

Project information

Keywords

oceanography, marine biology, chemical oceanography, fjord, seasonality

Project title

Impact of massive Winter Herring Abundances on the KaLdfjorden Environment (WHALE)

Year

2019

Project leader

Angelika Renner

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

Kaldfjorden, Troms, approx. 69.8°N, 18.7°E

Participants

Project leader: Angelika Renner (IMR)

Participants: Jon Albretsen, Lars Asplin, Martin Biuw, Melissa Chierici, Elizabeth Jones, Anna Nikolopoulos, Jofrid Skarðhamar (IMR), Ole Anders Nøst, Paul Renaud, Qin Zhou (Apm), Marit Reigstad, Ingrid Wiedmann (UiT), Zoe Walker (UW/UiT) Evgeny Yakushev (NIVA)

Flagship

Fjord and Coast

Funding Source

Fram Centre flagship Fjord and Coast

Summary of Results

WHALE investigates the physical, chemical and biochemical environment of Kaldfjorden. The fjord has recently experienced massive winter herring abundances and high numbers of whales with large effects on the local fisheries, aquaculture industry and tourism. Close collaboration with two other Fram Centre Fjord and Coast projects (weShare, PI M. Biuw; EFFECTS, PI P. Renaud; both ended in 2018 but analyses continue) and the RCN project JellyFarm (PI P. Renaud) provided an integrated investigation into the physical-biological-human coupling in this fjord where baseline data are lacking, making impact assessments of extreme events such as the herring invasions difficult.

In this third and last project year, focus was

1. on consolidation of the observational results – all biological and chemical samples are processed, and manuscripts addressing Tasks 1.1, 3.1 and 4.1-3 are in very advanced stages close to submission;

2. finalising the hydrographic model runs, and analysing the output – both FVCOM and NorFjords were now run for periods covering the WHALE sampling as well as

focus periods for weShare and EFFECTS (Task 1.3). A manuscript addressing Tasks 1.2 and 2.1-2 is in preparation;

3. data exchange with weShare, EFFECTS and JellyFarm – this is ongoing (Tasks 1.3, 3.3 and 4.3) and will continue throughout 2020 as analyses and publishing of results will continue after the official end of the projects.

WHALE revealed a surprising amount of complexity in the fjord's hydrography, both spatially and temporally. This impacts the fjord's chemical and biological environment. Large seasonal variability was visible throughout the fjord system with closely interlinked processes influencing hydrography, water chemistry, biological activity, and pelagic-benthic coupling. Even in a small fjord like Kaldfjorden, highly variable circulation features lead to spatial variability, and despite limited river runoff, seasonal freshwater input plays a major role in structuring the physical and chemical environment.

Successful collaboration of the three Fram Centre-funded Kaldfjorden-focused projects was continued with regular meetings involving all participants. To ensure a fully integrative outcome, planning work on a synthesis has begun and will likely result in a new proposal to the Fram Centre Fjord&Coast flagship in 2020.

Students in the UiT courses BIO-2516 Ocean Climate (BSc level course) and BIO-3504 Production and Growth in Polar Areas (MSc level course) collected data and conducted course projects during a teaching cruise onboard RV Helmer Hanssen in Kaldfjorden also in 2019. Data, analyses and experiments were linked to WHALE sampling and results, and opportunistic sampling of the inflow paths into Kaldfjorden will form the base of an additional manuscript. As a side note, participation in the teaching cruise enabled a study into cruise based teaching, which has been submitted for publication (Wiedmann et al., submitted; see list of submitted publications).

Master and PhD-students involved in the project

Emily-zoe Walker, Master of Resource Management, University of Akureyri, University Centre of the Westfjords, Isafjordur, Iceland: Pelagic-Benthic Coupling in a Northern Norwegian Fjord Over Winter: Considering Seasonality in High-Latitude Aquaculture. May 2018

BSc students:

Emma Persson, BSc, Uit: A comparison between short-term sediment traps with filtered sea water and without during two contrasting periods with respect to Chl a and phytoplankton composition. June 2018

For the Management

The fjords in our neighbourhood are important for our health and wellbeing, as recreational area, but also for industrial activity such as aquaculture and tourism. In several winters during the past years, Kaldfjorden was visited by massive numbers of herring and whales, which led to an explosive development of whale tourism concurrently to ongoing fishery. The herring invasions had obvious effects on the fjord environment as the salmon in the aquaculture farm in the innermost part of Kaldfjorden suffocated due to low oxygen concentration in the water.

In order to improve our understanding of the impact of such extreme events on the fjord environment, better knowledge of the interaction between physical, chemical, and biological processes and between water column and seafloor is needed. After a year of monthly surveys with hydrographic measurements and chemical and biological sampling, we clearly see how seasonal signals dominate the processes in the entire fjord system. Winter mixing of the present water masses, large freshwater input in spring, and stratification in summer determine circulation patterns and seasonal availability of nutrients. Combined with the low biological activity in winter, the phytoplankton bloom in spring, and secondary productivity in summer, vertical particle and carbon fluxes vary greatly throughout a year. Impact assessments of human activity in northern Norwegian fjords have to take into account variability due to seasonality.

Published Results/Planned Publications

Published:

- A. H. H Renner, K. Dunlop, I. Wiedmann, J. Skarðhamar, E. Mul (2019): A tale of a local fjord - investigating a marine system in our backyard. *Fram Forum* 2019, p. 50-55

- J. Petersen, CTD in Kaldfjorden. Bachelor thesis, UiT-The Arctic University of Norway, December 2018.

Submitted:

- I. Wiedmann*, A. H. H. Renner*, C. Barth-Jensen, S. Gamst, F. Norrbin, B. Schartmüller, T. Vonnahme: What do we gain from cruise-based teaching in marine science university education? *Oceanography*, submitted September 2019. (* shared first-authorship)

Planned/In preparation:

- E. Jones et al: The impact of seasonality on hydrography and water chemistry in a sub-Arctic fjord. To be submitted December 2019.

- E. Jones et al: Nutrient and DIC data from Kald fjorden, 2016-2018. To be submitted for public access in NMDC upon submission of the above manuscript.

- A. Renner: Hydrographic data from Kald fjorden, 2016-2019. To be submitted to NMDC upon submission of the above manuscript.

- Z. Walker et al: Pelagic-benthic coupling in a sub-Arctic fjord from autumn to spring. To be submitted winter 2019/2020.

- A. Nikolopoulos et al: Seasonality in fjord circulation and hydrography as represented in two different numerical ocean models. Spring 2020.

- E. Jones et al: Seasonal dynamics in hydrography and biogeochemical cycling in a sub-Arctic fjord. Abstract to be submitted for presentation at EGU General Assembly, May 2020.

- A. Renner & I. Wiedmann: What do we gain from cruise-based teaching in marine science university education? Abstract to be submitted for presentation at EGU General Assembly, May 2020.

- E. Jones et al: Contribution of shelf waters and freshwater inflow to water chemistry in Kald fjorden. In prep for submission in late 2020.

Communicated Results

- Norwegian fjord over winter. Arctic Frontiers, Tromsø, Norway, 2019 (talk)

- Z. Walker: Pecha Kucha talk at Arctic Frontiers Open, Tromsø, Norway, 2019

- Z. Walker: What's going down in Kald fjorden? Institute of Marine Research, Tromsø, Norway, 2019 (seminar)

- A. Renner: Fjorden foran hjemmet vårt: Kald fjorden gjennom et år. Dialogdagen, Tromsø library, Norway, October 2019 (Pecha Kucha talk & round table discussion)

Interdisciplinary Cooperation

The project was interdisciplinary from the start, integrating physical, chemical and biological sciences. In addition, Z. Walker's master project included a social science aspect by discussing implications for aquaculture management. Collaboration with two other Fram Centre Fjord & Coast projects (EFFECTS and weShare) further boosted this interdisciplinary approach.

As the project was planned to work across disciplines, the results were only possible to be obtained through cooperation. While this can be challenging at times as communication sometimes needed to be adjusted to be understandable for all, we believe that the interdisciplinary approach has been exclusively positive, and enhanced and strengthened the scientific output.

Budget in accordance to results

Funding from the Fram Centre was crucial for the project as it provided the single most important funding source, with further internal funding in previous project years tied to the Fram Centre funding. As WHALE is officially finished after 2019, further internal funding will be required for publication and outreach in 2020.

Could results from the project be subject for any commercial utilization

No

Conclusions

The project was successful – the proposed observational data collection was done, the last outstanding lab analyses were concluded, two high resolution hydrographic models were set up and run, peer-reviewed papers are anticipated for publication in 2020. Data exchange with the partner projects is ongoing and further common publications are in planning. Three undergraduate and graduate students successfully conducted their thesis research within the project, and several postdoctoral researchers took leading roles in the project and in publications.

Further data analyses are continuing beyond the project period, including model data analyses, and potential further master thesis projects are under planning. The hydrographic models also open for potential new investigation into the impact of e.g. industrial activity within Kald fjorden and beyond. Observational and model results clearly show the need to improve current impact assessment practices by taking into account the large seasonality in the Kald fjorden system.

The project together with the partner projects EFFECTS and weShare provided an integrated study of the Kald fjorden ecosystem, but also revealed the need for a larger perspective synthesis. This is planned to be conducted in 2021, pending funding, when more of the individual project results are available and published.