Clare Margaret Andvik (Department of Biosciences, University of Oslo)

Effect of multiple stressors on Norwegian killer whales

Killer whales (Orcinus orca) are apex predators, and considered sentinel species for the health of marine ecosystems. Norwegian killer whales are, however, subject to effects from multiple stressors. In this study, we investigate how three stressors (anthropogenic pollution, disturbance from whale watching activities, and prey availability) can affect individual killer whales. We took blubber and skin biopsy samples from 106 killer whales from northern Norway 2019-2022, which could all be individually identified by Photo ID. 24 samples were taken during Winter 2020, where COVID-19 travel restrictions meant fewer tourists and presumed less disturbance from boat traffic. Of these, five individuals were re-sampled either in Winter 2021 or Winter 2022, with increased boat traffic, to allow a direct comparison between winters. A further three whales were re-sampled between a winter with high boat traffic and the comparatively undisturbed summer season. Each biopsy sample was sub-sampled to allow for material for at least eight different analyses, including dietary markers, quantification of pollutants and effect parameters. Effects will be measured by 1) quantification of steroid hormones in blubber (including the stress hormone, cortisol) 2) transcriptomics in blubber to quantify changes in gene expression to give an indication of the stress, lipid metabolism and immune/endocrine functions of individuals and 3) metabolomics in skin to quantify 206 targeted metabolites, including those involved in energy metabolism and stress. Laboratory work has begun and preliminary results are expected Autumn 2023. Our results will have important implications for international contaminant regulations and implementation of sustainable tourism (whale watching). Lastly, our findings will be relevant to an assessment of the population status of killer whales in Norway.

Eleni Kontostathi (NCLOS, University of Tromsø)

Legal challenges in establishing an MPA on the Arctic high seas under the OSPAR Convention

So far, the biodiversity framework in the Arctic Ocean is fragmented and does not offer coherent and holistic protection, especially in Areas Beyond National Jurisdiction (ABNJs). Considering the obligation set in articles 192 and 197 of the UN Convention on the Law of the Sea (UNCLOS) for contracting parties to protect and preserve the marine environment in cooperation with global or regional organisations, the OSPAR Convention pioneers in introducing Marine Protected Areas (MPAs) on the high seas. In 2016, OSPAR approached the Arctic Council with a proposal to establish an MPA under its mandate in the high-seas Arctic waters. The respective area had also been described to meet the criteria set by the Convention of Biological Diversity (CBD) for an “Ecologically or Biologically Significant Area (EBSA)”. Nevertheless, introducing an MPA in the Arctic high seas raises serious legal questions concerning the competence overlapping among existing institutions in the region and the obligations and consequences for parties and non-parties of the OSPAR Convention. Issues regarding the restriction of the high sea’s freedoms under article 87 of UNCLOS and the outer continental shelf submissions by the Arctic states - in accordance with article 76 of UNCLOS – are also under consideration. This thesis aims to identify the legal challenges in this effort. It also analyses the importance of a multi-sector cooperative approach in the region to legitimate OSPAR’s regulatory measures in the Arctic ABNJ and to ensure the broadest possible participation of non-member States. Lastly, it intends to highlight the role of the new Internationally Legally Binding (ILBI) instrument in protecting biodiversity in ABNJ.

Sara Torrpa (Arctic Biology, University of Tromsø)

Mechanisms of neural protective shutdown in hooded seal

Hooded seals (Cystophora cristata) may perform more than 1-hour long breath-hold dives to depths exceeding 1 km. This causes a lower-than-normal oxygen (O2) supply to several organs/tissues (hypoxia); a challenge to which they are highly adapted through two main strategies: large body oxygen reserves and reduced O2-demand during diving, in certain parts of the body. Nevertheless, deep-diving seals have been shown to repeatedly experience severe hypoxia. The two main strategies must therefore be supplemented with defense and repair mechanisms that minimizes the risk for hypoxic damage. One of these appears to be a regional decrease in cerebral neuronal activity, so called neuronal protective shutdown.

During hypoxia, cells must resort to anaerobic metabolism, which produces nearly 20 times less ATP molecules than when O2 is present, but the mammalian brain is a prime example of a tissue that typically lacks the ability to produce ATP at sufficient rates without O2. Its high dependence on O2 is mainly due to the highly energy-demanding process of synaptic transmission, which requires continuous pumping of ions to maintain normal neuronal membrane potential.

However, even in severely hypoxic conditions, seal brain neurons appear to somehow be able to maintain stable membrane potential. Despite its high energy demand, synaptic transmission in the hippocampus of hooded seals may remain functional for several hours in hypoxia. Moreover, the seal brain appears to be unusually tolerant to lactate, which may accumulate during the long dives in amounts that would be expected to cause neuronal malfunction. So far, the role of lactate as a metabolite is well-known, but its role as a signalling molecule has only started to emerge, and the lactate receptor HCAR1 has been demonstrated in the human and rodent brain where it promotes protective responses such as angiogenesis. In my MSc project I will investigate the potential roles of HCAR1 in the remarkable hypoxia tolerance of the seal brain.

Annika Heimrich (Arctic Acoustic Group, University of Victoria, Canada & WCS Canada)

Seasonal trends in the marine soundscape in the Kitikmeot Region of Nunavut, Canada between 2017-2019

The Arctic Ocean is an ecologically important ecosystem, offering either a temporary or long-term habitat for numerous migrating and resident marine mammal species every year. Due to the dampening effects of sea ice, the Arctic Ocean has less noise disturbance from anthropogenic activities than other marine areas. However, as climate change causes longer ice-free periods during summer, ship traffic continues increasing, leading to increasing underwater noise levels. Because the underwater soundscape is crucial habitat feature for marine mammals, it is important to monitor this environment.

This study will present the first year-round soundscape analysis based on passive acoustic data collected between August 2017 and March 2019 in the Kitikmeot Region of Nunavut, Canada. Acoustic data were analysed for marine mammal vocalizations, as well as underwater sound levels and ship noise were examined.

Ringed seal (Pusa hispida) vocalizations were present consistently throughout the year, whereas bearded seal (Erignathus barbatus) vocalizations were present between October and August with a peak during their breeding season. Underwater sound levels were strongly driven by wind speed, sea ice concentration, and ship noise however, ship noise only occurred between August and September. Our findings suggest that ringed seals are exposed to high amounts of ship noise, raising further concern for a species listed as of Special Concern in Canada (COSEWIC 2019).

This study presents the first long-term passive acoustic measurements in the Kitikmeot Region and can be used as baseline for future studies on underwater noise within this region.

Emma Høgh Åslein (Marine Biology, University of Oslo)

Killer whale predation on harbour porpoise in the Hardangerfjord, Western Norway

Two killer whale pods have been observed migrating southwards from Northern Norway along the Norwegian coast, frequently visiting the inner Western fjords (Jourdain et al., 2022, Norwegian Orca ID, 2021). Among them, there have been observations of killer whales entering the Hardangerfjord where they reside for an unknown period of time every year and predate on harbour porpoise (Bjørge, 2021, Jourdain et al., 2022). The aim of this master thesis is to quantify the presence of migrating killer whales in the Hardangerfjord and investigate the population-level impact of killer whale predation on the residing harbour porpoise population. By identifying the killer whale's predation rates and duration time the fjord, the number of killed porpoises per duration of killer whale stay can be estimated. Predation rates can be estimated with use of known killer whale energetic requirements and porpoise energy content. Additionally, the killer whales' spatial and temporal presence in the fjord can be estimated with use of citizen science and mark-recapture data from NOS. Potentially, this can be further supported by quantifiable, acoustic data recorded with acoustic recording devices termed CPODs. Further, an individual-based model will be established to explore the potential population-level impact of killer whale predation on the porpoise population over time.

The estimated mean population size of the harbour porpoises in the Hardangerfjord is 1339 individuals with a mean pod size of 1.2 porpoises (Deanna Leonard, IMR, pers. com.). It is hypothesised that killer whales migrate south and enter the Hardangerfjord in search of marine mammal prey like harbour porpoise. Furthermore, it is hypothesized that killer whale predation affects the harbour porpoise dynamics.