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NORWAY - PROGRESS REPORT ON MARINE MAMMALS 2023

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I. INTRODUCTION

This report summarises the bulk of Norwegian research on pinnipeds and cetaceans conducted in 2023 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 (NPI): 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
- University of Oslo (UiO): www.uio.no
- Akvaplan-niva (APN): www.akvaplan.niva.no
- Directorate of Fisheries, Sea Surveillance Unit (SSU): www.fiskeridir.no
- Norwegian Orca Survey (NOS): www.norwegianorcasurvey.com
- Whale2Sea (W2S): www.whale2sea.no
- Norwegian Defence Research Establishment (FFI): www.ffi.no

II RESEARCH BY SPECIES 2023

PINNIPEDS

No UiT research cruise was conducted in 2023. However, research on the physiology of **hooded seals** from the Greenland Sea stock has been continued based on animals/samples collected in previous years (UiT-AMB-ACP).

In the period 18–30 March 2022, reconnaissance and aerial surveys were performed in the Greenland Sea pack-ice (the West Ice), to assess the pup production of the Greenland Sea populations of **harp** and **hooded seals**. One fixed-wing aircraft, stationed in Akureyri (Iceland), was used for reconnaissance flights and photographic surveys along-transects over the whelping areas. A helicopter, operated from the expedition vessel (Research Icebreaker Kronprins Haakon) also flew reconnaissance flights, and was subsequently used for monitoring the distribution of seal patches and age-staging of the pups. Reconnaissance surveys were flown by the helicopter (18–22 March). Due to poor weather conditions, the first reconnaissance flight with the fixed-wing aircraft was delayed until the 25 March, when it managed to cover the region from 71°30'N / 17°47'W in the northeast, to 70°00'N / 19°54'W in the southwest. As was observed in 2018, the ice cover was narrow and the edge closer to the Greenland coast compared to previous survey years. The reconnaissance surveys were adapted to the actual ice configuration, usually flown at altitudes ranging from 160–300 m, depending on weather conditions. Repeated systematic east-west transects with a 10 nm spacing (sometimes 5 nm) were flown from the eastern ice edge and usually 20–30 nautical miles (sometimes longer) over the drift ice to the west.

On 28 March, two photographic surveys were flown to cover the entire whelping patch area which was a little more than 86 nm in south-north direction. Due to limited fuel capacity of the aircraft, the spacing between transect lines was ~3nm. In total, 2492 photos were taken during the surveys. Pup staging surveys were carried out on March 22nd, 23rd, 25th, 28th and 30th. The model achieved a good fit to the observed recalculated stages based on the staging surveys. For harp seals, this resulted in an estimated correction factor of 0.99 for the day of the photographic surveys, suggesting that only about 1% of all pups born may have been unavailable for photography. For hooded seals, the corresponding correction factor was 0.86, suggesting roughly 14% of pups would have been missed during aerial surveys. These correction factors were used to scale the pup production estimates. The corrected pup production estimates were 92,769 (CV = 20.2%) for harp seals. The harp seal pup production estimate is significantly higher than the 2018 estimate, and similar to that based on the 2012 survey (89,590; CV = 13.7%). For hooded seals, the corrected 2022 estimate was 13,509 (CV=12.9%). This is slightly but not significantly higher than the 2018 estimate. (IMR)

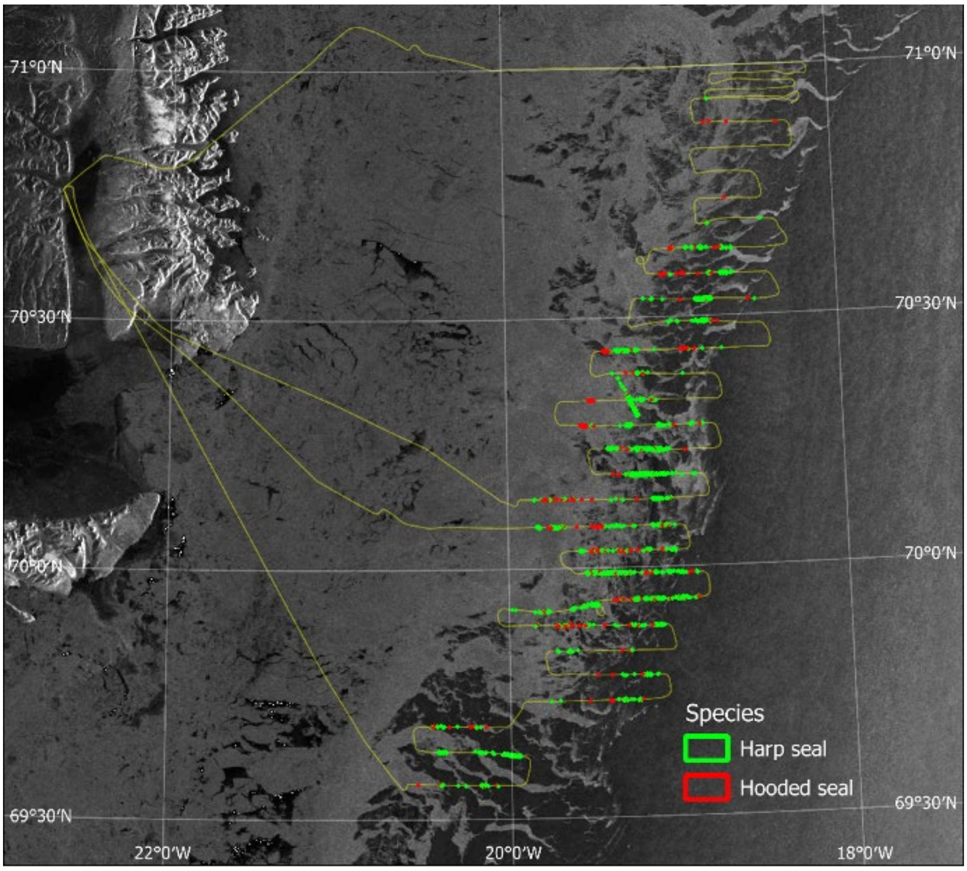

Photo surveys in the West Ice on March 28 in 2022 overlaid on a satellite image of ice conditions during that same date. The thin yellow line represents the flight path, and aerial images were taken along the straight E/W transect lines. Green and red markers represent respectively harp and hooded seals.

Estimates of pup production of **harp** and **hooded seals** are based primarily on photographic surveys, which are time-consuming to analyze manually. Software-based automatic detection methodology using artificial intelligence (deep learning) is being developed through a collaboration between the Norwegian Computing Center, Institute of Marine Research, Norway and Fisheries and Oceans, Canada. Deep learning has revolutionized image analysis in recent years in terms of its ability to extract content and information from images. Using the Faster R-CNN object detection architecture, we have applied to the photographs acquired on the West Ice 2022 survey. The detector was pre-trained on data from the surveys in Canada 2008, 2012 and 2017 and West Ice in 2007, 2012 and 2018, and then fine-tuned on the assigned calibration images (250 images where 84 of them contained seal pups). We counted a total of 2 688 harps seal pups and 280 hooded seal pups on the 2719 images obtained from the 29 transects. This resulted in an estimated pup production of 87 263 (SE 16 216) harps and 8 958 (SE 1 280) hoods, without correcting for pup staging. In general, the automatic abundance estimation was quite good, at least for harp seals. However, a pretrain-then-finetune approach was necessary to obtain an acceptable performance. (NCC, IMR)

Data for assessment of biological parameters (growth, condition, age at maturity, fertility) were collected from 176 **harp seal** females during Norwegian commercial sealing in the West Ice in 2019. Preliminary results show that mean age at maturity (MAM) for this sample was estimated at 6.4 years, which was almost identical to the MAM of 6.2 (±0.3 SD) years estimated for the previous sample collected in 2014. The pregnancy rate estimated for the 2019 sample was 0.85 (0.04 SD) and thus nominally a bit lower than the 2014 estimate of 0.91 (0.03 SD). These estimates are based on presence/absence of a large, luteinized *corpus albicans* in post-breeding females and thus pertain to the pregnancy rate in the reproductive cycle prior to capture. The pregnancy rate estimated for 2019 was based on 96 parous females. (IMR)

Data for assessment of biological parameters (growth, condition, age at maturity, fertility) were collected from 306 **harp seal** females during Norwegian commercial sealing in the East Ice in 2021. Preliminary information show that mean age at maturity (MAM) for this sample was estimated at 6.6 years, which was close to the MAM of 6.9 (±0.5 SD) years estimated for the previous sample collected in 2018. The pregnancy rate estimated for the 2021 sample was 0.72 (0.03 SD), which was significantly lower than the 2018 estimate of 0.91 (0.03 SD) ($P<0.01$). As for the Greenland Sea harp seals, the estimated pregnancy rates were based on presence/absence of a large, luteinized *corpus albicans* in post-breeding females. The pregnancy rate estimated for 2021 was based on 217 parous females. (IMR)

Arctic food webs are being impacted by borealization and environmental change. To quantify the impact of these multiple forcings, it is crucial to accurately determine the temporal change in key ecosystem metrics, such as trophic position of top predators. In a recent paper, stable nitrogen isotopes (δ15N) in amino acids were measured in **harp seal** teeth from across the North Atlantic spanning a period of 60 years to robustly assess multi-decadal trends in harp seal trophic position, accounting for changes in δ15N at the base of the food web. Long-term variations were revealed in trophic position of harp seals which are likely to reflect fluctuations in prey availability, specifically fish- or invertebrate-dominated diets. It is shown that the temporal trends in harp seal trophic position differ between the Northwest Atlantic, Greenland Sea and Barents Sea, suggesting divergent changes in each local ecosystem. The results provide invaluable data for population dynamic and ecotoxicology studies. (IMR)

A new "Handbook of the Mammals of Europe" is currently under production by SpringerLink. The aim of the handbook is to review exhaustively the key recent research of all known mammal species in Europe. It will provide an overview about the historic and current status of European mammals, as well as management strategies. In 2023 a comprehensive species-specific chapter on **harp seals** was produced. It covers all aspects of the species' biology, including paleonthology, physiology, genetics, reproduction and development, ecology, habitat, diet, mortality, and behaviour. The economic significance and management of the species and future challenges for research and conservation are addressed as well. The chapter includes a distribution map, a photography of the animal, and a list of key literature. (IMR)

Harbour seals assessments were carried out along the entire mainland Norwegian coast during molt in 1996-1999, 2003-2006, 2008-2015 and 2016-2021. Results show that the numbers of harbour seals in Norwegian Skagerrak have increased to approximately the levels before the PDV-outbreak in 2002. On the west coast south of Stad (62°N) the numbers were slightly lower than in the first counting period 1996-1999. North of Stad, harbour 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 harbour seal numbers increased by 14% after 2008-2015 to ca 1120 in 2021. The total minimum harbour seals numbers were ca 6960 along the Norwegian coast in 2016-2021, which is close to the Target Level of 7000 seals. New counts along the coast started in Norwegian Skagerrak in 2022, which showed a significant increase in harbour seal numbers in the northern part of that area. The total numbers in Østfold, Vestfold and Telemark, had doubled from 792 seals in 2016 to 1591 seals in 2022. In southwest Skagerrak, the counts were less than 100 seals in both periods. Tagging experiments showed migrations between the counties in Skagerrak and to Sweden and Denmark. The large increase in seal numbers is most probably due to both population growth and migrations from Swedish Skagerrak. In 2023, harbour seals were counted in Rogaland and Vestland (previous Sogn and Fjordane County). In Rogaland, the harbour seal numbers had increased by approximately 70 % since 2017. In Vestland, the harbour seal numbers showed a small decrease of about 6%. (IMR)

Incidental capture of non-target species by fisheries, also referred to as bycatch, is a major concern for the management of marine megafauna species. In Norway, it has been estimated that 555 **harbor seals** get entangled and drown in gillnets every year. The majority of these bycatch events occur in large-mesh gillnet fisheries targeting cod and monkfish. Young-of-the-year individuals represent the largest proportion of bycaught harbor seals. To increase our understanding of harbor seal bycatch events along the Norwegian coast, times and areas of potential bycatch risk were identified. Seasonal variation in the at-sea distribution of harbor seals was simulated based on movement from their molting site to predicted at-sea locations. Relative age-specific bycatch abundances were used to weigh the different seasons (times of the year) based on harbor seal age. The over-lap in the distribution of harbor seals and the documented distribution of fishing effort was then used to estimate the relative bycatch risks between harbor seals and fisheries in defined Statistical Sea Locations (SSLs) in each of the four seasons. The method used here provides a general framework for understanding temporal and spatial interaction between harbor seals and coastal gillnet fisheries. The times and areas of high interaction risk that were identified can be used in management practices to increase our understanding of bycatch events, and to ultimately reduce unwanted bycatch of harbor seals in coastal fisheries along the Norwegian coast. (IMR, UiO)

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. Results showed a reduction of pups born in Troms by ca 25% from 65 pups in 2016 to 49 pups in 2021. Grey seal pup production in Finnmark increased by ca 10% from 206 pups in 2015 to 226 pups in 2021. In 2022, 37 grey seal pups were counted on a small breeding colony (Tjør) in Rogaland in southwest Norway, where usually 30-40 pups are born annually. Pup counts were carried out in Trøndelag and Nordland (not including Lofoten) in October 2023. In Trøndelag, pup production has gradually reduced from 272 pups born in 2007-2008 to 83 pups in 2023. Also, grey seal pup production along the mainland coast in Nordland was reduced from 487 pups in 2007-08 to 119 pups in 2023. (IMR)

As reported previously, considerable progress has been made towards producing habitat-based predictions of the at-sea distribution of **grey** and **harbour seals** in Norwegian coastal waters. This work leverages fitted habitat models for these species that were developed as part of a recent study in the UK (http://hdl.handle.net/10023/21558) based on extensive tracking studies. The idea is to apply the original models to Norwegian environmental data and seal abundance data to produce a raster grid with habitat suitability indices (HSI) and at-sea relative probability of occurrence for grey and harbour seals. Preliminary model runs have given sensible results. Pending some further work, final modelling results should be forthcoming in 2024. Both the at-sea distribution and the HSIs for grey and harbour seals constitute highly useful estimates, e.g., for entanglement mortality estimation (results may be helpful in evaluating individual species identifications in coastal reference fleet data, which are uncertain). (IMR, UiO)

The ability of marine mammals to accumulate sufficient lipid energy reserves is vital for mammals' survival and successful reproduction. However, long-term monitoring of at-sea changes in body condition, specifically lipid stores, has only been possible in **elephant seals** performing prolonged drift dives (low-density lipids alter the rates of depth change while drifting). This approach has limited applicability to other species. Using hydrodynamic performance analysis during transit glides, a novel satellite-linked data logger that calculates real-time changes in body density (∝lipid stores) was developed and validated. As gliding is ubiquitous amongst divers, the system can assess body condition in a broad array of diving animals. The tag processes high sampling rate depth and three-axis acceleration data to identify 5 s high pitch angle glide segments at depths >100 m. Body density is estimated for each glide using gliding speed and pitch to quantify drag versus buoyancy forces acting on the gliding animal. Tag data from 24 elephant seals (*Mirounga* spp.) was used to validate the onboard calculation of body density relative to drift rate. The new tags relayed body density estimates over 200 days and documented lipid store accumulation during migration with good correspondence between changes in body density and drift rate. The study provided updated drag coefficient values for gliding ($C_{d,f} = 0.03$) and drifting ($C_{d,s} = 0.12$) elephant seals, both substantially lower than previous estimates. The study also demonstrated post-hoc estimation of the gliding drag coefficient and body density using transmitted data, which is especially useful when drag parameters cannot be estimated with sufficient accuracy before tag deployment.This method has the potential to advance the field of marine biology by switching the research paradigm from indirectly inferring animal body condition from foraging effort to directly measuring changes in body condition relative to foraging effort, habitat, ecological factors and anthropogenic stressors in the changing oceans. Expanding the method to account for diving air volumes will expand the system's applicability to shallower-diving (<100 m) species, facilitating real-time monitoring of body condition in a broad range of breath-hold divers. (IMR)

To study potential impacts of tourist visitations on **walrus** haul-out sites in Svalbard the haul-out site at Poolepynten, Prins Karls Forland, is monitored with camraes. This is the haul-out sites that has the most visitations in Svalbard and cameras taking pictures every 15 mins were deployed from May to October. Dynamics in haul-out numbers will be studied in relation to visitations to explore potential impacts. (NP)

As part of a Norwegian Research Council funded project entitled: Arctic marine mammals in a time of climate change: a Kongsfjorden Case Study (ARK) **ringed, bearded and harbour 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. Five ringed, two bearded and 14 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)

Ringed seals in all ice-covered areas in Isfjorden, Svalbard, were surveyed with drones in May/June for hauled-out ringed seals (and any other marine mammals hauled out here). This is part of a new time series to monitor ringed seal population trends in selected fjords in the archipelago. (NP).

In addition, 25 **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).

Walrus haul-out sites in Svalbard was photographed with drones and numbers found used as ground truthing for numbers found in pictures from remote sensing of the same haul-out sites (NP)

CETACEANS

Persistent organic pollutants (POPs), including brominated flame retardants (BFRs), perfluoroalkyl substances (PFAS) and metals, can accumulate in marine mammals and be transferred to offspring. In a recent study, emerging and legacy contaminants were investigated in **common minke whales** from the Barents Sea. A total of 64 lipophilic POPs, including four emerging BFRs, were studied in the blubber, liver and muscle of 17 adult whales to investigate occurrence and tissue partitioning. In addition, the placental transfer concentration ratios of 14 PFAS and 17 metals were quantified in the muscle of nine female-fetus pairs to investigate placental transfer. Legacy lipophilic POPs were the dominating compound group in every tissue, and the study observed generally lower levels compared to previous studies from 1992 to 2001. The study detected the emerging BFRs hexabromobenzene (HBB) and pentabromotoluene (PBT), but in low levels compared to the legacy POPs. It also detected nine PFAS, and levels of perfluorooctane sulfonate (PFOS) were higher than detected from the same population in 2011, whilst levels of Hg were comparable to 2011. Levels of lipophilic contaminants were higher in blubber compared to muscle and liver on both a wet weight and lipid adjusted basis, but tissue partitioning of the emerging BFRs could not be determined due to the high number of samples below the limit of detection. The highest muscle ΣPFAS levels were quantified in fetuses (23 ± 8.7 ng/g ww), followed by adult males (7.2 ± 2.0 ng/gg ww) and adult females (4.5 ± 1.1 ng/g ww), showing substantial placental transfer from mother to fetus. In contrast, Hg levels in the fetus were lower than the mother. Levels were under thresholds for risk of health effects in the whales. This study is the first to report occurrence and placental transfer of emerging contaminants in common minke whales from the Barents Sea, contributing valuable new data on pollutant levels in Arctic wildlife. (IMR, UiO)

There is increasing interest in assessing the impact of whales on nutrient and carbon cycling in the ocean. By fertilising surface waters with nutrient-rich faeces, whales may stimulate primary production and thus carbon uptake, but robust assessments of such effects are lacking. Based on the analysis of faeces collected from **common minke whales** (n = 31) off Svalbard, Norway, this study quantified the concentration of macro and micronutrients in whale faeces prior to their release in seawater. Concentrations of the macronutrients nitrogen (N) and phosphorous (P) in minke whale faeces were 50.1 ± 10.3 and 70.9 ± 12.1 g/kg dry weight, respectively, while the most important micronutrients were zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu). By combining measured faecal nutrient concentrations with estimated prey-consumption and prey-assimilation rates it was calculated that the current population of approximately 15, 000 individuals in the small management area (SMA) of Svalbard defecates daily 7 ± 1.4 tonnes (t) N and 10 ± 1.7 t P during summer. The molar ratio of N:P in minke whale faeces was 1.6:1, meaning that N was proportionally limiting, when compared to average elemental ratios of 16:1 in phytoplankton. In case of no N limitation in surface waters at that time, the release of elemental P through defecation in surface waters has the potential to stimulate 407 ± 70 t of carbon per day during summer as new or regenerated primary production in the SMA of Svalbard. This amounts to 0.2 to 4 % of daily net primary production in this region. This study provides the first assessment of nutrient concentration in whale faeces prior to their dissolution in sea water. Further research, namely on the amount of N released via urine and seasonal changes in excreted nutrients, is needed to better assess the full potential of whale nutrient additions to dissolved nutrient pools in surface waters at regional and global scales. (IMR)

During the period 21 June to 11 August 2023, a double-platform sighting surveys was conducted with the chartered vessel M/S Stålbas in the North Sea, the Small Management Area EN. In addition, Sognefjorden and Hardangerfjorden were surveyed to follow up on earlier harbour porpoise surveys in these fjords. In total, about 3,200 nautical miles were conducted on primary effort. During primary search effort, the number of combined observations from the two platforms was 65 sightings of **minke whales**. Sightings of other cetacean species include **fin whales** (18 primary sightings), **harbour porpoise** (295 primary sightings, primarily within the fiord systems), **white-beaked dolphins** (31 sightings), **white-sided dolphins** (10 primary sightings). Within the North Sea proper, we also recorded sightings of **common dolphins** and **Risso's dolphin**. As part of a local study at Raet National Park, southeastern Norway, that area was also surveyed, the only cetaceans observed there were harbour porpoises and minke whales. (IMR).

Minke whale catch data for the 2023 season have been computerised and evaluated. (IMR).

Solvang and Ohish developed an R package, trec, for trend estimation and classification among multivariate time series observations. The tool is available to investigate dominant common trend for top predators, the prey species, and relevant oceanographic data and to improve communication among stakeholders who discuss common tendencies between biological community in a marine ecosystem and the local environmental factors.

Furthermore, Yamamura et al. (Solvang, Øien, Haug are co-authors) have developed spatio-temporal modelling using generalized fused lasso and the practical numerical algorithm to identify the influence of spatial effects to body condition of **common minke whale**. The procedure is expected robust identification to nonuniformity in the density of spatial data and the proposed algorithm gives considerably faster running time comparing with mgcv R package used in applying GAM, some extensions, and regression with multiple smoothing parameter estimation, widely applied in marine ecosystem study. The statistical novelty was presented by Solvang at a workshop on inference for stochastic processes and applications held in Bergamo, Italy, and she has received an offer for submission the TR to Environmetrics by the chief editor of the journal at the meeting. The article is now under review. (IMR).

During the ongoing Moby Dick-project, UiT (in cooperation with IMR) tagged two **minke whales** (one in Lofoten and one off Andenes) with a limpet SPLASH tag that recorded both horizontal and vertical (diving) movements. The tags stayed on for 5-6 days. During this period the whale tagged at Andenes swam along the coast all the way almost to the opening of the White Sea in Russia, while the one tagged in Lofoten staid in the same area while the tag was on. (UiT, IMR)

Migration patterns are fundamentally linked to the spatiotemporal distributions of prey. How migrating animals can respond to changes in their prey's distribution and abundance remains largely unclear. During the last decade, **humpback whales** used specific winter foraging sites in fjords of northern Norway, outside of their main summer foraging season, to feed on herring that started overwintering in the area. A study used photographic matching to show that whales sighted during summer in the Barents Sea foraged in northern Norway from late October to February, staying up to three months and showing high inter-annual return rates (up to 82%). The number of identified whales in northern Norway totaled 866 individuals by 2019. Genetic sexing and hormone profiling in both areas demonstrate a female bias in northern Norway and suggest higher proportions of pregnancy in northern Norway. This may indicate that the fjord-based winter feeding is important for pregnant females before migration. The results suggest that humpback whales can respond to foraging opportunities along their migration pathways, in some cases by continuing their feeding season well into winter. This provides an important reminder to implement dynamic ecosystem management that can account for changes in the spatio-temporal distribution of migrating marine mammals. (UiT, IMR, NPI)

Understanding how individual animals modulate their behaviour and movement patterns in response to environmental variability plays a central role in behavioural ecology. Marine mammal tracking studies typically use physical environmental characteristics that vary, and/or proxies of prey distribution, to explain predator movements. Studies linking predator movements and the actual distributions of prey are rare. In this study satellite tag data from ten **humpback whales** in the Barents Sea (north-east Atlantic) were analysed to examine how their spatial movement and dive patterns are influenced by the geographic and vertical distribution of capelin, which is a key prey species for humpback whales. The study used capelin density estimates based on direct observations from a trawl-acoustic survey and sun elevation to explore the drivers of changes in movement patterns. It was found that the humpback whales exhibited characteristic area restricted search movement where capelin density was the highest. While horizontal movements showed both positive and negative individual relationships with sun elevation, humpback whale dive depth was positively correlated with diurnal variations in the vertical distribution of capelin. This suggests that in addition to whales foraging in regions of high capelin density, they also target the densest shoals of capelin at a range of depths, throughout the day and night. Overall, these findings suggest that regions of high capelin density are important foraging grounds for humpback whales, highlighting the central role capelin plays in the Barents Sea marine ecosystem. (UiT, IMR, NPI)

From 2016-2021 a satellite tracking study was conducted to track **humpback whales** over long distances (see: https://en.uit.no/prosjekter/prosjekt?p_document_id=505966). In total, about 50 individuals was tagged at the coast of northern Norway and in the northern Barents Sea (10). Many of these whales were followed from their main feeding areas and all the way down to their tropical breeding areas, including one that was followed for a full year circle back to where it was originally tagged. Much of the data is still in the publication process, but have given a lot on new insight into the long-distance migration behaviour of humpback whales, including important feeding area, migration corridors, arrival/departure times, swimming speed, feeding behaviour in relation to food sources etc. These studies have also been combined with extensive ID-pictures and biopsy samples (sex and pregnancy rates, contaminants, diets). Together these have identified a connection between the northern Barents Sea area and the autumn and early winter feeding on herring in northern Norwegian fjords, where possibly 10-15% of the whales feeding in the northern Barents Sea seem to use the coast of northern Norway as a stop-over area before they continue to Caribbean waters. Females are dominating in the stop-over area in Northern Norway, many of them pregnant. They possibly uses this area to refuel or get additional energy before they start their southern mating migration. Unpublished data also show that these whales mainly belong to two genetically different groups, the largest possibly breed in Caribbean waters and the smaller outside Cap Verde in West Africa. In the last three years, UiT and IMR have equipped many humpbacks with short terms CatCam tags (suction cup tags with video, acoustics and dive behaviour parameters) in the fjords of northern Norway during November and December. These data will be used both to map their natural feeding behaviour and study how they react to sounds that are used to keep the whales away from fishing gears so that they do not get entangled. (UiT)

During the ongoing "Moby Dick-project" UiT - The Arctic University of Tromsø have in cooperation with Whale2Sea (Andenes) and NPI since 2020 tagged over 30 male **sperm whales** with satellite tags along the continental shelf edge from the area outside Vesterålen/Andenes (>25) and up to the edge vest of Svalbard (7). Some of these individuals have been followed for >8 months. Additionally, several biopsies, faecal samples, eDNA-samples, ID-photos (tails) and acoustic recordings have been collected parallel to this, where we have analysed the biopsies for contaminants (high values), isotopes and fatty acids (to identify diet). Genetics will also be examined. We have also used CATS-video suction cup tags (CATS) on several de-predating individuals around Greenland halibut fishing boats at the continental shelf edge. The project is still ongoing but have already revealed a lot of new knowledge related to these whales' seasonal area use, their (surprisingly) long distance mating migration (almost to the Caribbean), fishery interaction, diving behaviour and diet. (UiT, NPI, W2S)

Back in 2020, three male **sperm whales** stranded on the island of Andøya in North Norway. This created an opportunity to do gross necropsies with a focus on stomach contents as the diet of 13 sperm whales in Norwegian waters is poorly understood, and also to study potential presence of marine debris. Four new prey types for sperm whales in Norwegian waters were identified: angler fish, cod, cartilaginous fish and Histioteuthis sp. In general, the results support earlier studies of male sperm whale diet in high latitude foraging grounds in North Atlantic consisting of a mixture of Cephalopods and meso- and bathypelagic fish. The only type of marine debris found was a fishing line. The age of the whales, based on estimates from teeth, was 25, 45 and 49 years. The size of all individuals was smaller than the median length based on whaling data for these year classes in Iceland in 1970s. (IMR,W2S). This study is now published and also makes a basement for the ongoing Moby Dick-project related to diet (faecal samples, isotopes and fatty acids from biopsies).

Top marine predators, such as odontocetes, pinnipeds, and seabirds, are known to forage around fishing boats as fishermen aggregate and/or discard their prey. Recently, incidents of **humpback whales** interacting with fishing boats have been reported. However, whether humpback whales utilise discard fish as a food source and how they forage around fishing boats is unknown. This study reports, for the first time, the foraging behaviour of a humpback whale around fishing boats. Three whales were tagged using a suction-cup tag containing a video camera, and a behavioural data logger in the coastal area of Tromsø, Norway. Video data from one tagged whale showed that the whale remained in close vicinity of fishing boats for 43 minutes, and revealed the presence of large numbers of dead fish, fish-eating killer whales, fishing boats, and fishing gear. In waters with large numbers of dead fish, the whale raised its upper jaw, a motion associated with engulfing discard fish from fishing boats, and this feeding behaviour differed markedly from lunge-feeding observed in two other whales in the same area. This behaviour was defined as "pick-up feeding". No lunge feeding was seen on the data logger when the whale foraged around fishing boats. This study highlights a novel humpback whale foraging strategy: low energy gain from scattered prey but also low energy costs as high-energy lunge feeding is not required. (IMR)

Despite holding the accolade as the largest animal ever to live on planet earth and ubiquitously inhabiting the world's major oceans, an acute paucity of information surrounds the geographical distribution and migration phenology of the endangered **blue whale** in the northeast Atlantic. Current migration and distribution information derived from robust scientific studies is required to ensure the formulation and implementation of successful conservation measures with a vision to support the ongoing recovery of the northeast Atlantic population. At 10:21 (UTC) on the 9th of November 2020, two blue whales were observed at position 55°13.99′N, 01°13.62′W, 18 km off the coast of the UK in the central North Sea just north of Newcastle at a water depth of 76 m. This is the first paper that has confirmed an account of live blue whales frequenting shallow waters of the central North Sea and represents a new area of occurrence within the accepted range of the northeast Atlantic population, an area in which sightings are extremely rare and may provide insight into the intricacies of migration routes and behaviour. (IMR)

Experiments were carried out in November/December 2022 to test acoustic deterrent devices (ADDs) to minimise the risk of **humpback** and **killer whales** getting entangled in herring purse seines. Following these successful experiments, which showed that in particular killer whales responded significantly to the deterrent devices, the project has received continued funding for 2024-2025. The objectives of the next phase are to: 1) conduct tests to ensure that fish do not show a startle/flight response to the deterrence signals, 2) modify the deterrent signals to achieve a stronger response by humpback whales, 3) test the modified system during controlled experiments as well as during active fishing operations, and 4) to come up with a system configuration that allows the method to be easily implemented by fishermen during active operations. Initial examinations of the fish response were carried out during November 2023, and preliminary analyses suggest no strong response by herring to the signals. Fieldwork testing the effects of modified signals on whales (in particular humpback whales) will be carried out during Nov/Dec 2024, and work on implementing practical solutions for an operational system will be carried out in 2024 and 2025. (IMR, UiT)

Due to little prior knowledge, a study aimed to investigate the biology of bycaught **harbour porpoises** from the northernmost Arctic Norwegian coastline was conducted with sampling in 2016 and 2017. The harbour porpoise (latin name *Phocoena phocoena*) is a highly mobile cetacean species primarily occurring in coastal and shelf waters across the Northern hemisphere. It inhabits heterogeneous seascapes broadly varying in salinity and temperature. In a new study (which also included material from the Norwegian sampling program in 2016 and 2017) 74 whole genomes were produced at intermediate coverage to investigate the species' evolutionary history and investigate the role of local adaptation in the diversification into subspecies and populations. The study identified ~6 million high quality SNPs sampled at eight localities across the North Atlantic and adjacent waters, which was used for population structure, demographic and genotype–environment association analyses. The results suggest a genetic differentiation between three subspecies (*P.p. relicta*, *P.p. phocoena* and *P.p. meridionalis*), and three distinct populations within *P.p. phocoena*: Atlantic, Belt Sea and Proper Baltic Sea. Effective population size and Tajima's D suggest population contraction in Black Sea and Iberian porpoises, but expansion in the *P.p. phocoena* populations. Phylogenetic trees indicate post-glacial colonization from a southern refugium. Genotype–environment association analysis identified salinity as major driver in genomic variation, and the study identified candidate genes putatively underlying adaptation to different salinity. The currentr study highlights the value of whole genome resequencing to unravel subtle population structure in highly mobile species, shows how strong environmental gradients and local adaptation may lead to population differentiation, and how neutral and adaptive markers can give different perspectives on population subdivision. The results have great conservation implications as the study found inbreeding and low genetic diversity in the endangered Black Sea subspecies and identified the critically endangered Proper Baltic Sea porpoises as a separate population. (IMR)

The year 2023 marked the 3rd year of the MULTIWHALE project funded by the Research Council: https://www.mn.uio.no/ibv/english/research/sections/aqua/research-projects/multiwhale/ . As part of this project, analyses of dietary markers (Fatty acids, bulk isotopes, compound specific isotopes), hormones, gene expression and organic contaminants were conducted from skin and blubber samples of 100 free ranging **killer whales** sampled in Norway in 2020-2022. Publications are currently in preparation.
- Funding was received from Klima-og miljødepartementet (Arktisk 2030) in 2018 to sample stranded cetaceans all over Norway and to conduct a comprehensive screening of contaminants in blubber and various organs. Publications related to this project are in preparation, including one recently published:
https://www.sciencedirect.com/science/article/pii/S0025326X23013711
- Long-term census and biopsying of killer whales in Norway continues, and NOS conducted fieldwork as every other year since 2013. NOS has also sampled stranded cetaceans along the Norwegian coast in 2023. (UiO, NOS)

During the ongoing Moby Dick-project, UiT (in cooperation with IMR) tagged one **fin whale** in Vestfjorden (Lofoten) in Norway with a limpet SPLASH tag that recorded both horizontal and vertical (diving) movements. During this period the whale used less than three days from the Lofoten area to the Brents Sea northeast of the Bear Island. UiT also tagged two fin whales in Øksfjord (Northern Norway) in November 2023 with SPLASH satellite tags (horizontal position + diving information). Unfortunately, these tags did not report despite good tag placement. (UiT, IMR)

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 2023 at various locations in the Svalbard area. (NP).
In addition, a sound trap to record cetaceans (most likely **white whales**) and underwater noise (mainly underwater vessel noise) was deployed late in the year close to the entrance of Adventfjorden (Svalbards busiest location wrt boat traffic) (NP).

As part of NAMMCO's MINTAG project three **minke whales** were equipped with prototype tracking devices in Isfjorden, Svalbard. Tags reported data only for a few days (NP)

Due to the security situation, there is increasing naval activity in our immediate areas, and this means more noise. A technological trend within the development of military sonars is that the sound sources that previously sent short pulses become more continuous. Continuous sound increases the risk of masking and possibly also leads to behavioral changes more quickly. We cannot necessarily extrapolate from knowledge of how the animals respond to pulsed sound sources and therefore need more knowledge about the effects of continuous sound sources on marine mammals, especially species that are known to respond to military sonars and that vocalize in the same frequency band (orcas are a good example). We also need more knowledge on how to extrapolate from experimental data on how sonar and seismic affect marine mammals to real operations (military or civilian seismic surveys) that last much longer. FFI is therefore leading a new project which aims to compare the effects of pulsed and continuous sonars, and also to look at the effects of longer exposures. In October this year, we carried out a trip where **killer whales** were fitted with splash-limpit tags or so-called Mixed-dtag+ data loggers and exposed to such sonar pulses. A total of 18 animals were tagged in the Kvænangen-Lopphavet area and four 8-hour long sonar exposures were carried out. It is too early to say anything about the results. The project is planning another trip next year. (FFI)

Knowledge of the species' hearing ability is critical in order to say something about what kind of noise will affect them and how. We know the hearing curve of many species of seals and toothed whales, but no baleen whales have been studied due to the difficulty of keeping them in captivity. FFI is carrying out, together with the National Marine Mammal Foundation in the USA, LKARTS and Kristiansand Zoo, a project where **minke whales** are captured in a modified salmon cage and their hearing ability is measured using non-invasive electrophysiological methods. After the measurements have been completed, the animals are tagged with a satellite transmitter and released. This summer, phase 3 of the project was carried out in Lofoten and for the first time so-called "auditory brainstem responses" were measured in animals stimulated by sound. The animals are exposed to low sound levels at different frequencies to measure hearing thresholds. No complete audiogram has yet been established for minke whales, but we can already say that previous assumptions about baleen whales' hearing are incorrect. Minke whales appear to be able to hear ultrasound up to 90kHz, and this is very unexpected. The result means that minke whales hear both echo sounders and fishing sonars, and will be able to be disturbed by these, which it was previously assumed would not be the case. Two animals were captured this year, and both showed normal behavior in the weeks after being released. The project has been controversial and became even more controversial when a minke whale drowned in one of our joint nets this summer. The animal was not in our custody when this happened. The circumstances surrounding this incident were that extremely bad weather pushed a net out of its intended position and thus possible to try and dive under. Measures were immediately taken to prevent this from happening again. The Marine Mammal Committee has previously pointed out the importance of this project and supported it. This research project will provide critical knowledge to help protect baleen whales from human influence. The project ends next year. (FFI)

In August-October 2023 marine mammal observers were onboard the vessels participating in the **Barents Sea ecosystem survey** which is a joint project with Russia. The participating vessels were G.O. Sars, Kronprins Haakon and Johan Hjort from Norway and Vilnius from Russia. A total of 2734 individuals were registered in 758 observations; this included 205 pinnipeds and cetaceans not identified to species and two polar bears. As in previous years, **white-beaked dolphin** (Lagenorhynchus albirostris) was the most common species (about 70% of all individual registrations) with a high density in the central and northern Barents Sea and west off Spitsbergen. Other toothed whales represented but in modest numbers were **sperm whales** (Physeter macrocephalus), **harbour porpoises** (Phocoena phocoena), and **killer whales** (Orcinus orca). There was also an observation of a large group of **white whales** (200 individuals) off Longyearbyen, Spitsbergen. The baleen whale species minke (Balaenoptera acutorostrata), **humpback** (Megaptera novaeangliae), and **fin** (Balaenoptera physalus) **whales** were abundant in the Barents Sea especially north of 76°N. These species were often found together in aggregations and overlapping with capelin. Also, a **bowhead whale** (Balaena mysticetus) was observed north of Svalbard. (IMR).

In 2023 several analyses on **humpback whales** were published, including humpbacks' use of herring feeding areas of northern Norway (Kettemer et al. 2023), and foraging behaviour related to lateral and vertical distribution of capelin in the Barents Sea (Vogel et al. 2023).

Research vessels, coastguard vessels and other providers have collected incidental observations of marine mammals. Recorded data include date, position, species, and numbers. During 2023, 449 observations were reported under this project. The most often reported species included **minke**, **fin**, **humpback**, **blue** and **killer whales**, **Lagenorhynchus species** and **harbour porpoises**. The most important regular provider of incidental observation data is the Norwegian Coastguard. (IMR).

PINNIPEDS AND CETACEANS

The Barents Sea is one of the Polar regions where current climate and ecosystem change is most pronounced. In a recent review the current state of knowledge of the physical, chemical and biological systems in the Barents Sea. **Seals** and **whales** are integrated parts of this review. Physical conditions in this area are characterized by large seasonal contrasts between partial sea-ice cover in winter and spring versus predominantly open water in summer and autumn. Observations over recent decades show that surface air and ocean temperatures have increased, sea-ice extent has decreased, ocean stratification has weakened, and water chemistry and ecosystem components have changed, the latter in a direction often described as "Atlantification" or "borealisation," with a less "Arctic" appearance. Temporal and spatial changes in the Barents Sea have a wider relevance, both in the context of large-scale climatic (air, water mass and sea-ice) transport processes and in comparison to other Arctic regions. These observed changes also have socioeconomic consequences, including for fisheries and other human activities. While several of the ongoing changes are monitored and quantified, observation and knowledge gaps remain, especially for winter months when field observations and sample collections are still sparse. Knowledge of the interplay of physical and biogeochemical drivers and ecosystem responses, including complex feedback processes, needs further development. (IMR, NPI, UiO, UiB, NTNU, UiT, UNIS)

III ONGOING (CURRENT) RESEARCH

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

Brain tissue was collected after culling of six **hooded seals** that were captured as pups in 2022 (for use in studies of thermoregulatory adaptations). In vitro electrophysiological studies were conducted of synaptic transmission in hippocampal slices, in order to investigate the potential role of lactate as a signalling substance. The studies reveal that synaptic transmission is depressed in response to activation of the HCAR1 type lactate receptor. This may represent a protective shutdown mechanism during long dives. Further samples were collected from the visual cortex, for dissociation and isolation of neurons and glia cells for use in several studies aimed at disentangling the metabolic roles and interactions of the two cell types. This was done in part in acute experiments in which the mitochondrial respiration of neurons vs astrocytes was studied using Oroboro mitochondrial respirometers. Whole brain (visual cortex) tissue samples were also fixed and used in immunohistochemical studies of mitochondrial densities and the distribution of membrane-bound monocarbocylate transporter (MCT) proteins, in neurons vs astrocytes. These studies support the notion that seal brain astrocytes have a high capacity to import and metabolize lactate, which may allow seal neurons to survive severely hypoxic conditions through a combination of hypometabolism and anaerobic glycolysis (UiT-AMB-ACP).

Mathematical analyses of the efficiency of heat and water exchange mechanisms in the noses of **bearded seals** (Erignathus barbatus) vs **Mediterranean monk seals** (Monachus monachus) have been conducted and published, in a collaboration between NTNU, UiO, University of Cambridge and UiT (UiT-AMB-ACP).

Collection of material to assess status of condition and life history parameters of **harp seals** will be attempted in the Greenland Sea (West Ice) during the commercial hunt in 2024. (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 sattellite based tags, **harp seals** in the White Sea - will be attempted by Russian colleagues in April/May 2024. (IMR)

A new aerial survey to assess the pup production of **harp** and **hooded** seals was conducted in the Greenland Sea in 2022, publication of the results are in progress. (IMR)

Ship based counting of **harbour seals**, using electronic helicopter drones with camera, will be conducted in Mid Norway in September 2024. (IMR)

Sampling of DNA from **harbor seal** pups along the Norwegian coast was completed in June 2022. Publication of the results are in progress. (IMR)

In autumn in 2022, 9 **harbor seals** were tagged (GPS phone tags) in Norwegian Skagerrak. When all data are received, the results will be published, including telemetry data on harbor seals sampled earlier in that area. (IMR)

Ship based counting of **grey seals** will be conducted in Northern Nordland (including Lofoten) in October/November 2024. (IMR)

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

Total **grey seal** population modelling is planned to be carried out in 2024. (IMR)

Publication of results from studies of the feeding ecology, life history and ecological role of **harbour porpoises** is in progress. (IMR, UiT)

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

Experiments with tagging of **minke whales** with a new type of electronic tags will be carried out in Norwegian coastal areas in May and in Svalbard waters in August/September. (IMR)

Experiments aimed to test methods to avoid whales (**humpback** and **killer** whales) in purse seine fisheries were conducted in Troms in late autumn in 2022 and 2023. Late in 2024, further tests of ADDs operated onboard fishing vessels will be done. In addition, results from the first field seasons will be analysed. (IMR, UiT)

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).

New methodologies, including **infrared scanning and use of drones**, will be investigated during the 2024 dedicated **minke whale** sightings survey. (IMR)

During 2024 testing of the **new satellite tags** developed for use on smaller cetaceans like **minke whale** will be conducted. This is part of the ongoing development project **MinTag** under NAMMCO.

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 and in 2022 the program covered the Norwegian EEZ of the Barents Sea (SMA EB) and parts of the Svalbard area (SMA ES). In 2023 the North Sea (SMA NS) was covered and **in 2024 Svalbard (SMA ES) will be surveyed**. The 2024 survey will be the last one during the survey cycle 2020-2025 and there will be a pause in the minke whale dedicated survey program to explore other possible methodology to inform the management of the Norwegian minke whaling (IMR).

IV ADVICE GIVEN AND MANAGEMENT MEASURES TAKEN

Sealing

<u>Harp and hooded seals</u>

Advice on the management of **harp** and **hooded seals** is traditionally based on deliberations in The Joint ICES / NAFO / NAMMCO Working Group on Harp and Hooded Seals (WGHARP). This group met during 21-25 August 2023 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. The Joint Norwegian-Russian Fisheries Commission used the report from this WGHARP meeting as background for their discussions aimed to develop and establish management advice for 2024 to the JNRFC. On 28 September the two parties met digitally in a bilateral meeting to have an initial discussion of the advice.

WKBSEALS

Previous to the WGHARP and the JNRFC meetings, a process aimed to improve the assessment models used in seal management had been conducted (WKBSEALS). 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 became 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, the model only estimates three parameters: initial population size and pup and adult mortality. It 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. In addition, ICES has facilitated the establishment of a benchmark process. A kick-off meeting for this benchmark process was held in early December 2021, which laid out the agenda for the preparatory work leading up to a face-to-face benchmark meeting (WKBSEALS) in May 2023.

WKBSEALS aimed to benchmark harp seals in the White Sea / Barents Sea (BS/WS) and the Greenland Sea (GS), as well as hooded seals in the Greenland Sea. This represents the first ever benchmark for seals. The meeting was run as a hybrid meeting, with most participants present at the ICES Headquarters in Copenhagen and some participating via Teams. The benchmark concluded that there were sufficient data to produce an assessment model for the Greenland Sea stock of harp seals, but that data were insufficient for the Barents Sea / White Sea harp seal stock and too weak a signal for the Greenland Sea hooded seals for viable assessments for these stocks.

There has been no pup production survey for WS/BS harp seals since 2013. In the absence of more recent survey data, the benchmark concludes that viable assessment of current stock status or catch advice cannot be produced. Furthermore, the most recent available pup production estimates indicated a poor status. There have been limited catches since 2019, and the benchmark recommends that a pup survey and subsequent revised assessment is required prior to the resumption of any substantial commercial hunt. The model version with capelin abundance informing model dynamics does perform well in the time period for which data exist.

For the GS harp seal stock, the benchmark proposes a revised assessment model using cod and capelin alongside a first order autocorrelation (AR1) process to drive the model dynamics. Owing to the provisional nature of the recent pup survey, Reference Points were not calculated but could well be considered at WGHARP 2023 when the final data are available. The historical modelled population absolute level is uncertain, but the overall recent trend is relatively flat and has not been adversely affected by recent catches. Although a harvest is taken, advice is not currently given through ICES. An existing HCR is used for advice outside ICES, and there is a desire to conduct a HCR evaluation to produce a basis for future ICES advice.

The benchmark notes the current low level of the GS hooded seal stock, and that no commercial hunting has been conducted since 2007. No commercial hunting should be considered unless a clear upward trend in the pup abundance estimate can be observed, taking account of the uncertainty in these data. In the event of such an improving trend being observed, a new revised assessment would be needed prior to the resumption of hunting in order to give information on stock status and potential harvest levels.

The benchmark also performed a preliminary evaluation of the existing catch-at-age data for the different stocks. There was sufficient sign of signal in the data consistent with population structure (exponential decay with age, sign of recruitment failure tracking between years) to consider the possibility for using these data for model tuning. The benchmark strongly encourages such work.

WGHARP
When WGHARP met in Tromsø in August 2023 all advice from the benchmark process was discussed and implemented in the new assessments.

A Precautionary harvest strategy has been developed 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. It has been 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 at 30% (N_{30}) of N_{max}) is the ultimate limit point at which all harvest must be stopped.

Current 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, and environmental variables related to resource and competitor dynamics impacting cumulative mortality of pup prior to the surveys (called "abortion rate") and which contribute to modulating the impact of fecundity rates on the estimated pup production in the model. Note that these environmental data are included for the models of the two harp seal stocks (WS/BS and GS) , but not for the GS hooded seals. The modelled abundance is projected into the future to provide a future population size for which statistical uncertainty could be 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, if nothing else is mentioned.

The 2022 pup production estimate for **Greenland Sea harp seals** is higher than the previous survey estimate from 2018, but at the same level as those in precious surveys (2012 and earlier). Using a combination of mark-recapture based (1983-1991) and aerial survey based (2002-2022) pup production estimates, the new current assessment model, suggests a current (2023) abundance of the total Greenland Sea harp seal stock which is 2,180,866 (95% CI: 210,080, 29,653,499) animals. This is much higher than the previous assessment based on the previous assessment model, in 2019, which provided an estimate of 426,808 (95% C.I. 313,004-540,613) animals. This provides an adult to pup ration of approximately 22:1, which is unlikely. However, while the population level is deemed unreliable, the trend in population size is deemed reliable in the new population model. The new model fits, however, very well to the pup production estimates, even the earlier once that showed considerable variability (i.e., the mark-recapture (MR)-based pup production estimates)

In ICES terminology the Greenland Sea harp seal population is data rich, but on the verge of data poor with regards to reproductive data. However, new data and estimates from a survey in 2019 is now processed and ready to be implemented into the model. Nevertheless, given the unreliable population level in the new population model it cannot be used to assess catch options. Instead, two different methods were used, both deemed sustainable, to assess harvest quotas; 1) based on pup production estimates, which have been quite stable, and 2) based on the harvest records in the period 20-10 years before present, as these would have been the harvest levels that would have affected the current harvested population. These two methods provided quotas of 5,875 and 7,397 seals, respectively. WGHARP recommended not to exceed the highest estimate of 7397.

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 new assessment model show that the most likely explanation for the change in pup production seems to be a decline in the reproductive state of females. The new model shows a very good fit to the pup production estimates, as opposed to the previous assessment model. Using this new model, the estimated total 2023 abundance of White Sea/Barents Sea harp seals was 1,361,993 (95% C.I. 440,884 - 3,696,003). The modelled total population indicates that the abundance has decreased since the late 1990's, a decline predicted to continue. However, since the model lack updated pup production estimated this trend is unreliable.

The last available information about the reproductive potential for the Barents Sea / White Sea harp seal population is based on data from 2018, but new data from 2021 are ready to be implemented in the model. However, the last pup production estimate is from 2013, i.e., more than 10 years old, and the population is considered "data poor". In such cases WGHARP recommend use of the PBR approach to estimate catch quotas. However, given the extended period without new pup production data, the working groups recommended that harvest is stopped until new pup production estimates are available and that a reliable increase in pup production and population size is evident. If this happens, the working groups recommends a new assessment and potentially a new benchmark to assess potentially new model variants.

Results from the most recent (2022) pup survey suggest that current **Greenland Sea hooded seal** pup production remains at similarly low level as in 2018, and lower than observed in comparable surveys in 1997, 2005, 2007 and 2012. Even though there is some uncertainty regarding the historical data on pregnancy rates, previous assessments have run the population model for a range of pregnancy rates (assuming 50%, 70% or 90% of the mature females produced offspring, respectively). All model runs have 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. Hence, in the recent assessment only a pregnancy rate of 0.7 has been applied. Using this scenario, the model estimates a 2023 total population of 76,832 (95% C.I. 60,262-98,009). Following the Precautionary harvest strategy and the fact that the population is below N_{lim} (currently at 5.7% of N_{max}), WGHARP 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 2023 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 but it was agreed that this should remain untaken as long as the recommended stop in harvest in the area prevail.

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 2024 for **harbor seals** in Norway are 380 animals. For **grey seals** a quota of 200 animals, distributed with 60 in Rogaland (southern Norway) and 140 in Troms and Finnmark (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 2024.

<u>Seals in Svalbard</u>

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.

Bycatch

The use of pingers on gillnets set in Vestfjorden in January-April has been mandatory since 2021. At-sea inspections and interviews of fishers conducted after the cod fishing season in 2021 suggested that 1) compliance to the pinger mandate was only about 62%, 2) some fishers experienced practical problems with the pingers and 3) the effect of pingers on porpoise bycatch rates was less than what was demonstrated in the previously reported field trials from 2018-2020. Further informal interviews with fishers during the years 2022 and 2023 suggest that putting pingers in bait bags (agnposer), that are then tied to the float line, may alleviate some of the practical issues.

A preliminary evaluation of harbor porpoise bycatch rates based on data collected by the coastal reference fleet in 2021-2023 suggest that the average rates were lower in 2021-2023 than in the preceding 6-year period, but the uncertainty associated with those estimates is very high. The Directorate of Fisheries conducted 12 at-sea inspections of pinger use in 2023, and based on this limited data set, compliance to the pinger mandate was still low, at about 64%. The IMR is currently preparing to launch a second pinger trial, set to start in mid-January 2024. This second pinger trial doubles the number of participating vessels, compared to the 2018-2020 trials, but will only run for one season. Results will be forthcoming by the end of 2024.

It should be noted that before, during and after the 2021 cod fishery in Vestfjorden, a leading fishery newspaper published several articles that were highly negative towards pingers, casting doubt and uncertainty on the scientific basis of and need for the pinger regulation, the political process leading up to regulation, the effects, and possible side-effects of using pingers, the fairness of requiring fishers to cover pinger purchasing costs, and technical and practical aspects of pinger use. Additionally, early in the season, the Directorate of Fisheries made a public statement that was understood by the fishing industry to mean that pinger use would not be enforced, and that violations would not be prosecuted. This was subsequently clarified by the directorate, but the clarification also implied that violations of the regulation would not necessarily be prosecuted, but instead go on a record, with no further details on what consequences that would entail for fishers.

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 the North Atlantic common minke whales was conducted in 2022. The review concluded that there is one single panmictic minke whale population in the Northeast Atlantic and new abundance estimates for the region have been approved for use in RMP. From the 2014-2019 period, the total estimate for the areas surveyed by Norway is 149 722 (cv 0.152), of which 104 692 (cv 0.172) animals are in the Eastern area. (IMR).

After the end of the quota period 2016-2021, a new six-year block quota was calculated which included the new abundance estimates based on the survey period 2014-2019. The annual total catch quota 2022-2027 was estimated as 917 animals of which 664 animals can be taken within the **Northeastern stock area** (the Medium E Small Areas, i.e. the EW, EN, ES and EB Small Areas) and 253 within the CM Small Area of the Central **minke whale** stock. The catch quotas are set for each of the five small management areas, however, the E Medium Area is treated as a merged area in the quota handling. Unused quotas can be transferred to following years within the period which the block quota is set for.

The total catch in the Medium Area E in 2023 was 507 animals, leaving a rest quota of 157 animals for transfer. With addition of the rest quota of 83 animals from 2022 (the catch was then 581 minkes), the total transfer will be 240 animals. No catches were taken in the Jan Mayen area in 2023.

Thus, for 2024 the total catch quota, including transfers, will be set to 1157 minke whales of which 904 animals can be taken in area E and 253 animals in area CM (Jan Mayen block).

The catching season opens April 1 and closes medio September.

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VI DATA REPORTING TO NAMMCO COMMITTEES

Sealing

Harp and hooded seals

Norwegian catches in the Greenland Sea (West Ice) in 2023 was taken by one vessel, whereas no Russian seal vessels participated in the area. Due to the uncertain status for Greenland Sea hooded seals, no animals of the species were permitted taken in the ordinary hunt operations in 2023. The 2023 catch volume for harp seals in the Greenland Sea was set at 11,548 animals of all ages. The total catch in 2023 was 1,877 harp seals (including 1,793 pups) (Table VI.I).

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 52nd Joint Norwegian-Russian Fisheries Commission (JNRFC) supported this ICES recommendation for 2023 and Russia allocated 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 2015-2023. No Norwegian vessels participated in the area in 2023.

Table VI.1. Norwegian catches of harp and hooded seals in 2023. 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	1793	84	1877	0	0	0
Hooded seals	0	0	0			

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, 2022 and 2023, the quotas were reduced to 257, 268 and 346 harbor seals, respectively. 238 were taken in the hunt in 2021, 251 in 2022, and 316 in 2023.

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 2018-2023. Annual catches were 19-216 grey seals in 2012-2022. In 2023, a catch of 96 grey seals were taken.

Additional hunt on the Norwegian coast in 2023 include 2 ringed seals shot in North Norway.

Seals in Svalbard

In 2003-2022, total annual **ringed seal** catches in Svalbard ranged between 15 and 78 animals. In 2023, 39 ringed seals were taken in the hunt.

The number of **bearded seals** taken annually in Svalbard in 2003-2022 ranged between 2 and 34 animals, and the number taken in the 2023 hunt was 12 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, 2014-2017 and 2022. 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, 9 vessels participated in the 2023 season of whaling and the catching period was 1 April to 17 September. Table VI.2 shows the number of minke whales taken by area in the 2023 season. The quotas are given as annual catches in six-year block quotas but is not fully utilised in all areas and years. 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 2022-2027. The calculated annual basic quota for this period is 664 animals within Medium Area E and 253 whales within the Small Area CM, giving a total of 917 minke whales. The total catch in the 2023 season was 507 whales while the total quota including transfers was set to 1000 minke whales for 2023.

Table VI.2. Quotas and catches of minke whales in 2023 by management area as defined in RMP.

2023	Management area					
Small-type whaling	EB	EN	ES	EW	CM	Total
Catch	169	15	99	224	0	**507**
Quota	747				253	1000
Stock area	Eastern				Central	