

Project information

Keywords

benthos, modeling, scavenging, ecosystem impacts

Project title

EFFECTS: Examining the role of Fish-Falls on ECosystem processes in highly exploitEd fjord Systems

Year

2018

Project leader

Paul Renaud

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)

69.8°N 18.7°E

Participants

Katherine Dunlop, Ole Anders Nøst, Qin Zhou (Akvaplan-niva)

Evgeniy Yakushev (NIVA)

Martin Biuw, Angelika Renner (Institute of Marine Research)

Andrew Sweetman (Heriot Watt University) (UK)

Daniel O B Jones (National Oceanography Centre) (UK)

Flagship

Fjord and Coast

Summary of Results

Within the past decade, a large proportion of the migrating Norwegian Spring Spawning herring stock has made an extended stopover in the fjords of Kvaløya. This has led to intense fishing efforts whereby over 90% of the Norwegian catch during this period has been in Kaldfjorden waters. In addition, hundreds of both killer whales and humpback whales have followed the herring to these coasts. The herring catch and whale tourism has added greatly to the local economy, but this superabundance of herring has led to mass mortality in salmon pens as the herring schools can reduce oxygen levels to lethal levels. High mortality levels in herring are suspected from predation, and it is likely that considerable numbers of dead and injured herring fall to the fjord floor after unsuccessful predation or fishing efforts. Large fish falls are found in oceans around the world, and can provide significant organic input to the benthic system. In fjords of the size of Kaldfjorden, this rapid flux of labile food from herring falls could have significant effects on the benthic system, but these effects have not been studied. Our objective in this Fram proposal is: **to determine the impact of organic inputs from herring-falls on benthic community functioning.**

This Fram project fits into the framework of our on-going JellyFarm project, which evaluates the consequences of the combined inputs of OM on ecosystem and socio-economic processes. To carry out this work we need to determine how much OM from herring falls reaches the seafloor, how quickly it is scavenged by fishes and hyperbenthic invertebrates, and then evaluate the effects of this net input on sediment community processes. We use a validated biogeochemical model (BROM, Yakushev et al. 2016) to identify the effects of multiple OM sources.

This report summarizes work performed specifically through EFFECTS, even though there is significant overlap with the F&C weShare and WHALE projects. Please consult the specific reports for those projects for details.

The main field work for this project took place in early December 2017 from *Johan Hjort*. We conducted yo-yo camera transect to determine the abundance of herring (and other organic falls) on the seafloor. At the same time, we determined scavenging rates on herring carcasses using a baited time-

lapse camera lander (Dunlop et al. in press). We will compare results to those from scavenger lander trials on Svalbard in August 2017 (Fig. 1). Results from Svalbard indicated large differences among fjords in scavenging intensity, which could have important implications for spatial differences in benthic processing of organic matter.

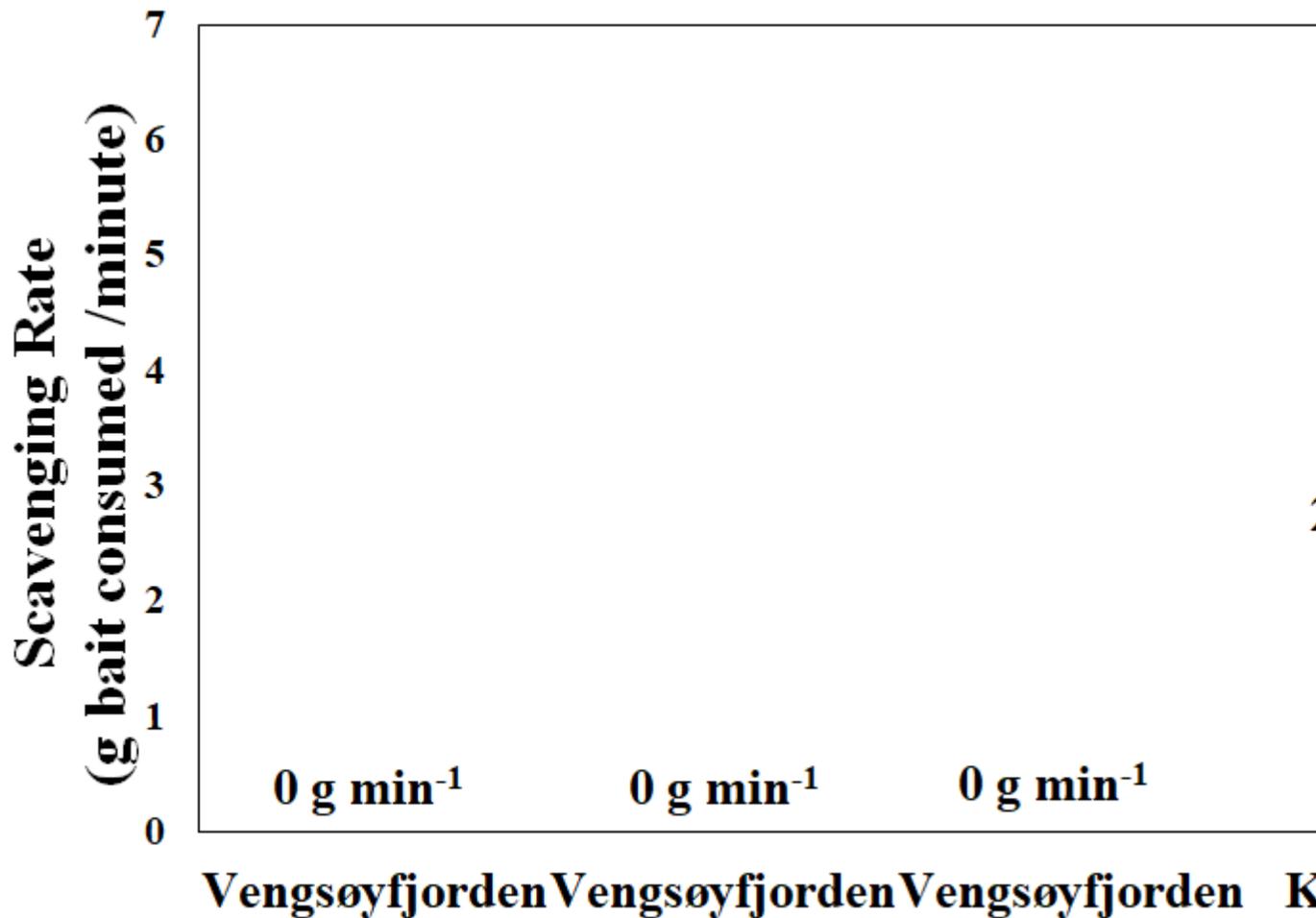


Figure 1. Scavenging rates on herring calculated from deployments in Kaldfjorden and neighboring Vengsøyfjorden.

Hydrographic modeling will be performed in two ways, with the ROMS platform that uses identical square grids (160 m x 160 m), and the unstructured grid FVCOM platform. Both FVCOM and ROMS runs have begun (see WHALE annual report). Data will be compared to identify prominent circulation features. Preliminary results suggest highly variable circulation with periodic eddies dominating flow for several days at a time (Fig. 2)

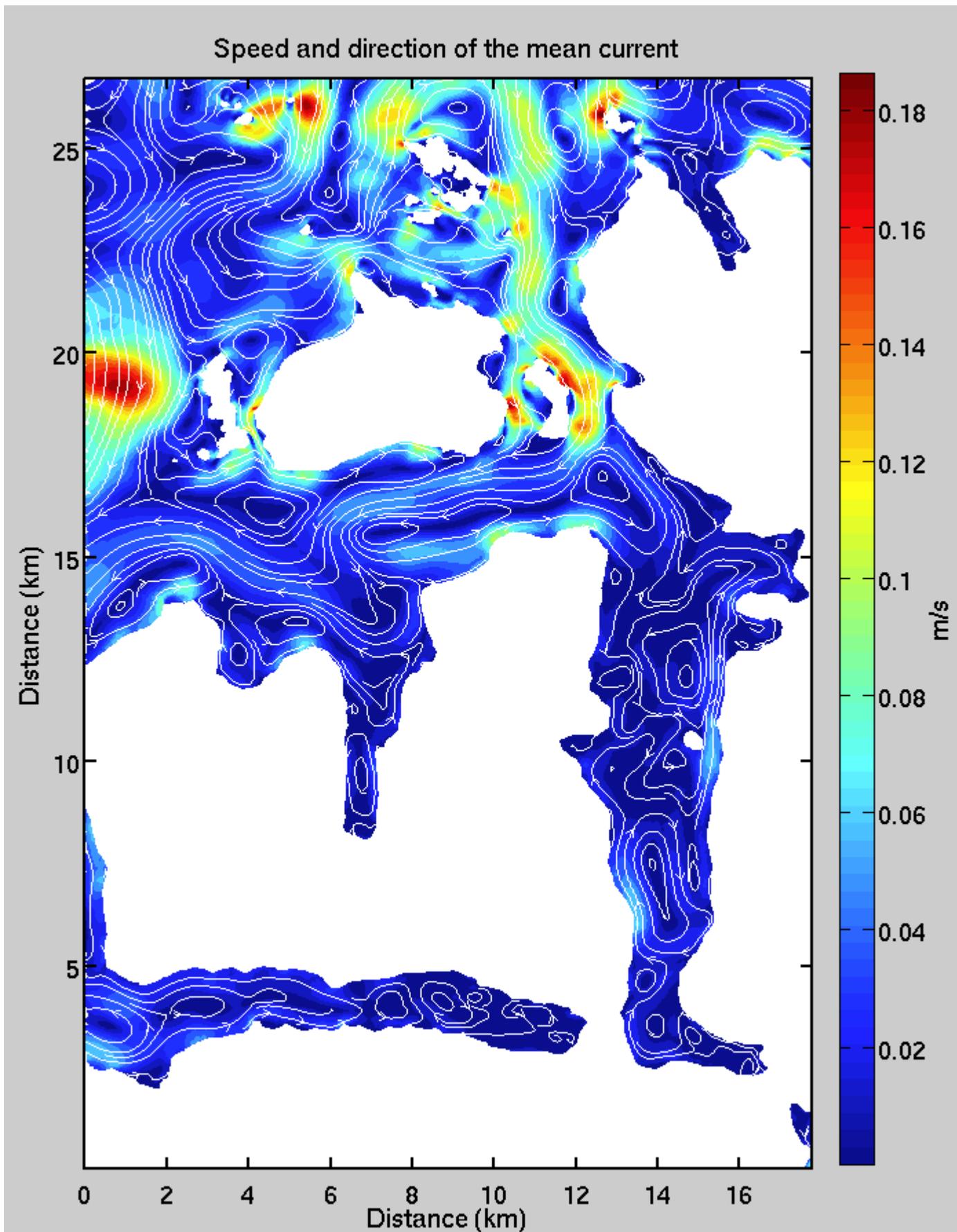


Figure 2. FVCOM results for the Kaldfjorden region. Current patterns are shown for 31 December

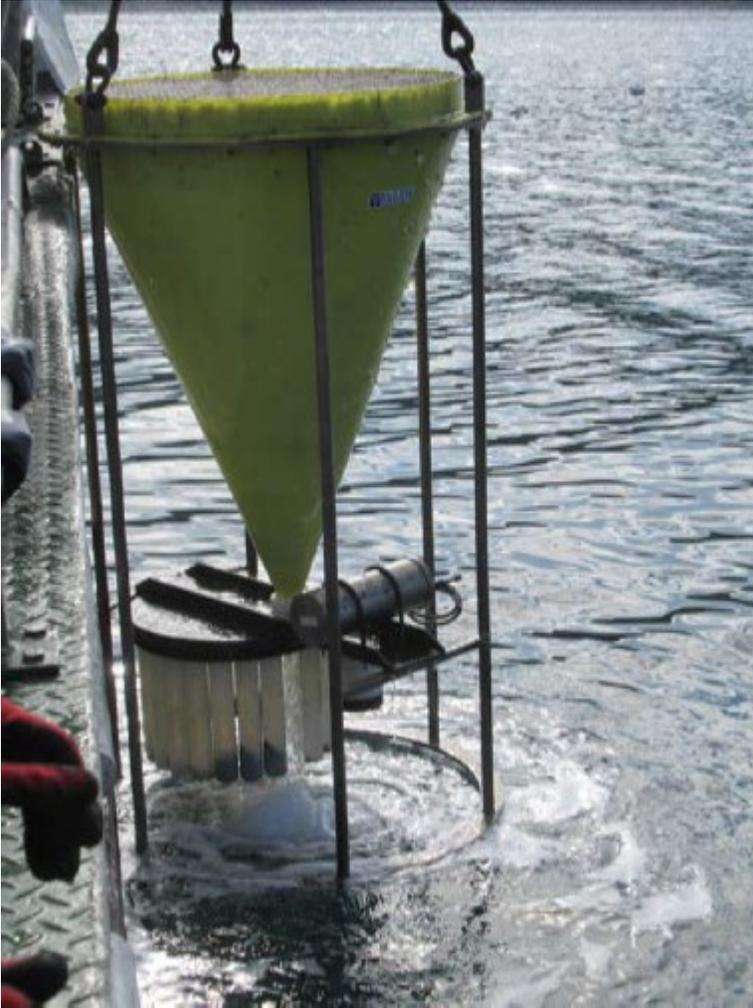


Fig. 3. Rotating sediment trap sampling vertical flux over an annual cycle.

In July 2018, moorings were recovered from two locations in the fjord after 10 month deployments. Each mooring included sediment traps collecting a time series of vertical flux (Fig. 3) and an Acoustic Doppler Current Profiler (ADCP) for measuring 3-D current velocities throughout the water column. ADCP data are still being processed and will be compared to model outputs, as well as being used to parameterize flow in the integrative biogeochemical model. The sediment traps had remarkably similar flux estimates, and indicated autumn and late winter peaks in vertical flux, with a diatom flux event in early April. These results will be combined with those from monthly short-term (24 h) trap deployments conducted the the WHALE project of the Fjord and Coast Flagship.

Data from all three Flagship projects will be integrated in the BROM biogeochemical model run by Evgeniy Yakushev at NIVA. Additional parameterization of the model will come from results of the NFR-funded JellyFarm project.

Master and PhD-students involved in the project

PhD student Robert Harbour (HWU). Several other MS and PhD students (from HWU, UiOslo, U Gent (Belgium), and UiT) are involved indirectly through the JellyFarm, weShare, and WHALE projects.

This study addresses ecosystem-relevant processes linked with community structure in a fjord system of high economic and social importance. The Kaldfjorden ecosystem has supported the coastal fishery for Norwegian spring-spawning herring in recent years, and a vibrant tourism industry around whale watching. Changing herring dynamics, as suggested by the absence of large herring schools in 2017-18, indicates the need for a general understanding of the effects of herring on northern fjord systems for general understanding of their consequences. Management of the system for maximum sustainability in the face of multiple and fluctuating uses is only achievable through an integrated ecosystem understanding involving the physical environment, biotic communities, and the human dimension. This project contributes to such a multi-faceted perspective.

Published Results/Planned Publications

1. Dunlop, Sweetman, Harbour, Berge, Tandberg, Renaud. Variable roles of Atlantic cod in scavenging activity of high Arctic fjords. *in preparation, to be submitted February 2019*
2. Lalande, C, I Wiedmann, Z Walker, P Renaud, A Renner. Seasonal cycles of vertical flux in an Arctic fjord: insights from short- and long- term sediment traps. February 2019
3. Yakushev, Nøst, Zhou, Wiedmann, Sweetman, Renner, Biuw, Renaud. Implications of multiple sources of organic matter on benthic ecosystem processes: insights from a combined hydrodynamic-geochemical model. *Autumn 2019*
4. Skardhamar, Zhou, Myksvoll, Renner, Renaud. Comparison of two modeling platforms in resolving hydrodynamics in Kaldfjorden, north Norway. *Autumn 2019*

Communicated Results

The JellyFarm project runs a blog (<http://jellyfarmproject.blogspot.no>) where work from the combined F&C projects have been highlighted. In addition, we have published an article in Svalbardposten ('Se opp for disse når du bader!' Berge, Sweetman, Renaud, Dunlop, 25.08.2017) on scavenging in Svalbard fjords. This work was also profiled on Akvaplan-niva's Facebook site.

In addition, scavenging and the Svalbard experiments were well integrated into the recent Arctic Benthic Ecology course (AB321/821) at UNIS in Autumn 2017. Students learned the theory and practice of scavenging ecology and one of the course projects specifically dealt with this topic.

Renaud, PE, M Biuw, A Renner, KØ Gjelland. 2018. Herring impacts on north Norwegian fjord ecosystems. *Fram Forum* pp 20-23.

Dunlop, K., Renaud, P.E., Berge, J., Sweetman, A. 2018. Is the northern expansion of Atlantic cod (*Gadus morhua*) impacting scavenging communities in high Arctic fjords? *Deep Sea Ecology Meetings*, 10-14 September 2018, Monterey, CA USA (oral presentation)

Wiedmann, I, and 11 co-authors. 2018. From water to whale: ecosystem studies in Kaldfjorden. *Fjord and Coast Flagship DialogueDay*. 16 October 2018, Tromsø. (similar presentations have also been made at several workshops and the opening ceremonies of the Fram Centre)

Interdisciplinary Cooperation

This project is one of three F&C projects studying aspects of the Kaldfjorden ecosystem. weShare (M Biuw) investigates herring populations, whale migration and feeding, and citizen science. WHALE (A. Renner) performs hydrodynamic modeling (ROMS and co-funds the FVCOM modeling this project also contributes to), water column sampling for nutrients and the CO₂ system, and short-term vertical flux estimates on a monthly basis through the year. EFFECTS has collected data on annual cycles in vertical flux and ocean currents from two moorings in the fjord. These different kinds of sampling and modeling complement the work done here and will be integrated in the BROM modeling framework.

Budget in accordance to results

Yes.

Could results from the project be subject for any commercial utilization

No

Conclusions

The fieldwork for this project has been successful and we see no major problems conducting the remaining lab work as planned. Oceanographic modelling (and thus the dependent biogeochemical modeling) are somewhat delayed, but model runs are in progress. Herring and whales did not re-entered Kaldfjorden in large numbers in the winter 2017-18, so the immediate relevance of herring-falls is reduced, but the effects of organic fluxes on benthic processes, and scavenging on fish-falls, are highly relevant for many fjords. The larger context this project is placed in, both the combined F&C projects in Kaldfjorden and the JellyFarm project, will provide valuable information on ecosystem functioning and dynamics.