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winter arrivals of herring and whales into Northbased fisheries in
Kaldfjord/Vengs&oslash;yfjord and outside Kval&oslash;ya, and a
large fraction of humpback whales migrating south from the
Barents Sea now appear to use the same region as a temporary
feeding stopover. However, the timing of arrival and departure of
both herring and whales remains uncertain. As a continuation of a
pilot study in 2013 and repeated surveys in 2014, 2015 and 2016,
this project will examine key aspects of these events, and
attempt to describe the key drivers and broad consequences of

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such superabundance occurrences in constricted fjord systems.

Goal

This project will provide important data to understand the dynamics associated with overwintering migrations in NSS herring, and the potential role of climate change, oceanography, predation and fisheries in potential future changes in this migration pattern. This project is a key step in the planned development of an innovative, integrated science, education, communication and outreach program based on the concepts of public participation, 'citizen science' and open data access.

Summary of Results 2017

In early 2017 we successfully completed our 4th field season (2 of which have so far been done with support from the F&K Flagship. During the 2016–2017 field season, we further expanded on our already extensive national and international collaborative network, adding scientists from Japan (Atmosphere and Ocean Research Institute, University of Tokyo). We also continued a collaborative research project with colleagues from Scotland and France, focusing on behavioural responses by humpback whales to underwater sound, specifically that of killer whales. We completed a total of 6 hydroacoustic surveys from a small research vessel, and an additional one extended survey with the assistance of colleagues at the Institute of Marine Research aboard their R/V GO Sars. This vessel also extended the range of our visual surveys for whales by including one whale observer (Mr Evert Mul). In terms of the photo-ID effort on humpback whales, we now have over 860 individuals catalogued in our database, and the majority of these sightings have been collected as part of weShare-related fieldwork over the past 3–4 seasons (Fig 1.). Four more acoustic surveys are planned to be undertaken in November–December 2017.

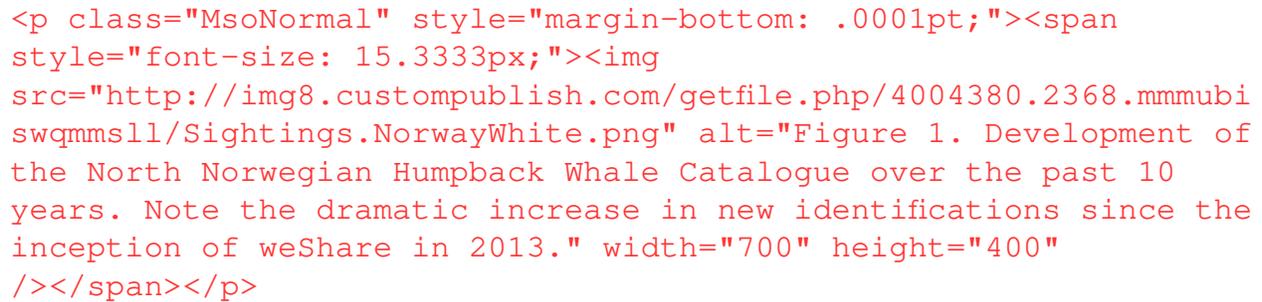


Figure 1. Development of the North Norwegian Humpback Whale Catalogue

over the past 10 years. Note the dramatic increase in new identifications since

the inception of weShare in 2013.

In collaboration with the University of Tromsø, and supported by a Insentivmidler grant, we also deployed 11 satellite transmitters on humpback whales to track their migrations after they leave the local fjord area. The duration of transmissions from these whales varied from ~2 weeks to over 6 months, and three whales were tracked for their entire migrations to the Caribbean breeding grounds. To stimulate public interest in our work, these tracks were published online (<https://whaletracking.uit.no/>), and the site has had more than 1000 visits since it was published in April 2017. After 4 seasons of accumulating long data series, we have now built up a solid dataset that is now mature and ready to be exploited for analyses and publications. Fisheries data and whale surveys have shown the tight link between these two occurrences, and how the dynamics of these occurrences have developed over the years our study has been carried out (Fig. 2 and 3).

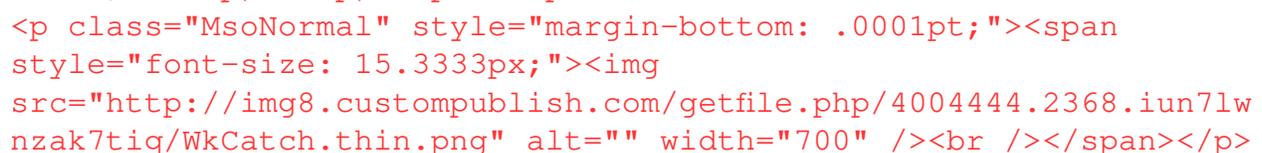


Figure 2

left: 30px; ">Figure 2. Weekly catches of NSS herring nationwide (grey) and in the 5-31 subarea (blue) which includes our focal study area. Note the reduction in overall nationwide catches and the increase in proportion of nationwide catches occurring in subarea 5-31. Source of fisheries data: Fiskeridirektoratets Statistikkbank.</div>

<div class="MsoNormal" style="margin-bottom: 0.0001pt;"> </div>

<div class="MsoNormal" style="margin-bottom: 0.0001pt;"></div>

<p style="padding-left: 30px;">Figure 3. Weekly catches in subarea 5-31. Notice the gradual lengthening of the season, and the bimodal pattern caused by a break in fishing over Christmas and New Year’s, and the start of fishing the new year’s quota. Minimum estimated number of individual humpback whales present (based on photo-ID data) is indicated in red. Note that photo-ID data from 2016/2017 has not yet been completely analysed, and numbers will likely be higher than indicated here. Source of fisheries data: Fiskeridirektoratets Statistikkbank.</p>

<p class="MsoNormal" style="margin-bottom: .0001pt;">In addition, our detailed and regular echosounder surveys in vengsfjord and Kaldfjord have shown the substantial dynamic variation in herring distribution and biomass in these two fjord systems (Fig. 4), and allowed us to estimate the maximum biomass of herring inside the fjords (Fig. 5). </p>

<p class="MsoNormal" style="margin-bottom: .0001pt;"></p>

<div class="MsoNormal" style="margin-bottom: 0.0001pt; padding-left: 30px;">Figure 4. Biomass estimates of NSS herring in Kaldfjord and Vengsfjord Nov 2014 – Jan 2015 (dotted lines show 95% confidence intervals).</div>

<div class="MsoNormal" style="margin-bottom: 0.0001pt; padding-left: 30px;"> </div>

A map showing transect lines and relative herring biomass along those lines during repeated surveys in the 2015-2016 season. The map is titled "Transect Biomass Map" and has a width of 800 pixels.

Figure 5. Map of transect lines and relative herring biomass along transect lines during repeated surveys carried out in the 2015-2016 season. Note the seasonal dynamics and progression of herring inward and outward migration as the season progresses.

So far, these analyses have been completed for the 2014-2015 season, and work is now underway to process the entire dataset for all years of study. Since the herring appears to have moved northeastward to the Kvænangen area this year, the weShare project now enters into a more focussed analysis and write-up phase, and fieldwork will be limited during the ongoing season.

To date, weShare has directly contributed to two local PhD projects, and has directly led to the successful recruitment of one VISTA PhD student, who will focus on the spatial and temporal overlap between whales and vessel traffic, as well as predicting the exposure of whales to environmental pollution such as oil spills. There are also a number PhD and postdoctoral students involved in the project via our international collaborators. In addition, weShare has laid the foundation for work specifically addressing the detailed interactions between whales and local tourism, and an application was recently submitted to the Regional research Fund for Northern Norway (RFFNORD) to specifically focus on this issue. weShare has thus directly led to substantial competence building among Tromsø-based institutions, and also supported several successful proposals as well as proposals still under evaluation. Results from weShare and associated projects were recently presented at the Biennial Conference on the Biology of Marine Mammals in Halifax, Nova Scotia, Oct 22-27.

Master and PhD-students involved in the project

family: Calibri, sans-serif;">Masters students:

Mr Kevin Ochoa (UiT)

PhD students:

Ms Ana Sofia Aniceto (APN)

Mr Evert Mul (UiT)

Mr Benjamin Benti (Cerema (France), University of St-Andrews (UK), University of Strasbourg (France))

Mr Rene Swift (University of St Andrews, Scotland)

For the Management Extensive analyses of fisheries data are being undertaken to map the

fisheries and estimate the fishing intensity in the Kaldfjord/Vengsfjord study area in relation to the distribution and biomass of herring measured from repeated EK60 echosounderf surveys, and also in relation to the overall national fishery on NSS herring. These analyses will be updated at the end of the 2017–2018 field season and written up as a management oriented research paper. Interactions with the Coast Guard (Kystvakten) and the Fisheries Directorate have been initiated as part of the ongoing field season. Platforms of opportunity will be provided by the Fisheries Directorate's Sjøtjeneste when their new coastal vessel becomes operational in Jan 2018.

Published Results/Planned Publications

Gjelland, K., Biuw, EM et al. Seasonal dynamics of herring distribution and biomass in a constricted fjord system (planned submission Dec 2017)

Biuw, EM, Broms, F, Rikardsen, A et al. Resights and residence times of humpback whales at a north Norwegian feeding stopover (planned submission Jan 2018).

Stevick, P., Berrow, S., Bævre, M., Bouveret, L., Broms, F., Jann, B., . . . Wenzel, F. (2016). There and back again: Multiple and return exchange of humpback whales between breeding habitats separated by an ocean basin. *Journal of the Marine Biological Association of the United Kingdom*, 96(4), 885–890. doi:10.1017/S0025315416000321

Communicated Results

Aniceto, AS, Biuw EM, Lindstrøm, U, Carroll, JL (2017) Model-based detection of marine mammals using an Unmanned Aerial Vehicle (UAV) – survey design and detection probability. Poster presentation, Biennial Conference on the Biology of Marine Mammals, Halifax, Nova Scotia, Oct 22–27, 2017

Charlotte Curç, Patrick J. O. Miller, Saana Isojunno, Benjamin Benti, Fleur Visser, Heike Vester, Nicoletta Biassoni, Erik Martin Biuw (2017) Vocal discrimination of fish- and mammal-eating killer whales sounds by humpback and pilot whales. Oral presentation, Biennial Conference on the Biology of Marine Mammals, Halifax, Nova Scotia, Oct 22–27, 2017

Fredrik Broms, Frederick W Wenzel, Pedro Lopez Suarez, Audun Rikardsen, Erik Martin Biuw, Peter Stevick, Manuel Rodrigues, Thomas Fernald (2017) Fashionably late – From Norway to Cape Verde: New insights into the migratory behavior of an endangered humpback whale population. Poster presentation, Biennial

Conference on the Biology of Marine Mammals, Halifax, Nova Scotia, Oct 22-27, 2017

Takashi Iwata, Kagari Aoki, Patrick J. O. Miller, Erik Martin Biuw, Michael Williamson, Katsufumi Sato (2017) A humpback whale utilizes fishing boats to forage on herring. Poster presentation, Biennial Conference on the Biology of Marine Mammals, Halifax, Nova Scotia, Oct 22-27, 2017

Interdisciplinary Cooperation

Citizen Science project: Hvalid-Image-based identification of humpback whales. Participation by locals, tourist operators and several research organisations.

WhaleFeast - Ecological, commercial and social challenges of the recent extreme winter arrivals of whales in Northern Norway. Multidisciplinary application submitted to RFFNORD, Oct 1 2017.

Budget in accordance to results

Given the budget constraints within the Fram Centre Flagships, the weShare project (along with its companion projects, e.g. WHALE (A. Renner, IMR) has attempted to showcase how an approach using relatively simple infrastructure, such as small vessels, can accomplish a great deal of high-quality field data collection within nearshore fjord systems. This small scale approach has also allowed us to be flexible and adaptable in our sampling protocols, showing how such an approach can be utilized as a "fast-response" data collection setup at times and places of rapid and sudden dramatic changes. We believe such an approach can substantially improve our ability to address unforeseen but potentially important processes in marine systems, and should be considered as an extension to more traditional large platform marine science.

Could results from the project be subject for any commercial utilization

No

Conclusions

The weShare project took advantage of a sudden dramatic change in the migration and overwintering patterns of one of the most important commercial fish species in Norwegian waters. The consequences in terms of fisheries, whale tourism and ecosystem responses have been dramatic. Similar situations, with high concentrations of prey and associated large congregations of

whales, have occurred in the past, and are currently also observed in other parts of the world's oceans. The situation in Norway has received substantial interest, and was recently highlighted in an interview in Science magazine

(<http://www.sciencemag.org/news/2017/10/hundreds-humpback-whales-are-massing-tiny-spot-ocean-here-s-why>)</p>

<p>After 4 years of intensive data collection, the project now enters into a more focussed analysis and publication phase, and given the great international interest in these events, and provided continued funding, we expect a large number of high.profile publications to be generated over the coming 1-2 years. </p></dd></dl></fieldset></body></html>