

## Observations of gadoid feeding by large baleen whales in the Norwegian Sea

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### Summary

In this study, systematic transect observations of cetaceans were collected in the Norwegian Sea between the 4<sup>th</sup> and 28<sup>th</sup> of July 2013. Coherent multi-frequency acoustic recordings and systematic net and trawl station data were collected for analyses of potential relationships between cetacean distribution and the most abundant plankton and fish species. Preliminary results show that killer whales were allocated to the central and northern part of the Norwegian Sea associated with small and loose shoals of adult northeast Atlantic mackerel. Fin whale sightings were made in the northeastern part of the Norwegian Sea and along the coast of Finnmark. White beaked dolphins overlapped with the areas of the fin whale sightings. Humpback whale sightings were made south of Bear Island and also in the northernmost part of the Norwegian Sea. The fin whale, white beaked dolphin and humpback whale observations were associated with high and dense concentrations of juvenile cod and haddock appearing in the upper 50 m of the water column, clearly indicating foraging activity. Fin- and humpback whales are normally associated with krill, amphipods and pelagic fish in this area; this is the first time such significant overlap between large baleen whales and juvenile gadoids has been documented.

### Introduction

During the last decade, several ecosystems including the Norwegian Sea in the Northeast Atlantic have experienced considerable changes in abundance and composition of species important as prey for cetaceans that reside in large numbers throughout the summer season (Evans *et al.* (2010). The distribution and abundance of Northeast Atlantic mackerel, Norwegian spring-spawning herring and blue whiting have changed significantly the last ten years (ICES 2013). A general warming of the water masses of this system is regarded a major driver of the current registered ecosystem change (Huntington and Moore 2008). We aim at studying the in situ behaviour and ecology of cetaceans when combining different visual, acoustic, oceanographic and biological techniques and data in a synoptic way to better understand the feeding ecology of cetaceans

### Materials and methods

In this study, systematic transect observations of cetaceans were collected in the Norwegian Sea between the 4<sup>th</sup> and 28<sup>th</sup> of July 2013. Coherent multi-frequency acoustic recordings were done with a Simrad ER 60 echosounder including the frequencies 18, 38, 70, 120 and 200 kHz. The acoustic data were scrutinized using the post-processing system Large Scale Survey System (LSSS) (Korneliussen *et al.* 2006). Systematic trawl station data were collected with a standardized Mulpelt 832 pelagic sampling trawl for analyses of potential relationships between cetacean distribution and the most important juvenile and adult fish species. Oceanographic recordings of temperature, salinity and oxygen were sampled from the surface to a maximum of 500 m depth with a SAIV CTD sensor.

Plankton samples were taken as vertical tows from the surface down to a maximum of 200 m depth with a WP2 180µm mesh size plankton net.

### Results and Discussion

Killer whales were allocated to the central and northern part of the Norwegian Sea associated with small and loose shoals of northeast Atlantic mackerel. This is similar results as documented earlier on killer whale feeding ecology by Nøttestad *et al.* (2014). Fin whale sightings were made in the northeastern part of the Norwegian Sea and along the coast of Finnmark. White beaked dolphins overlapped with the areas of the fin whale sightings. Humpback whale sightings were made south of Bear Island and also in the northernmost part of the Norwegian Sea. This is in line with results from Nøttestad *et al.* (2013). A large number of dense aggregations of juvenile fish from cod, haddock and herring were recorded on the echogram from the surface and down to about 50 m depth (Figure 1). Verifications of these juvenile fish aggregations were done by pelagic trawling and 0-group cod, haddock and herring were caught in the pelagic Multipelt 832 trawl. A large numbers of fin- and humpback whales and white beaked dolphins were associated with and in a close vicinity to dense aggregations of juvenile cod and other species such as haddock and herring. We strongly believe these large baleen whales were aggregating in the area to feed on dense aggregations of juvenile fish dominated with juvenile cod and haddock caught in the trawl samples. Fin- and humpback whales are normally associated with krill, amphipods and pelagic fish in this area (Nøttestad *et al.* (2013). Thus, this is the first time such significant overlap between large baleen whales and juvenile gadoids has been documented.

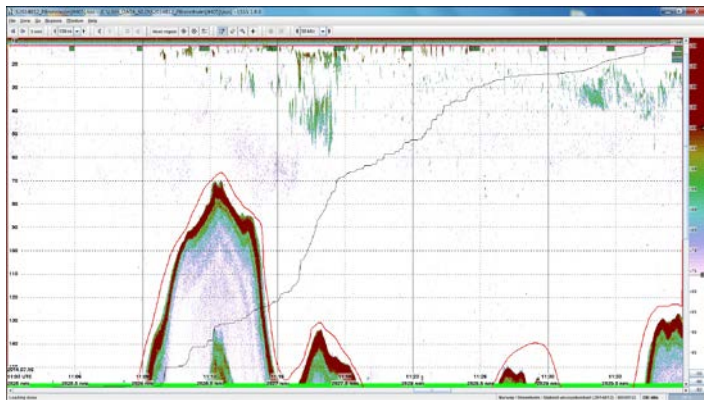


Figure 1. Echogram printout showing juvenile cod, haddock and herring in the upper 50 m of the water column along the coast of Finnmark.

### References

- Evans P.G.H., Pierce, G. Panigada S. 2010. Climate change and marine mammals. *Journal of the Marine Biological Association of the U.K* 90:1483-1487.
- Huntington H.P. and Moore S.E. (eds) 2008. Arctic marine mammals and climate change. *Ecological Applications* 18(Supplement):S1-174.
- ICES. 2013. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 27 August - 2 September 2013, ICES Headquarters, Copenhagen, Denmark. ICES CM 2013/ACOM:15. 950 pp.
- Korneliussen, R. J., Ona, E., Eliassen, I., Heggelund, Y., Patel, R., Godø, O.R., Giertsen, C., Patel, D., Nornes, E., Bekkvik, T., Knudsen, H.P., Lien, G. 2006. The Large Scale Survey System - LSSS. Proceedings of the 29<sup>th</sup>. Scandinavian Symposium on Physical Acoustics, Ustaoset, 29 January – 1 February, 2006.
- Nøttestad, L. and E. Olsen. 2004. Whales and seals: top predators in the ecosystem. In: *The Norwegian Sea Ecosystem* p.395-434 Ed. by. H.R. Skjoldal, O.A. Misund, R. Sætre, A. Fernø and I. Røttingen
- Nøttestad, L., L.D. Sivle, B.A. Krafft, L. Langård, V. Anthonypillai, M. Bernasconi, H. Langøy, B.E. Axelsen 2013. Ecological aspects of fin whale and humpback whale distribution during summer in the Norwegian Sea. *Marine Ecology* 1-12 doi:10.1111/maec.12075
- Nøttestad, L., L.D. Sivle, B.A. Krafft, L. Langård, V. Anthonypillai, M. Bernasconi, H. Langøy, A. Fernø 2014. Prey selection of offshore killer whales *Orcinus orca* in the Northeast Atlantic in late summer: spatial associations with mackerel. *Marine Ecology Progress Series* 499:275-283.