

Marine Mammal Student Symposium

Connecting scientists, policy-makers and users: How can we cooperate to safeguard marine mammals and their environment?

Programme

10:00 - 10:10	Welcome and Introduction
10:10 - 10:30	NAMMCO and NCLOS Presentations
10:30 - 10:50	Icebreaker
10:50 - 11:00	10-minute break
11:00 - 11:50	<u>Session 1: Student Talks</u> <ul style="list-style-type: none">• Stine Skalmerud (University of Tromsø)• Medy Dervovic (University of Lapland)• Emma Vogel (University of Tromsø)• Ingvild Ytterhus Utengen (University of Tromsø)
11:50 - 12:10	Breakout session followed by discussion
12:10 - 13:00	Lunch break
13:00 - 13:50	<u>Session 2: Student Talks</u> <ul style="list-style-type: none">• Sofia Albrecht (Galway Mayo Institute of Technology)• Drofel Tampoy (Mindanao State University)• Jac Romaric (Institut Universitaire European de la Mer)• Azin Vedad (University of Tromsø)
13:50 - 14:00	10-minute break
14:00 - 15:00	<u>Session 3: Invited guest speakers</u> <ul style="list-style-type: none">• Richard Caddell (Cardiff University)• Victoria Buschman (University of Alaska Fairbanks & Greenland Institute of Natural Resources)
15:00 - 15:10	10-minute break
15:10 - 15:30	Talk by Martin Binachon (NAMMCO) followed with breakout session
15:30	Symposium wrap-up followed by informal (in-person) networking

Abstracts

Stine Skalmerud (University of Tromsø, Arctic Biology)

Diving and movement behavior of humpback whales (*Megaptera novaeangliae*) during foraging in the Barents Sea

Humpback whales travel all the world's oceans, studying an animal's movement through space and time can shed light on the strategies used to optimize foraging and adapt to environmental variation. In addition, learning about humpback whale feeding, movement and diving behavior is important to identify factors that can heavily impact their population. The main objective of the study is to characterize dive profiles and movement of humpback whales in their foraging grounds and identify factors that may drive or affect these patterns. Specifically, we will investigate how bathymetry, solar angle and potential prey distributions affect diving and dispersal patterns of humpback whales. In this study we found the Barents Sea capelin distribution heavily overlap with the humpback whale distribution, both horizontally and vertically. Solar angle affects the diving depth of humpback whales; deeper dives around mid-day and shallower in the evening/night. Bathymetry does not seem to influence diving depth. As the world's longest mammal migrator, humpback whales (this subpopulation) heavily overlap with the capelin population.

Medy Dervovic (University of Lapland, Law of the Sea)

Law-Science Nexus in International Law-Making: Perspectives from Arctic Fisheries Governance

In light of global climatic and geophysical changes, particularly exacerbated in the polar regions, the integration of science in the making and implementation of international and regional treaties emerges as an essential component of modern international law-making. This law-science nexus trend is all the more relevant amidst the proliferation of environmental-related treaties for which a comprehensive scientific understanding of natural phenomena is essential to adopt effective frameworks.

After briefly presenting the role and challenges of science in the international climate change and biodiversity legal frameworks, this presentation will mainly concentrate on the significant importance of science in shaping a comprehensive legal regime governing Arctic high seas fisheries. In this regard, it is important to analyze the 2018 Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean (CAOFA), which is the first regional fisheries agreement of its kind. In establishing a de facto moratorium on commercial fisheries in the Central Arctic Ocean, the CAOFA shines through its stepwise approach to fisheries management embodied, inter alia, by the overarching role attributed to science as a determining feature for future developments.

This presentation is based on a paper that will be presented during the 11th Annual Conference of the Cambridge International Law Journal (26-27 March 2022) on the same topic by myself and Katharina Heinrich. By presenting our findings at the NAMMCO Marine Mammal Symposium in Tromsø, we hope to receive multi-disciplinary feedback and engage in thought-provoking discussions on why and how science should further be integrated into international law-making. Eventually, the debate on safeguarding marine mammals and their environment could also benefit from this presentation

Emma Vogel (University of Tromsø, Arctic Biology)

Killer whale movements on the Norwegian shelf are associated with herring density

Killer whales *Orcinus orca* 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 *Clupea harengus* 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. Our 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. Our data indicated that whales continue to feed on herring along the Norwegian shelf. We conclude 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.

Ingvild Ytterhus Utengen (University of Tromsø, Arctic Biology)

Characterizing searching behavior seen in Humpback Whale (*Megaptera novaeangliae*) during feeding on overwintering herring at the Norwegian coast

Humpback whale migration and large-scale movement patterns are well documented, however finer scale movement patterns and habitat use are not well understood. In this study we segmented whale tracks into five distinct movement modes to investigate small scale patterns and individual variability in searching behavior when foraging on overwintering herring at the Norwegian coast. This was done by using a change point analysis (BCPA) to select robust, homogenous velocity-persistence states at small scales and then modeled the net squared displacement (NSD) over time to differentiate movement modes. The movement modes categorized was ranging, encamped, nomadic, roundtrip and semi-roundtrip. The relationship between ranging and encamped mode is similar to the commonly assessed transiting versus area restricted search behaviors in previous studies. Round and semi-round trips might be associated to actions of search or dispersal. Out of all classified segments we found ~12% were trips and ~13% nomadic, meaning a total of 25% of segments classified were other movements than ranging and encamped. This study is the first to segment humpback whale tracks into five distinct movement modes, and confirms the method is useful and applicable to analyze smaller scale movement patterns for this species.

We also confirmed an interesting behavior on intermediate scale (8-22days) where whales leave a fjord area, performs a looping behavior on the Norwegian shelf before it returns to the initial fjord area. This excursion was documented in 4 out of 12 whales. Why the whales decide to leave a fjord where there is already a lot of herring is contrary to what optimal foraging theory would predict. The excursions happen during Christmas when fisheries are on a break. Possible explanations could be an association to fisheries, prey, or that excess energy allows longer researching trips. This study serves as a baseline for future studies investigating this phenomenon.

Sofia Albrecht (Galway Mayo Institute of Technology/Atlantic Technological University, Marine and Freshwater Research Centre)

Impacts of anthropogenic activities and environmental change on the foraging ecology and nutritional status of common dolphin and its implications towards sustainable resource management

Overfishing has massively depleted several target species in European waters, altering marine food webs and impacting populations of top predators. The common dolphin is one of the most abundant cetaceans in the North-east Atlantic, playing a key functional role as a top predator. Large-scale movements in recent years have resulted in increased numbers inhabiting continental shelf and contiguous waters and increased exposure, at the population level, to the direct and indirect effects of fishing. Due to their high energy requirements, common dolphins target energy-dense prey and increasingly, stranded dolphins are showing evidence of starvation/emaciation. Through availing of samples and data collected by Irish stranding and observer bycatch programmes over a 25-year period and a multi-disciplinary approach, this PhD will investigate temporal changes in diet and nutritional status in this species and identify drivers of change. Work will include conventional stomach contents analysis and progress novel molecular approaches for detecting prey DNA, to assess occurrence of dietary shifts, potential consumption of lower quality prey, annual energy requirements and prey biomass consumption. Spatial modelling will assess spatial-temporal variations in prey energy densities, and potential drivers of dolphin distribution patterns. While nutritional status indicators focusing on stress physiology will provide a deeper/novel understanding of the biological pathways underpinning nutritional deficiencies in cetaceans. Through developing multiple methods of enquiry and generating new data sources and evidence based on a more complete understanding of its dietary consumption, preferences and requirements, interactions with fisheries, and changes in predator-prey dynamics due to overfishing and environmental change, work will inform policy makers and managers on the sustainable use of fishery resources, employment of a nutritional status biodiversity indicator for cetaceans, and the conservation status of common dolphins.

Diofel Tampoy (Mindanao State University, Marine Biology)

Diversity, distribution, diurnal behaviors of marine mammals in the Sarangani Bay protected seascape, Southern Mindanao, Philippines

Studies on marine mammals in the Philippines are insufficient, and most researches on marine mammals are geographically biased towards Europe, North America, New Zealand, and Australia. In the southern Philippines, particularly in Sarangani Bay, there is a paucity of marine mammal studies despite being one of the conservation priority areas for cetaceans and dugongs. In order to contribute to management and conservation efforts in the Sarangani Bay Protected Seascape, small boat surveys were conducted between November 2021 to January 2022 following a systematic zig-zag transect line design. The group size, behavioral state, date, time, geographical location, environmental parameters, and sea state were recorded whenever an individual or group of marine mammals were sighted. A total of 365 km line transect was covered, and four marine mammal species were documented from two families. The Gray's spinner dolphin was the most sighted ($n = 61.97$ indiv/100km), followed by the Common bottlenose dolphin ($n = 27.97$ indiv/100km), Risso's dolphin ($n = 2.7$ indiv/100km), and Dugong ($n = 0.5$ indiv/100km). The distribution of marine mammals varied across the survey area but are regularly sighted in the municipal waters of Malapatan, Alabel, and General Santos City. With the exception of dugongs, these animals exhibited behaviors such as traveling ($n=53.33\%$), resting ($n = 20\%$), socializing ($n = 13.33\%$), foraging ($n = 6.67\%$), and milling ($n = 6.67\%$). All the species recorded were threatened under the Philippine Red List, but only dugong is threatened under the IUCN Red List. The presence of neonates and calves of Gray's spinner dolphins may suggest that the bay represents critical nursing and foraging grounds for the population. However, the growing pressure from shipping vessels in their habitat may impact marine mammals' overall population survival. The results provide support for the protected area status of the bay and reinforce strict management guidelines as outlined in the protected area management plan.

Jac Romaric (Institut Universitaire European de la Mer, Biology)

Going north or deeper, or both, what's it gonna be?

The continental shelf and deep waters are heavily subjected to anthropogenic pressures like fishing and climate change-related environmental changes. One of the consequences is the drastic decline of commercially exploited stocks and associated collateral damage to bycatch species, many of them being chondrichthyans. Squaliform sharks and chimaeriformes are estimated to be the most threatened marine orders due to high bycatch rates. In many areas, including the northern Northeast Atlantic, they are poorly understood, and knowledge of their distribution and its environmental drivers are urgently needed to inform species-specific monitoring and management plans. Three examples, and our study species, are the rabbitfish (*Chimaera monstrosa*), the velvet-belly lanternshark (*Etmopterus spinax*) and the Blackmouth catshark (*Galeus melastomus*) which are common in the Norwegian sea with very high annual bycatch rates. Using 26 years of a national survey and environmental data and applying a combination of statistical models and GIS mapping tools, our study revealed that environmental changes throughout the last decades seem to have largely influenced the distribution of these three species, as they have moved to deeper and more northerly waters. As this exposes them to potential interaction with larger fishing operations in the north and in deeper waters, their vulnerability to bycatch has most likely increased. Our study highlights the value of survey data and especially long-time series in improving our understanding of species ecology as well as trends over time and underlines the potential of historical marine ecology to provide 'baselines' for management. Indeed, understanding historical changes in distribution allows for predictive future distributions in the light of projected climatic changes.

An additional study is being carried out to answer how far their prey species might have shifted with them throughout the time period. This is an ongoing analysis, and I will, hopefully, present those results at the conference.

Azin Vedadi (University of Tromsø, Law)

The Synergy of Legal and Managerial Factors in Marine Mammals By-catch Mitigation strategies

Any strategy designed to mitigate marine mammal fisheries is undoubtedly dependent on the performance of a set of legislative and management factors. Our main assumption in this article is that the synergy of these factors maximizes the efficiency and effectiveness of the by-catch strategy. Synergy, is the best way to coordinate the tools, methods and measures of different factors to achieve a certain goal. Management factors play a role at the micro and macro levels and consist of economic and organizational tools (economic tools such as gears) and organizational tools such as monitoring and evaluation (Monitor and Estimate). Legal factors can be effective at the national and international levels and include laws, regulations, judicial procedures and judicial interventions. It is clear that economic tools and methods of organization always need the support of legal tools and measures, and the application of regulations and judicial procedures also involve the proper functioning of economic tools and organization. As a result, if these two sets of tools and actions do not interact with each other in a determined framework, the effectiveness of the strategy and its desirability will decline sharply. Our emphasis in this article is on becoming more familiar with this synergy and we also try to find the effective factors influencing its formation and strengthening according to experience of NOAA (Administration National Oceanic and Atmospheric).