constraints but at which man-made structures could have acted as deterrents. Five cases assigned to *Category 3* involved lone, often young individuals settling in a restricted home range and engaging in interactions with people and boats. Overall, all or some of the killer whales swam out on their own after a mean of 36 d of entrapment (range: 1–172, SD = 51, *n* = 9 cases), died of nutritional/physiological stress after 58 d (range: 42–90, SD = 21, *n* = 3 cases) or of injury after 5 years of daily interactions with boat traffic (*n* = 1 case). Indication of the killer whales' declining condition or being at risk of injury, and of poor habitat quality, led to the decision to intervene in seven cases where a variety of methods were used to guide or relocate remaining individuals back to open waters after 39 d (SD = 51,range = 8–150). Monitoring protocols, which aided in identifying entrapment situations, and intervention methods which enhanced the health and survival of entrapped killer whales, were discussed in the study. (NOS, NP)

Satellite tags were deployed on **bowhead whale** in the Framstrait (N=19) in August 2021 and north of Svalbard at about 82° N (N=3) in September 2021.The tags were deployed from a helicopter with FF Kronprins Haakon as a base ship in the Framstrait and OceanX as baseship north of Svalbard. A biopsy for genetic studies was also collected from all individuals. This project is mainly funded by the Norwegian-Russian Environmental Commission in addition to internal funding. (NP)

Seven acoustic recorders (AURALs) listening for **bowhead whales**, **white whales** and **narwhals** (but also other species- and anthropogenic sounds) were served and redeployed during autumn 2021 at various locations in the Svalbard area. (NP).

Biopsies from 12 **narwhals** were collected in the drifting ice in the Framstrait from a helicopter with FF Kronprins Haakon as a base ship. These will be used for genetic and diet studies. In addition, two animals were tagged with satellite transmitters deployed from helicopter on the same cruise. (NP)

III ONGOING (CURRENT) RESEARCH

PINNIPEDS

Data for assessment of biological parameters (growth, condition, age at maturity, fertility) were collected from 400 **harp seal** females during Norwegian commercial sealing in the East Ice in 2021 – analyses are in progress. (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 progress. (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 – publication of the data is in progress. (IMR)

Tagging with satellite-based tags, **harp seals** in the White Sea - funding secured, will be attempted by Russian colleagues in April/May 2022. (IMR)

A new aerial survey to assess the pup production of **harp** and **hooded** seals will be conducted in the Greenland Sea in 2022. (IMR)

Previous studies in **hooded seals** have shown that their brain is remarkably tolerant to lack of oxygen (hypoxia). The overarching aim of our ongoing studies is to elucidate mechanisms underlying the enhanced tolerance to both hypoxia and to reactive oxygen species, in the brain of diving mammals. The current focus is to establish seal brain cell cultures in order to allow more continuous access to material for detailed cellular studies, rather than being dependent on the harvesting of fresh tissue from newly killed animals, thereby also reducing the need to cull seals for access to study material. Cell cultures will be used to assess mitochondrial function in a comparative context; both with regard to potential differences between cell types (neurons and astrocytes) in the pinniped brain and also to between-species differences, all in an attempt to identify and better understand the adaptive mechanisms that enable diving mammals to tolerate exposure to severe diving-induced hypoxia. (UIT-AMB-ACP)

Data from previous tracking studies of **Ross seals** and **harp seals** have been re-assessed in the context of climate change and possible interaction with human activities, as described in two new publications (Wege et al., 2021; Hamilton et al., 2021). (UiT-AMB-ACP)

The finding of plastic debris in the gastrointestinal system of a **hooded seal** has been reported in the scientific literature. (UiT-AMB-ACP).

Ship based counting of **harbour seals**, using electronic helicopter drones with camera, will be conducted in Southeast Norway in September 2022. (IMR)

In autumn in 2021, 5 **harbour seals** were tagged (GPS phone tags) in Norwegian Skagerrak. (IMR)

DNA samples from **harbor seal** pups were sampled in Southeast Norway. Such sampling will complement previous sampling in other areas in a project aimed to explore potential genetic segregations of harbor seals along the entire Norwegian coast. (IMR)

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

Bycatch rates and total bycatches for **harbour** and **grey seals** caught in Norwegian commercial gillnet fisheries were estimated using a stratified ratio estimator, with number of hauls as a proxy for fishing effort. Estimates were derived from data collected with a contracted reference fleet of small coastal vessels (less than 15 meters length overall) and scaled up to the whole fleet using data from national landing statistics. To address unreliable species identifications, bycatch data on both species were pooled before bycatch estimates were calculated. The relative abundances of each seal species in different coastal regions were then used to apportion total estimates into species-specific estimates. Average yearly bycatch was estimated to 757 seals (coefficient of variation CV 0.12), of which harbour seals comprised 381 (95% confidence interval CI 303 - 479) and grey seals comprised 376 (95% CI 298 – 474). (IMR)

Manuscripts on the feeding ecology, life history and ecological role of **harbour porpoises** is in preparation and will be submitted during the Spring 2022. (IMR, UiT)

Analysis of levels of legacy POPs (i.e., PCBs etc), PFAS and phthalate metabolites are being analyzed in blood samples from **grey seal** pups from the Froan breeding ground on the coast of Mid-Norway. (NTNU)

CETACEANS

Biopsies will be sampled from **minke whales** to establish a database for mark-recapture estimates based on use of the DNA register on caught minke whales (IMR).

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 2020-2025 was started in summer 2020, covering parts of the Norwegian Sea. In 2021 the program continued with surveying the Jan Mayen area – *SMA CM*. In 2022 the program will continue by covering the Barents Sea (*SMA EB*). (IMR).

Publication of ecological data (stomach contents, fatty acids, stable isotopes) from sampling of **minke whales** in 2016-2021 is in progress. (IMR, NP)

In November/December experiments aimed to test methods to avoid whales (**humpback** and **killer** whales) in purse seine fisheries were conducted in Troms. (IMR, UiT)

Whale2Sea continues the long term study on male **sperm whales**, the work includes photo identification (catalogue at present 310 individuals), sound recordings, behavioural observations and analysis of changes in seasonal distribution. Research on sperm whales depredating Greenland Halibut longline boats continues and in 2021 included cooperation with UiT involving satellite at datalogger tagging, biopsies and sound recordings. In 2021 sperm whales were observed depredating also from gillnets in May – June. A PhD study focuses on the behavioural context where clangs (also called slow clicks) are produced. With a help of newly developed software size estimates of sperm whales are analysed from the inter puls interval of the echolocation clicks, 41 individuals have been measured so far and growth rates for individually known animals sighted in different years are analysed. In a joint project with UiT and Marine Ecological Research Ltd the behavioural ecology is studied in more detail through tagging, biopsy sampling, collection of eDNA and faeces and development of new systems for acoustic detection and recording. (UiT)

Existing dive behaviour data from **humpback whales** that were tagged and tracked by UiT-AMB-AMSE (Rik ardsen) in collaboration with IMR (Biuw) is analyzed with regard to surfacing and breathing rates, as part of a MSc-project aiming to model energetics of humpback whales. Project supervision by IMR and UiT-AMB-ACP.

Behavioural data collected from **minke whales** that were attempted live-captured as part of the Norwegian Defence Research Establishment (FFI)-led SOST (US Subcommittee on Ocean Science and Technology) minke whale project form part of a MSc-project. The project aims to assess the animal welfare aspect of the live-capturing of large cetaceans, as well as the opportunities that successful capturing would give to gain new insights into the physiology of these animals. The project is co-supervised by FFI and UiT-AMB-ACP.

Baleens, sampled in previous years from **minke whales,** have been analyzed for stable isotope composition, and results evaluated with regard to feeding and migration habits, in collaboration with the University of Cambridge, UK. (UiT-AMB-ACP).

Electronic logs from reference vessels and fishery inspector logbooks were used to estimate fishing gear interaction rates for **humpback**, **minke** and **killer whales** in Norwegian fisheries from 2010 to 2020. Estimated rates were applied to fisheries data to estimate fleet-wide totals. Estimates showed that in an 11-year period, a total of 77 humpback whales (95% confidence interval CI 43 – 177) and 121 killer whales (95% CI 75 – 232) were entrapped in purse seines. Most whales were disentangled live, with an estimated mortality of 5% (CV 0.69, 0.0% – 11.8%) and 6% (CV 0.48, 95% CI 0.3% – 11.9%), respectively. In a 10-year period, 12 and 45 minke whales (95% CI 0 – 36, 0 – 139) were fatally bycaught on longlines and trawl, respectively. The average yearly mortality over the study period were thus approximately 0.67 killer whales, 0.35 humpback whales and 5.7 minke whales. Given the Potential Biological Removal sustainability limits of 98 humpbacks, 161 killer whales and 1,498 minke whales per year, it may be concluded that the average yearly mortality incurred to these whale populations by Norwegian fisheries does not constitute a significant risk to either of these species. (IMR, SSU)

Harbour porpoise bycatch for Norwegian commercial gillnet fisheries from 2006 to 2018 was estimated using a traditional ratio estimator and generalized additive linear mixed models, with weight of fish landed and number of gillnet hauls as proxies for fishing effort. Estimates were derived from data collected with a contracted reference fleet of small coastal vessels and scaled up to the whole fleet using data from landing statistics. Bycatch estimates exhibited large yearly variations, ranging from 1151 to 6144 porpoises per year. Bycatch estimates in 4 of the last 5 years were significantly less than in the preceding 2 years. The best ratio-based and model-based yearly bycatch estimates were 1580 porpoises [coefficient of variation, (C.V.) 0.10, 95% confidence interval (CI) 1302–1902] and 1642 porpoises (C.V. 0.15, 95% CI 1165–2142), respectively. About 75% of bycaught porpoises were taken in the cod (*Gadus morhua*) and monkfish (*Lophius piscatorius*) fisheries, while the rest were taken in a variety of different gillnet fisheries. Our results suggest that bycatch of harbour porpoise in Norwegian gillnet fisheries has been unsustainable for several of the last 13 years but are currently within international bycatch limits due to a recent reduction in monkfish fishing effort. (IMR)

A field trial was conducted to determine the effect of acoustic deterrent devices (ADDs, or pingers) on **harbour porpoise** and **harbour seal** bycatch in three Norwegian commercial gillnet fisheries targeting cod (*Gadus morhua*), saithe (*Pollachius virens*) and monkfish (*Lophius piscatorius*). Catch data on 3,500 net-km-days were collected by 8 fishing vessels operating gillnets in high bycatch regions over two years. A total of 20 harbour porpoises and 9 harbour seals were bycaught, with 19 harbour porpoises and 6 harbour seals taken in control (non-pingered) nets. Bycatch was modelled using a generalized additive mixed modelling approach and fitted with penalized maximum likelihood. Modelling results indicated that using pingers on gillnets reduced the risk of bycatching a harbour porpoise by an estimated 96% (95% CI 95% - 98%) compared to ordinary pinger-free nets. The effect of pingers was not significantly different between different fisheries. The pingers also had no significant effect on catch rates of fish (Wilcoxon rank sum test, $p = 0.24$) or harbour seals (Wilcoxon rank sum test, p = 0.19). Self-reported pinger-associated extra time costs on day-to-day fishing operations were low, averaging about 2.8 minutes per operation. These results add to a growing body of scientific evidence that pingers can lead to substantial reductions in harbour porpoise bycatch rates in gillnet fisheries, and that extra time costs associated with operating nets with pingers are low. (IMR)

Analysis of material (blubber, kidney, liver, muscle) from the by-caught **harbor porpoises** collected by IMR is continuing in order to analyze for levels of emerging contaminants not analyzed for previously. In addition samples collected by IMR around year 2000 will be analyzed in order to investigate if there have changes in the presence and levels of these compounds. (NTNU)

As part of the new Norwegian Research Council project “MULTIWHALE - Effects of multiple stressors on Norwegian **killer whales**” UiO aim to quantify the cumulative effects of multiple anthropogenic stressors on the health, demographics and trend of an ecologically structured killer whale population in Norway. The project started in 2021, including field season in both 2020 and 2021 with sampling of biopsies from identified killer whales for pollution effect and detailed dietary studies. (UiO)

IV ADVICE GIVEN AND MANAGEMENT MEASURES TAKEN

Sealing

<u>Harp and hooded seals</u>
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 2-6 September 2019 at IMR in the Fram Centre in Tromsø, Norway, to assess the status and harvest potential of stocks of Greenland Sea harp and hooded seals and harp seals in the White Sea. New advice was given formally by ICES 31 October 2019, based on the report from the 2019 WGHARP meeting. The Joint Norwegian-Russian Fisheries Commission used the advice from ICES to establish management advice for 2022.

The basis for the advice was a request from Norway in October 2018 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. PBR was developed by the United States for the management of marine mammals, primarily for use to assess sustainability in bycatches.

The 2018 pup production estimate for **Greenland Sea harp seals** is significantly lower than the previous survey estimates and represents an apparent drop of almost 40% from 2012. Using a combination of mark-recapture based (1983-1991) and aerial survey based (2002-2018) pup production estimates, the assessment model suggests a current (2019) abundance of the total Greenland Sea harp seal stock which is 426.808 (95% C.I. 313.004-540.613) animals. There is considerable uncertainty in the mark-recapture (MR)-based pup production estimates used in the model, and ICES suggested that the impact of using only the aerial survey estimates (including also a survey estimate from 1991) should be explored. ICES also raised concerns regarding the reliability of some of the reproductive parameters that have been measured at sparse intervals throughout the time period from 1946 to the present. To explore the impact of using different reproductive data, the group suggested that the model be run with fecundity fixed at the long-term mean from all sampling, (F=0.84), and with maturity curves being combined to a single curve representing the mean maturity throughout the time period. The final set of models considered were therefore:

1) All pup production estimates included (except the aerial survey estimate from 1991). This is similar to all past assessments.
2) Pup production estimates from aerial surveys only (including 1991);
3) Same as scenario 2), with constant F=0.84 and a single maturity curve.

The three runs resulted in some differences in estimated population trajectories, but the estimates of the 2019 population size were relatively consistent between runs.

In ICES terminology the Greenland Sea harp seal population is data rich. Nevertheless, given the apparent significant drop in pup production between the 2012 and 2018 surveys, the unexplained variability in the MR estimates, the poor fit of the model to all historical pup production estimates, and the subsequent uncertainty regarding model-based trajectories and projections, the conclusion by ICES was that management recommendations for this population should not be based on model projections at this stage. Because the model estimates of current population size were very similar and appeared to be robust to the assumptions of the various runs, ICES suggested that catch options should be based on the estimate of current pup and adult population sizes through the PBR framework. Given the very small difference in estimated current population size irrespective of model run, and similarity between PBR estimates based on these population estimates, ICES suggested that the PBR based on the averaged population estimates (and associated averaged CVs), be used when providing catch scenarios. Using the traditional PBR approach in this way, removals were estimated to be 11.548. Using a multiplier to convert age 1+ animals to pups is inappropriate for the PBR removals.

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 decided to continue to use the model which estimated a total 2019 abundance of 1.497.190 (95% C.I. 1.292.939-1.701.440). The modelled total population indicates that the abundance decreased from its highest level in 1946 to the early 1960s, where after an increase has prevailed. Current level is 74% of the 1946 level. The last available information about the reproductive potential for this population is new and based on data from 2018. But the last pup production estimate is from 2013, i.e., more than 5 years old, and the population is considered “data poor”. In such cases ICES recommend use of the PBR approach to estimate catch quotas. Given the uncertainty regarding the current status of this population, ICES suggest the application of a more conservative PBR approach in which the upper limit for removals were estimated to be 21.172 seals. Using a multiplier to convert age 1+ animals to pups is inappropriate for the PBR removals.

Results from the most recent (2018) pup survey suggest that current **Greenland Sea hooded seal** pup production remains at the same very low level as in 2012, 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 N30 (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 2019 total population of 76.623 (95% C.I. 58.299-94.947). Following the Precautionary harvest strategy and the fact that the population is below N_{lim}, ICES suggest 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 2022 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.

Suggested quotas in 2022 for **harbor seals** in Norway are 268 animals. For **grey seals** a quota of 200 animals, distributed with 60 in Rogaland (southern Norway) and 140 in Troms and Finmark (northern Norway), is recommended. Due to a severe reduction in pup production in recent years, no grey seal hunt is allowed in Trøndelag and Nordland (mid Norway) in 2022.

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 in lieu of the current Moratorium. 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 the Norwegian application of the RMP, a tuning level (long-term target) of 0.60 has been used in recent years.

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 2021 the total catch quota, including transfers, was set to 1278 minke whales. This was the same as the quotas set for each of the years 2018 - 2020. The catching season opens April 1 and are closed medio September. The guidelines for sightings surveys are established by IWC Scientific Committee and distance and angle experiments are routinely conducted as part of the surveys with the aim of estimating bias and variability in measurement error (ME). A simulation-based correction method has previously been applied to the abundance estimates; however, the isolated effect of distance and angle ME was not explicitly quantified. For the challenge, multiplicative/additive ME error models were considered. The approach confirmed that the abundance estimates obtained by taking ME into account are consistently larger than the abundance estimates without ME correction (Solvang et al. 2021).

Bycatch

Based on the about 96% reduction of **harbour porpoise** bycatch in the pinger trials (see Bycatch Mitigation under Item III), the Norwegian Marine Mammal Scientific Advisory Board recommended pingers be mandatory in the gillnet fishery for cod (*Gadus morhua*) in Vestfjorden. The Norwegian Ministry for Trade, Industry and Fisheries made pingers mandatory in Vestfjorden from January 1st to April 30th 2021. The pinger mandate is continued in 2022. Initial evaluations indicated a number of problems (eg water intrusion and damage to the outer housing) with the pingers when they were applied to a commercial fishery and the efficacy to reduce porpoise bycatch was less than demonstrated in the trials.

V PUBLICATIONS AND DOCUMENTS

Peer reviewed

Ahonen, H., Stafford, K. M., Lydersen, C., Berchok, C. L., Moore, S. E. & Kovacs, K. M. 2021. Inter-annual variability in acoustic detection of blue and fin whale calls in the Northeast Atlantic High Arctic between 2008 and 2018. Endangered Species Research 45: 209-224.

Andersen, M., Lydersen, C. & Kovacs, K. M. 2021. Stable ringed seal (*Pusa hispida*) demography despite significant habitat change in Svalbard, Norway. Polar Research 40, art. no. 5391: 1-14. https://doi.10.33265/polar.v40.5391

Andvik, C., Jourdain, E., Lyche, J.L., Karoliussen, R. & Borgå, K. 2021. High Levels of Legacy and Emerging Contaminants in Killer Whales (*Orcinus orca*) from Norway, 2015 to 2017. Environmental Toxicology and Chemistry 40: 1848-1858. https://doi.org/10.1002/etc.5064

Aoki, K., Isojunno, S., Bellot, C., Iwata, T., Kershaw, J., Akiyama, Y., López, L.M.M., Ramp, C., Biuw, M., Swift, R., Wensveen, P.J., Pomeroy, P., Narazaki, T., Hall, A., Sato, K., & Miller, P.J.O. 2021. Aerial photogrammetry and tag-derived tissue density reveal patterns of lipid-store body condition of humpback whales on their feeding grounds. Proceedings of the Royal Society B 288: 20202307. https://doi.org/10.1098/rspb.2020.2307

Bachmann, L., Cabrera, A. A., Heide-Jørgensen, M. P., Shpak, O. V., Lydersen, C., Wiig, Ø & Kovacs, K. M. 2021. Mitogenomics and the genetic differentiation of contemporary *Balaena mysticetus* (Cetacea) from Svalbard. Zoological Journal of the Linnean Society 191: 1192-1203.

Baines, M., Kelly, N., Reichelt, M., Lacey, C., Pinder, S., Fielding, S., Murphy, E., Trathan, P., Biuw, M., Lindstrøm, U., Krafft, B.A. & Jackson, J.A. 2021. Population abundance of recovering humpback whales *Megaptera novaeangliae* and other baleen whales in the Scotia Arc, South Atlantic. Marine Ecology progress Series 676: 77-94. https://doi.org/10.3354/meps13849

Bengtsson, O., Hamilton, C.D., Lydersen, C., Andersen, M. & Kovacs, K.M. 2021. Distribution and habitat characteristics of pinnipeds and polar bears (*Ursus maritimus*) around the Svalbard Archipelago, based on observations from 2005-2018. Polar Research 40, art. no. 5326: 1-20. https://doi.10.33265/polar.v40.5326

Benti, B., Miller, P.J.O., Biuw, M. & Curé, C. 2021. Indication that the behavioural responses of humpback whales to killer whale sounds are influenced by trophic relationships. Marine Ecology Progress Series 660: 217-232. https://doi.org/10.3354/meps13592.

Bilgmann, K., Armansin, N., Ferchaud, A.L., Normandeau, E., Bernatchez, L., Harcourt, R., Ahonen, H., Lowther, A., Goldsworthy, S.D. and Stow, A. 2021. Low effective population size in the genetically bottlenecked Australian sea lion is insufficient to maintain genetic variation. Animal Conservation 24: 847–861.

Bjørge, A. & Haug, T. 2021. In memory of Dr. Seiji Ohsumi. Cetacean Population Studies 3: 3.

Blanchet, M-A**,** Vincent C., Womble J., Steingass S. & Desportes G. 2021. Harbour seals: population structure, status, and threats in a rapidly changing environment. Oceans 2: 41-63.

Cleary, A.C., Hoffman, J.I., Forcada, J., Lowther, A.D., Lydersen, C. and Kovacs, K.M. 2021. 50,000 years of ice and seals: demographic impacts of the Last Glacial Maximum on Antarctic fur seals. Ecology and Evolution 11: 14003-14011.

Cunen, C., Walløe, L., Konishi, K. & Hjort, N.L. 2021. Decline in the body condition in the Antarctic minke whale (*Balaenoptera bonarensis*) in the Southern Ocean during the 1990s. Polar Biology 44: 259-273. https://doi.org/10.1007/s00300-020-02783-3

de la Vega, C., Mahaffey, C., Tuerena, R.E., Yurkowski, D.J., Ferguson, S.H., Stenson, G.B., Nordøy, E.S., Haug, T., Biuw, M., Smout, S., Hopkins, J., Tagliabue, A., & Jeffreys, R.M. 2021. Arctic seals as tracers of environmental and ecological change. Limnology and Oceanography Letters 6: 24-32. https://doi.10.1002/lol2.10176.

Eerkes-Medrano, D., Aldridge, D. & Blix, A.S. 2021. North Atlantic minke whale (*Balaenoptera acutorostrata*) feeding habits and migrations evaluated by stable isotope analysis of baleen. Ecology and Evolution 11 (22): 16344-16353. https://doi.org/10.1002/ece3.8224

Goldsworthy, S. D., Shaugnessey, P. D., Mackay, A. I., Bailleul, F., Holman, D., Lowther, A. d., page, B., Waples, K., Raudino, H., Bryars, S. & Anderson, T. 2021. Assessment of the status and trends in abundance of a coastal pinniped, the Australian sea lion *Neophoca cinerea*. Endangered Species Research 44: 421-437.

Gonzalez, A. P., Kovacs, K. M., Lydersen, C., Ims, R. & Lowther, A. D. 2021. Drones and marine mammals in Svalbard, Norway. Marine Mammal Science 37: 1212-1229.

Hamilton, C.D., Lydersen, C., Aars, J., Biuw, M., Boltunov, A.N, Born, E.W., Dietz, R., . Folkow, L.P., Glazov, D.M, Haug, T., Heide-Jørgensen, M.P., Kettemer, L.E., Laidre, K.L. Øien, N., Nordøy, E.S., Rikardsen, A.H., Rosing-Asvid, A., Semenova, V., Shpak, O.V., Sveegaard, S., Ugarte, F., Wiig, Ø., Kovacs, K.M. 2021. Marine mammal hotspots in the Greenland and Barents Seas. Marine Ecology Progress Series 659: 3-28. https://doi.org/10.3354/meps13584

Haug, T., Biuw, M., Gjøsæter, H., Knutsen, T., Lindstrøm, U., MacKenzie, K., Meier, S. & Nilssen, K.T. 2021. Harp seal body condition and trophic interactions with prey in Norwegian high Arctic waters in early autumn. Progress in Oceanography 191: 102498. https://doi.org/10.1016/j.pocean.2020.102498

Iwata, T., Biuw, M., Aoki, K. & Miller, P.J.O. 2021. Using an omnidirectional video logger to observe the underwater life of marine mammals: Humpback whale resting behaviour. Behavioural Processes 186: 104369. https://doi.org/10.1016/j.beproc.2021.104369

Jourdain, E., Goh, T., Kuningas, S.,Similä, T., Vongraven, D., Karoliussen, R., Bisther, A., & Hammond, P. S. 2021. Killer whale (*Orcinus orca*) population dynamics in response to a period of rapid ecosystem change in the eastern North Atlantic. Ecology and Evolution, 00, 1–18. https://doi.org/10.1002/ece3.8364

Jourdain, E., Barrett-Lennard, L.G., Ellis, G.M., Ford, J.K.B., Karoliussen, R., Towers, J.R. & Vongraven, D. 2021. Natural Entrapments of Killer Whales (*Orcinus orca*): A Review of Cases and Assessment of Intervention Techniques. Frontiers in Conservation Science 2:707616. https://doi.10.3389/fcosc.2021.707616

Kershaw, J.L., de la Vega, C., Jeffrey, R.M., Frie, A.K., Haug, T., Mahaffey, C., Mettam, C., Stenson, G., Smout, S. 2021. Compound-specific isotope analyses of harp seal teeth: tools for trophic ecology reconstruction. Marine Ecology Progress Series, 678: 211–225. https://doi.org/10.3354/meps13867

Kovacs, K. M., Citta, J., Brown, T., Dietz, R., Ferguson, S., Harwood, L., Houde, M., Lea, E. V., Quakenbush, L., Riget, F., Rosing-Asvid, A., Smith, T. G., Svetochev, V., Svetocheva, O. & Lydersen, C. 2021. Variation in body size of ringed seals (*Pusa hispida hispida*) across the circumpolar Arctic: evidence of morphs, ecotypes or simply extreme plasticity? Polar Research 40, art. no. 5753. https://doi.10.33265/polar.v40.5753

Kovacs, K.M., Romano, T.A., Reeves, R.R., Hobbs, R.C., Desportes, G., Brennan, R. & Castellote, M., 2021. Introduction - Special Cluster—Beluga whales (*Delphinapterus leucas*): knowledge from the wild, human care and TEK. Polar Research 40, art. no. 8235. https://doi.org/10.33265/polar.v40.8235.

Koen-Alonso, M., Lindstrøm, U. & Cuff, A. 2021. Comparative Modeling of Cod-Capelin Dynamics in the Newfoundland-Labrador Shelves and Barents Sea Ecosystems. Frontiers in Marine Science 8:579946. https://doi.10.3389/fmars.2021.579946

Kunisch, E.H., M. Graeve, M., Gradinger, R., Haug, T., Kovacs, K.M., Lydersen, C., Varpe, Ø & Bluhm, B.A. 2021. Ice-algal carbon supports harp and ringed seal diets in the European Arctic: evidence from fatty acid and stable isotope markers. Marine Ecology Progress Series 675: 181-197. https://doi.org/10.3354/meps13834

Llobet, S. M., Ahonen, H., Lydersen, C., Jørgen Berge, J., Ims, R. & Kovacs, K. M. 2021. Bearded seal (*Erignathus barbatus)* vocalizations across seasons and habitat types in Svalbard, Norway. Polar Biology 44: 1273-1287.

Lydersen, C. & Kovacs, K. M. 2021. A review of the ecology and status of white whales (*Delphinapterus leucas*) in Svalbard, Norway. Polar Research 40, art. no. 5509: 1-13. https://doi.10.33265/polar.v40.5509

Martins, S., Aniceto, S.A., Ahonen, H., Pedersen, G., & Lindstrøm, U. 2021. Humpback whale (*Megaptera novaeangliae*) song on a subarctic feeding ground. *Front.Mar.Sci.* https://doi.10.3389/fmars.2021.669748

McMahon, C., Roquet, F., Baudel, S., Belbeoch, M., Bestley, S., Blight, C., Boehme, L., Carse, F., Costa, D.P., Fedak, M., Guinet, C., Harcourt, R., Heslop, E., Hindell, M.A., Hoenner, X., Holland, K., Holland, M., Jaine, F.R.A., du Dot, T.J., Jonsen, I., Keates, T.R., Kovacs, K.M., Labrousse, S., Lovell, P., Lydersen, C., March, D., Mazloff, M., McKenzie, M.K., Muelbert, M.M.C., O' Brien, K., Phillips, L., Portela, E., Pye, J., Rintoul, S., Sato, K., Tsontos, V.M., Turpin, V., Sequeira, A.M.M., Simmons, S., van Wijk, E., Vo, D., Wege, M., Whoriskey, F., Wilson, K. & Woodward, B. 2021. Animal Borne Ocean Sensors – AniBOS – a complementary and essential component of the Global Ocean Observing System (GOOS). Frontiers in Marine Science 8**:** 751840. https://doi.10.3389/fmars.2021.751840

Pedersen, T., Mikkelsen, N., Lindstrøm, U., Renaud, P.E., Nascimento, M.C., Blanchet, M.-A., Ellingsen, I.H., Jørgensen, L.L. & Blanche, H. 2021. Overexploitation, Recovery, and Warming of the Barents Sea Ecosystem During 1950–2013. Frontiers in Marine Science 8:732637. https://doi:10.3389/fmars.2021.732637

Pinzone, M., Nordøy, E.S., Eppe, G., Malherbe, C., Das, K. & Collard, F. 2021. First record of plastic debris in the stomach of a hooded seal pup from the Greenland Sea. Marine Pollution Bulletin 167:112350

Routti, H., Harju, M., Lühmann, K., Aars, J., Ask, A., Goksøyr, A., Kovacs, K. M. & Lydersen, C. 2021. Concentrations and endocrine disruptive potential of phthalates in marine mammals from the Norwegian Arctic. Environment International 152, art. No. 106458, 1-10. https://doi.10.1016/j.envint.2021.106458

Ryeng, K.A., Lakemeyer, J., Roller, M., Wohlsein, P. & Siebert, U. 2021. Pathological findings in bycaught harbour porpoises (*Phocoena phocoena*) from the coast of Northern Norway. Polar Biology: https://doi.org/10.1007/s00300-021-02970-w

Ryeng, K.A. & Larsen, S.E. 2021. The relative effectiveness of two expanding bullet designs in young harp seals (*Pagophilus groenlandicus*): A randomised controlled field study in the Norwegian harp seal hunt. Animal Welfare 30: 155-167. https://doi.10.7120/09627286.30.2.155

Sivel, E.M., Planque, B., Lindstrøm, U. & Yoccoz, N.G. 2021. Multiple configurations and fluctuating trophic control in the Barents Sea food-web. PLOS ONE 16 (7). ISSN 1932-6203.s doi: 10.1371/journal.pone.0254015.

Skovrind, M., Louis, M., Westbury, M. V., Garilao, C., Kaschner, K., Castruita, J. A. S., Gopalakrishnan, S., Knudsen, S. W., Haile, J. S., Dalen, L., Meshchersky, I. G., Shpak, O. V., Glazov, D. M., Rozhnov, V. V., Litovka, D. I., Krasnova, V. V., Chernetsky, A. D., Belkovich, V. M., Lydersen, C**.,** Kovacs, K. M., Heide-Jørgensen, M. P., Postma, L., Ferguson, S. H. & Lorenzen, E. D. 2021. Circumpolar phylogeography and demographic history of beluga whales reflect past climatic fluctuations. Molecular Ecology 30: 2543-2559.

Solvang, H.K., Haug, T., Knutsen, T., Gjøsæter, H., Bogstad, B., Hartvedt, S., Øien, N. & Lindstrøm, U. 2021. Distribution of rorquals and Atlantic cod in relation to their prey in the Norwegian high Arctic. Polar Biology 44: 361-382. https://doi.org/10.1007/s00300-021-02835-2.

Solvang, H.K., Skaug, H.J. & Øien, N. 2021. Consideration of measurement errors for the Norwegian common minke whale (*Balaenoptera acutorostrata acutorostrata*) surveys. Journal of Cetacean Research and Management 22: 1-16.

Trimmel, S., Vike-Jonas, K., Villa Gonzalez, S., Ciesielski, T.M., Lindstrøm, U., Jenssen, B.M. & Asimakopoulos, A. 2021. Rapid determination of per- and polyfluoroalkyl substances (PFAS) in harbour porpoise liver tissue by HybridSPE (R)-UPLC (R)-MS/MS. Toxics 9, 183. https://doi.org/10.3390/toxics9080183.

Tryland, M. Lydersen, C., Kovacs, K. M., Rafter, E. & Thoresen, S. T. 2021. Serum biochemistry and haematology in wild and captive bearded seals (*Erignathus barbatus*) from Svalbard, Norway. Acta Veterinaria Scandinavia 63, art. 33. https://doi.10.1186/s13028-021-00598-8

Vacquié-Garcia, J., Lydersen, C., Lydersen, E., Christensen, G. N., Guinet, C. & Kovacs, K. M. 2021. Seasonal habitat use of a lagoon by ringed seals (*Pusa hispida*) in Svalbard, Norway. Marine Ecology Progress Series 675: 153-164.

Vogel, E.F., Biuw, M., Blanchet, M.-A., Jonsen, I.D., Mul, E., Johnsen, E., Hjøllo, S.S., Olsen, M.T., Dietz, R. & Rikardsen, A. 2021. Killer whale movements on the Norwegian shelf are associated with herring density. Marine Ecology Progress Series 665: 217-231. https://doi.org/10.3354/meps13685

Wege, M., Bornemann, H., Blix, A.S., Nordøy, E.S., Biddle, L. & Bester, M.N. 2021. Distribution and habitat suitability of Ross seals in warming ocean. Frontiers in Marine Science 8:659430 https://doi.org/10.3389/fmars.2021.659430

Others

Bjørge, A., Moan, A., Ryeng, K.A., and Wiig, J.R. 2021. Estimates of humpback (*Megaptera novaeanglia*) minke (*Balaenoptera acutorostrata*) and killer (*Orcinus orca*) whale fishing gear interactions in Norwegian fisheries suggest low anthropogenic mortality. IWC SC/68C/HIM/13. 13 p.

Chambault, P., Kovacs, K.M., Lydersen, C., Shpak, O., Teilmann, J., Albertsen, C.M. & Heide-Jørgensen, M.P. 2021. Arctic whales in warming waters: demographic and behavioural consequences? 7th Int. Bio-Logging Symp**.** Honolulu, Hawaii, 18-22 Oct. 2021**.**

Ciccone, C., Kante, F., Hazlerigg D.G., Folkow, L. West, A.C., Wood, S.H. 2021. Circadian clockwork and mitochondrial metabolism in a diving mammal: clues to hypoxia tolerance? – Scandinavian Physiological Society, Annual meeting, September 2021, Stockholm, Sweden.

Elnes, J.O. 2021. Predicted times and areas of interaction risk between harbour seals and coastal gillnet fisheries in Norway. MSC thesis, Dept. of Biosciences, University of Oslo.

Kante, F. 2021. Characterization of the circadian clock in Hooded Seals (*Cystophora cristata*) and its interaction with mitochondrial metabolism. A multi-tissue comparison and cell culture approach. Master of Science thesis, UiT – the Arctic University of Norway.

Kovacs, K.M., Belikov, S., Boveng, P., Desportes, G., Ferguson, S., Hansen, R., Laidre, K., Stenson, G., Thomas, P., Ugarte, F. & Vongraven, D. 2021. 2021 State of the Arctic Marine Biodiversity Report (SAMBR) Summary Report - Update: 2021 State of the Arctic Marine Biodiversity Report (SAMBR) Update: Marine Mammals. Conservation of Arctic Flora and Fauna International Secretariat: Akureyri, Iceland.

Lydersen, C., Ahonen, H., Kovacs, K. M., Øien, N., Vacquie-Garcia, J., Guinet, C. & Heide-Jørgensen, M. P. 2021. Fin whales in Svalbard: where do they go in the winter? Fram Forum 2021**,** Research Notes: 68-71.

Lydersen, C., Heide-Jørgensen, M. P., Blanchet, M.-A. & Kovacs, K. M. 2021. Narwhal in north-east Greenland – observations, biopsies and satellite tagging (from helicopter). NAMMCO Scientific Committees "Ad Hoc Working Group on Narwhal in East Greenland", 25-29 Oct. 2021, Copenhagen. NAMMCO SC/28/NEGWG/05. 8 pp.

MacKenzie, K. M., Lydersen, C., Haug, T., Routti, H., Aars, J., Andvik, C. M., Borgå, K., Fisk, A. T., Biuw, M., Lowther, A. D., Lindström, U. & Kovacs, K. M. 2021. Marine mammal ecological niches in the European Arctic. IsoEcol 2021. Covid Interluded 11th International Conference on the Applications of Stable Isotope Techniques to Ecological Studies, Virtual Meeting, May 19-21, 2021.

Moan, A. & Bjørge, A. 2021. Bycatch of coastal seals in Norwegian gillnet fisheries conducted by coastal fishing vessels. NAMMCO SC/28/BYCWG/04.

Moan, A. & Bjørge, A. 2021. Pinger trials in Norwegian commercial fisheries confirm that pingers reduce harbour porpoise bycatch rates and demonstrate low level of pinger-associated negative impacts on day-to-day fishing operations. IWC SC/68C/HIM/02. 13 p.

Øien, N. 2021. Report of the Norwegian 2020 survey for minke whales within the Small Management Area EW – Norwegian Sea. SC/68C/ASI/06. 10 pp.

Pedersen, A.E. 2021. The metabolism of lean and fat hooded seal pups (*Cystophora cristata*). How fat contributes to the total metabolic rate. Master of Science thesis, UiT – the Arctic University of Norway.

Routti, H., Luhmann, K., Kovacs, K. M., Lydersen, C., Harju, MJ. & Goksøyr, A. 2021, Pollutants in ocean's giants. Fram Forum 2021, Research Notes: 126-129.

Solvang, K.K., Skaug, H.J. and Øien, N. 2021. Abundance of common minke whales in the Northeast Atlantic based on survey data collected over the period 2014-2019. IWC SC/68C/ASI/04. 11 pp.

Søreide, J.E., Pitusi, V., Vader, A., Damsgård, B., Nilsen, F., Skogseth, R., Poste, A., Bailey, A., Kovacs, K.M., Lydersen, C., Gerland, S., Decamps, S., Strøm, H., Renaud, P.E., Christensen, G., Arvnes, M.P., Moiseev, D., Singh, R.K., Bélanger, S., Elster, J., Urbański, J., Moskalik, M., Wiktor, J. & Węsławski, J.M. 2021. Ecosystems in transition: how to monitor changes in coastal environments in Svalbard? Svalbard Science Conference 01-04 November, Oslo, Norway.

Wassmann, P., Biuw, M. and Haug, T. 2021. A critical evaluation of whales as ecosystem engineers. IWC SC/68C/EM/02.20 pp.

VI DATA REPORTING TO NAMMCO COMMITTEES

Sealing

Harp and hooded seals

Due to the uncertain status for Greenland Sea (West Ice) hooded seals, no animals of the species were permitted taken in the ordinary hunt operations in 2021. The 2021 catch volume for harp seals in the Greenland Sea was set at 11,548 animals of all ages. However, no Norwegian or Russian seal vessels hunted in the Greenland Sea in 2021. Only 16 hooded seals (whereof 12 were pups) and 10 harp seals (whereof 5 were pups) were taken for research purposes by Norwegian scientists. (Table VI.I).

Table VI.1. Norwegian catches of harp and hooded seals in 2021. 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	5	5	10	49	5012	5061
Hooded seals	12	4	16			

The last ICES recommendation (from 2019) for catch of harp seals in the White and Barents Sea was set at 21,172 animals of all ages. The 50th Joint Norwegian-Russian Fisheries Commission (JNRFC) supported this ICES recommendation for 2021 and Russia alloted 7,000 harp seals to Norway for removals. A ban implemented on all pup catches prevented Russian hunt in the White Sea during the period 2009-2013. Despite this ban being removed before the 2014 season, there have been no commercial Russian harp seal catches in the White Sea in 2015-2021. One Norwegian vessel, hunting in the southeastern Barents Sea (the East Ice) in 2021, took a total of 5061 (including 49 pups) harp seals of which 23 were reported as struck-and-lost.

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 2010-2020, annual harbor seal quotas ranged between 425 and 485 animals, while annual catches were 159-511 harbor seals. In 2021, the quota was 257 harbor seals and 238 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 and 200 animals in 2018-2020. Annual catches were 19-216 grey seals in 2012-2020. In 2021, the catch quota was again 200 animals and 29 grey seals were taken.

Additional hunt on the Norwegian coast in 2021 include 3 ringed seals and 1 harp seal shot in North Norway.

Seals in Svalbard
In 2003-2020, total annual **ringed seal** catches in Svalbard ranged between 15 and 78 animals. In 2021, 64 ringed seals were taken in the hunt.

The number of **bearded seals** taken annually in Svalbard in 2003-2020 ranged between 2 and 34 animals, and the number taken in the 2021 hunt was 30 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 *Small Management Areas (SMA)*. 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, 14 vessels participated in the 2021 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 2021 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 2021 season was 577 whales but not yet officially confirmed and the quota for 2021 was set to 1278 minke whales, including transferred unused catch options in the E area.

Table VI.2. Quotas and catches of minke whales in 2021 by management area as defined in RMP.

2021	Management area					
Small-type whaling	EB	EN	ES	EW	CM	Total
Catch	374	39	103	61	0	**577**
Quota	1108				170	1278
Stock area	Eastern				Central	