

# ***CLEAN* Case Study 3**

## **Coast and Fjords**

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**Fram Centre**

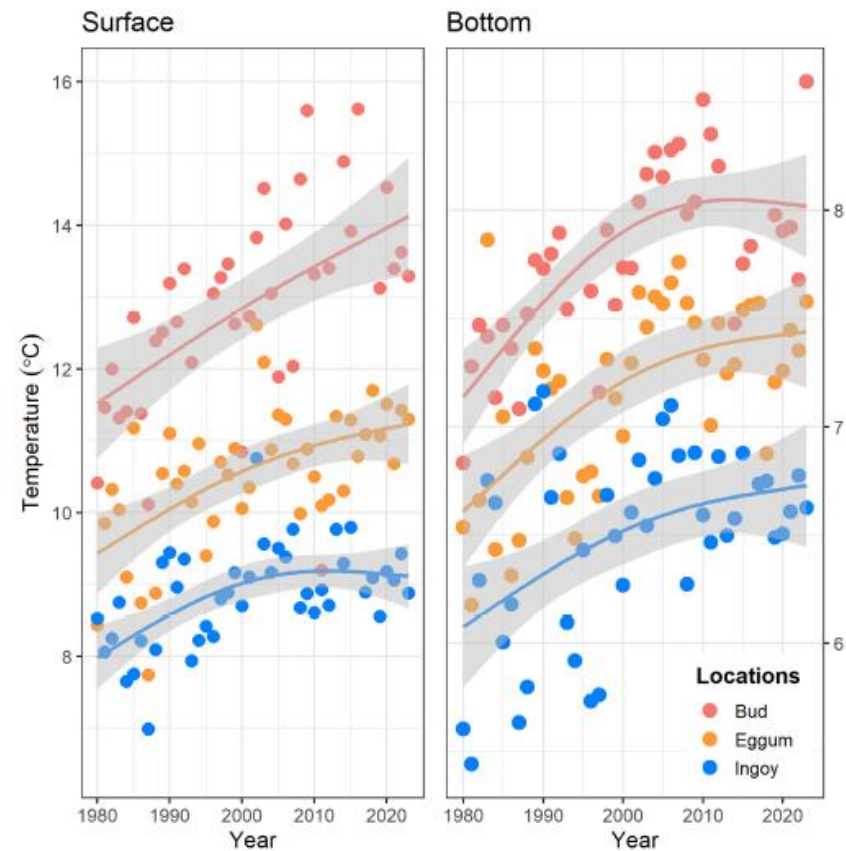
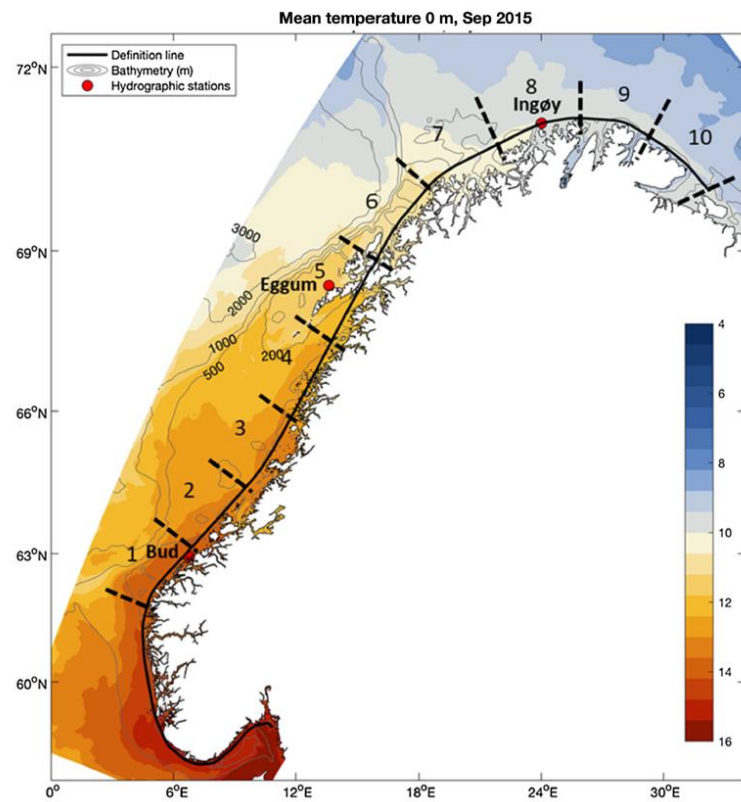
# ***CLEAN CS3* Coast and Fjords**

## Background

- rapid climate change
- increased human activities -  
aquaculture, shipping, tourism
- cod decline, king crab and pink salmon  
invasions, salmon lice, changes in kelp  
forest and sea urchins
- changes in ecosystem structure and  
functioning, goods and commercial value

# CLEAN CS3 Coast and Fjords

## Climate warming in coastal ecosystems



# CLEAN CS3 Coast and Fjords

## Human activities and pressures

Fisheries

Aquaculture

Tourism & recreation

Ship traffic

Petroleum

Eutrophication

Pollution

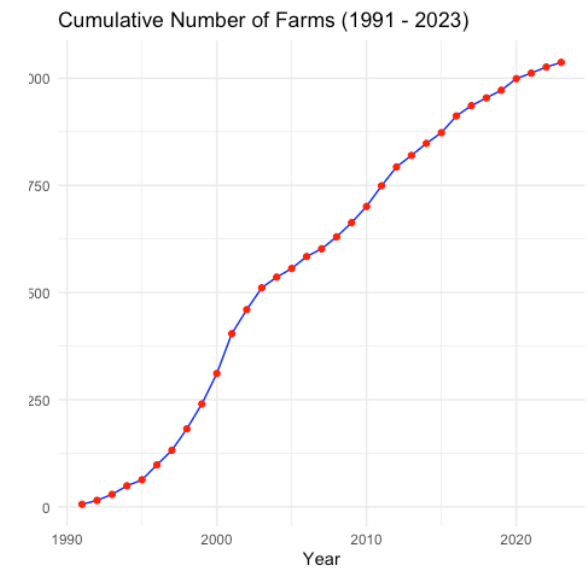
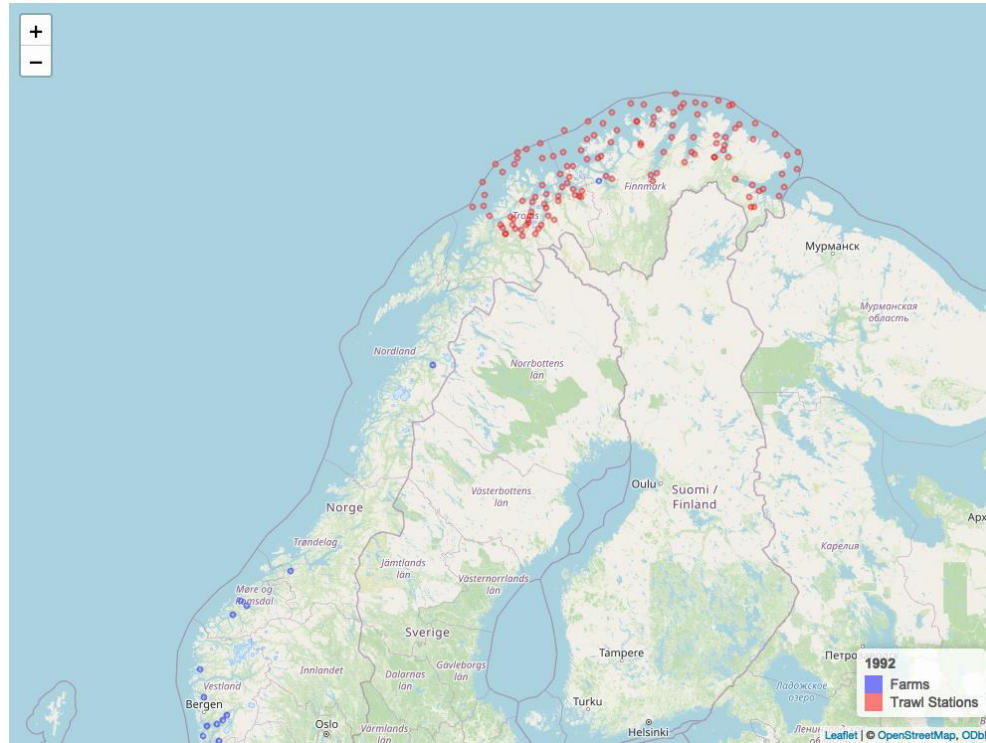
Noise

Mining

Dredging

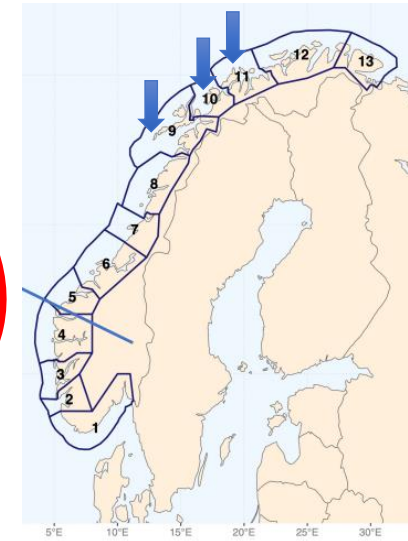
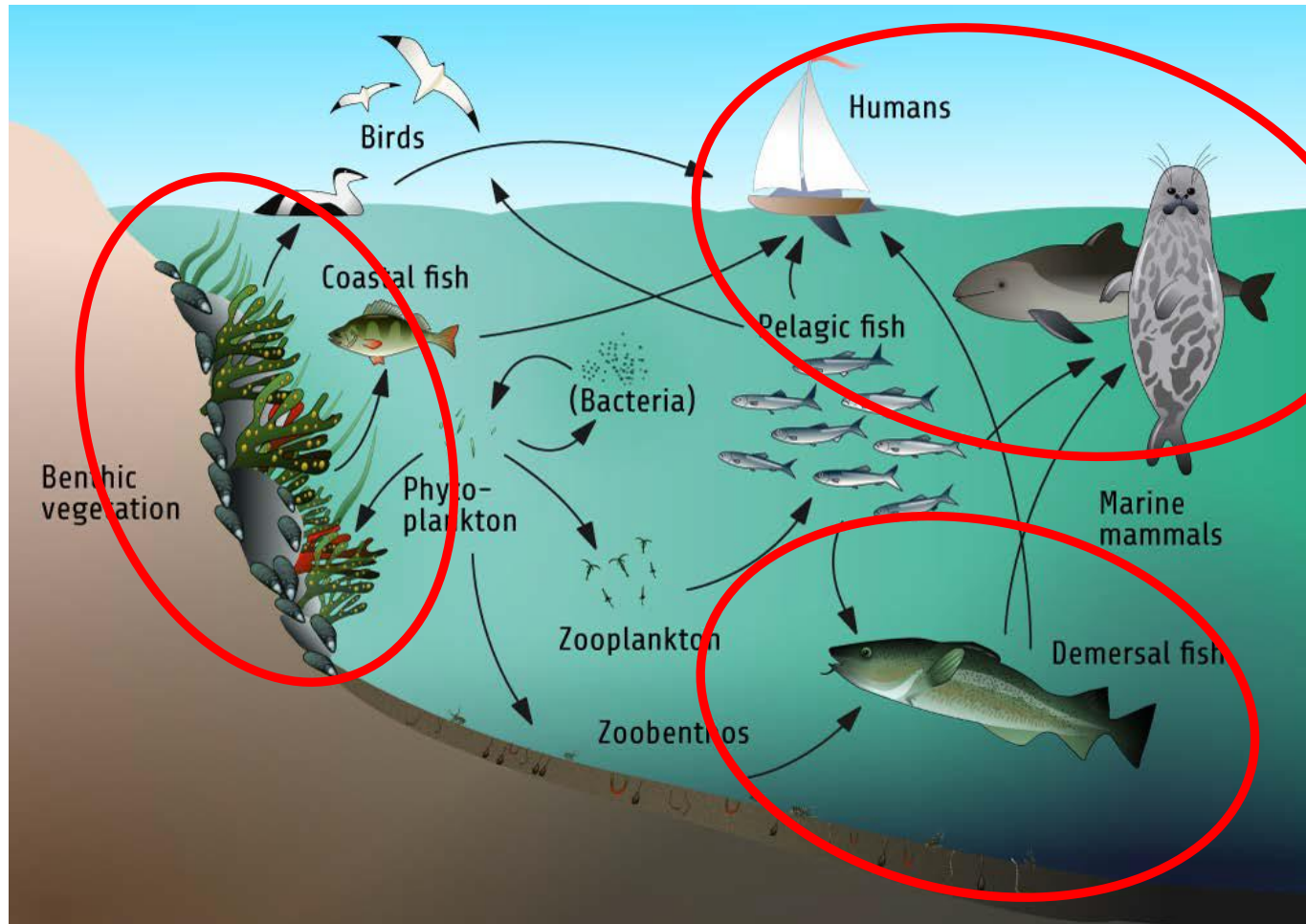


# CLEAN CS3 Coast and Fjords



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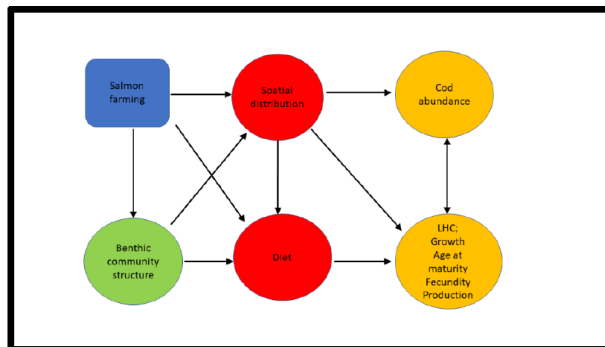
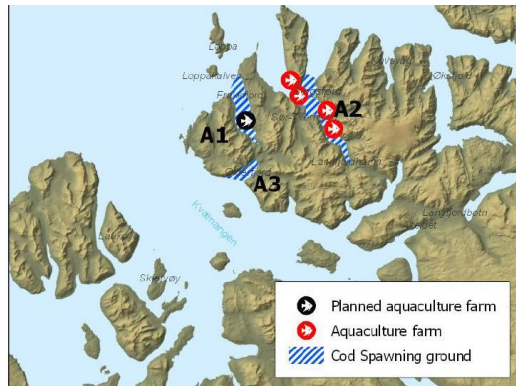
## Multiscale approach



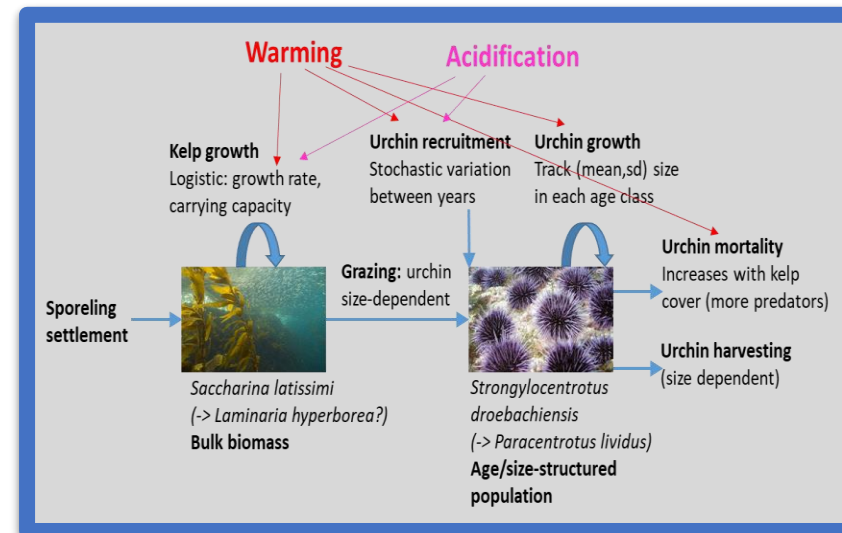
# CLEAN CS3 Coast and Fjords

## Small scale process studies

Impact of aquaculture on cod stocks (SalCod)



“Kelp-sea urchin” food web (NIVA)



# Cumulative impact on fish distributions

## Large scale studies

Received: 29 October 2023 | Revised: 28 February 2024 | Accepted: 8 March 2024  
DOI: 10.1111/gcb.17273

RESEARCH ARTICLE

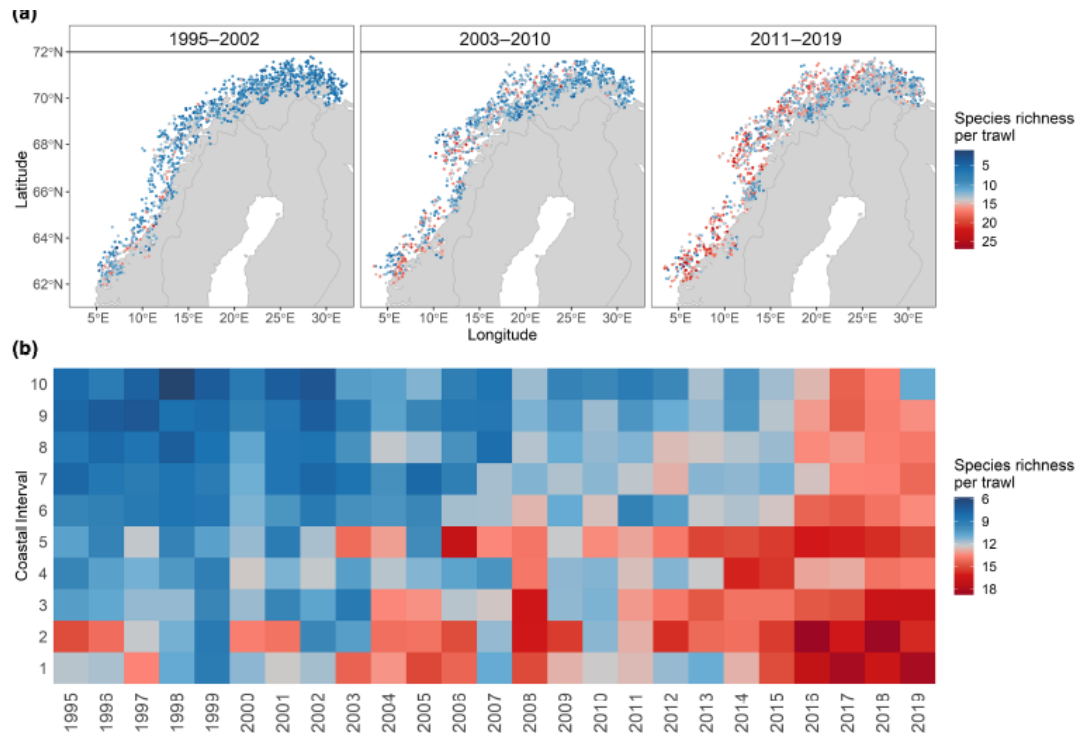
Global Change Biology WILEY

Rapid climate change increases diversity and homogenizes composition of coastal fish at high latitudes

Anna Siwertsson<sup>1</sup> | Ulf Lindström<sup>1,2</sup> | Magnus Aune<sup>1</sup> | Erik Berg<sup>1</sup> |  
Jofrid Skarðhamar<sup>1</sup> | Øystein Varpe<sup>3,4</sup> | Raul Primicerio<sup>1,2</sup>

### Demersal fish community

- HI trawl stations 1995-2019
- **Climate driven** shifts in species distributions and biodiversity



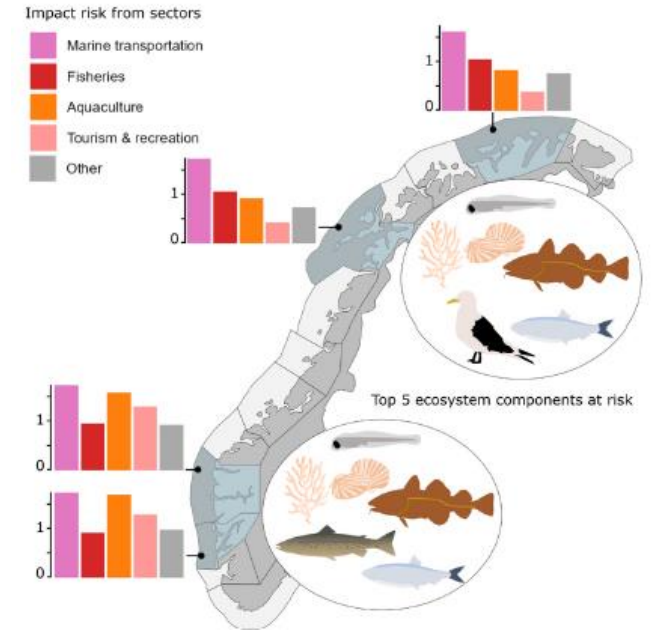
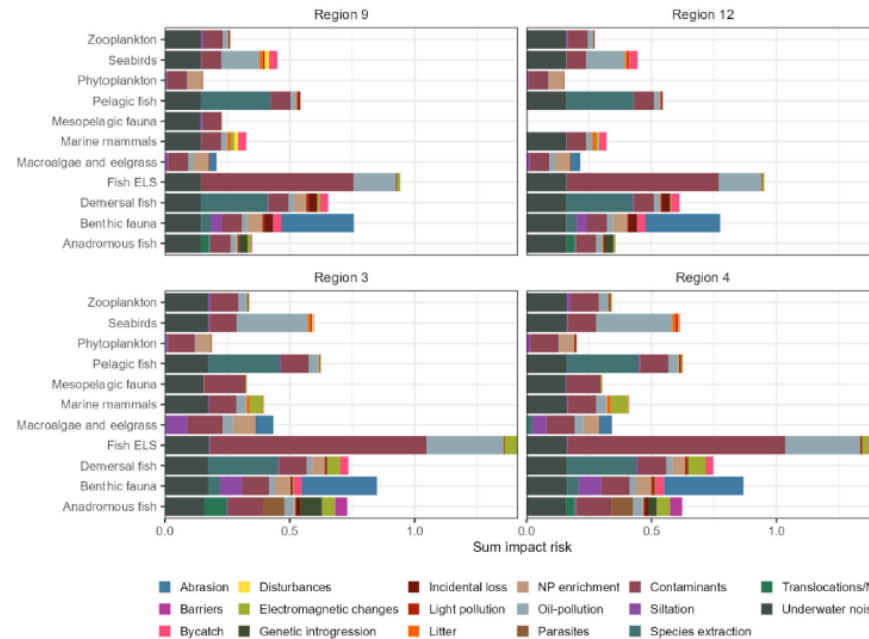
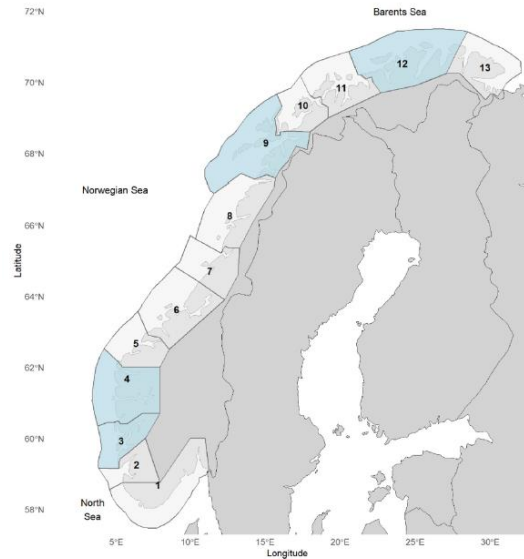
# Risk assessment from human use and resources

## Large scale studies



Ecosystem risk from human use of ocean space and resources: A case study from the Norwegian coast

Johanna M. Aarflot<sup>a,\*</sup>, Vilde R. Bjørndal<sup>b</sup>, Katherine M. Dunlop<sup>c</sup>, Marina Espinasse<sup>a</sup>, Bérengère Husson<sup>a</sup>, Ulf Lindström<sup>d</sup>, Felicia Keulder-Stenevik<sup>e</sup>, Kotaro Ono<sup>f</sup>, Anna Siwertsson<sup>g</sup>, Mette Skern-Mauritzen<sup>h</sup>



# Modelling impacts of climate change and pollution on a marine top predator

Received: 18 December 2023 | Accepted: 9 July 2024  
DOI: 10.1111/1365-2656.14159

RESEARCH ARTICLE

Journal of Animal Ecology

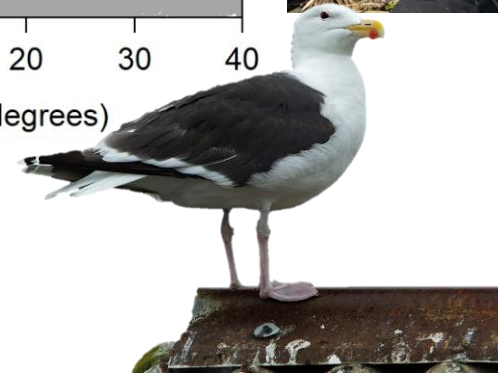
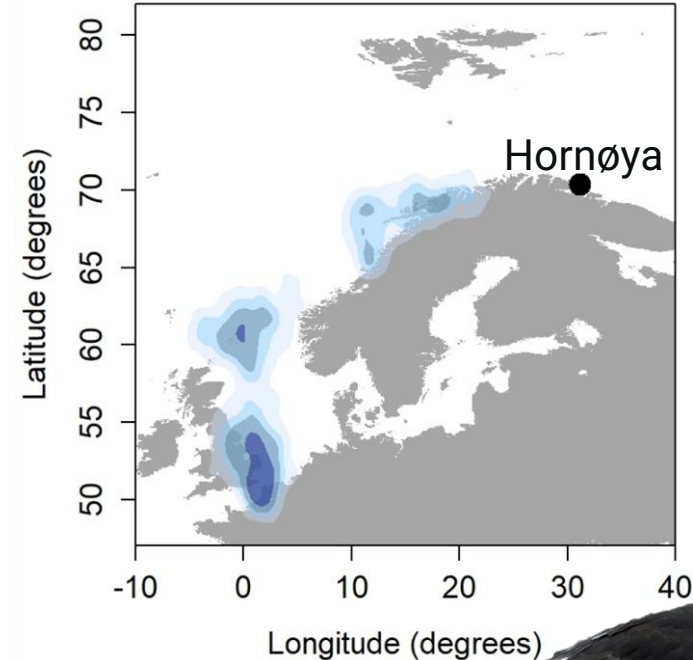
Path analysis reveals combined winter climate and pollution effects on the survival of a marine top predator

Kate Layton-Matthews<sup>1,2</sup> | Kjell Einar Erikstad<sup>1,3</sup> | Hanno Sandvik<sup>4</sup> | Manuel Ballesteros<sup>1</sup> | Kevin Hodges<sup>5</sup> | Michel D. S. Mesquita<sup>6</sup> | Tone K. Reiertsen<sup>1</sup> | Nigel G. Yoccoz<sup>1,7</sup> | Jan Ove Bustnes<sup>1</sup>

- Marine communities are under growing pressure from human activities
- Need for modelling approaches to study their cumulative impacts

## Results

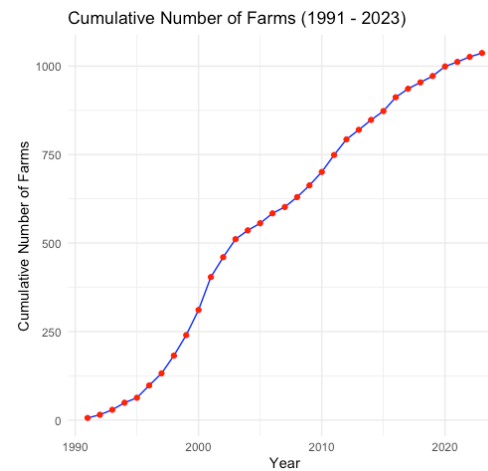
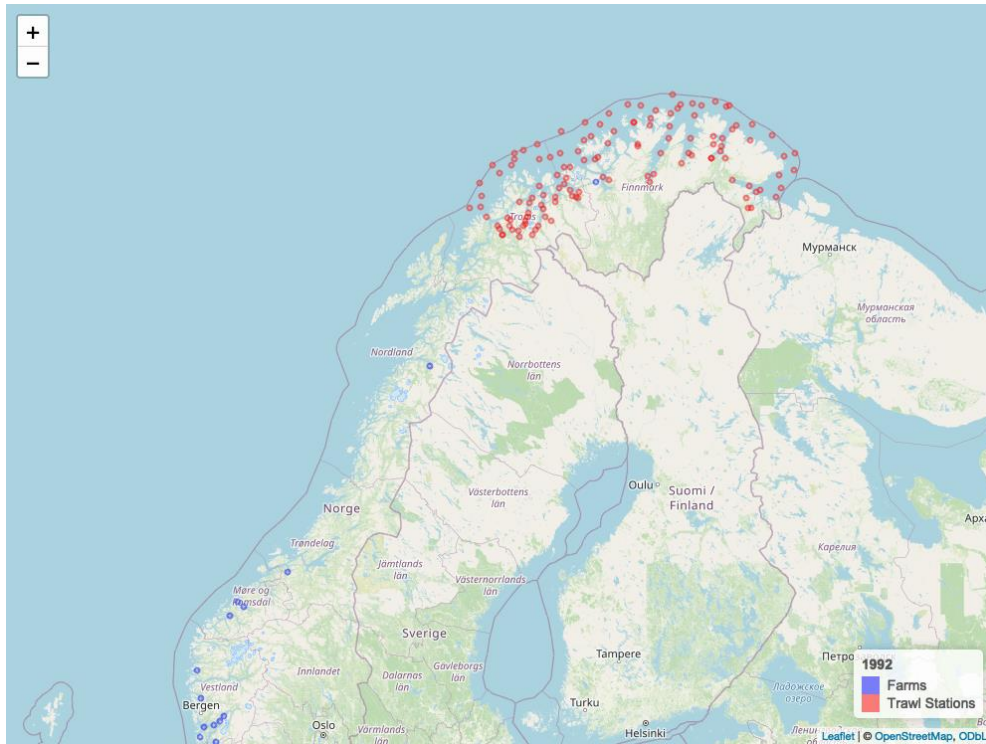
- Warmer ocean temperatures (SST), associated with prey shifts, in gull wintering areas correlated with higher survival
- Negative effects of pollutants (organochlorines) on adult survival via reduced body mass



# ***CLEAN CS3 Coast and Fjords***

***Ongoing work***

# Impact of aquaculture on cod



## ➤ Fact

- Major increase in number of aquaculture since the 1990's
- Aquaculture attract wild fish

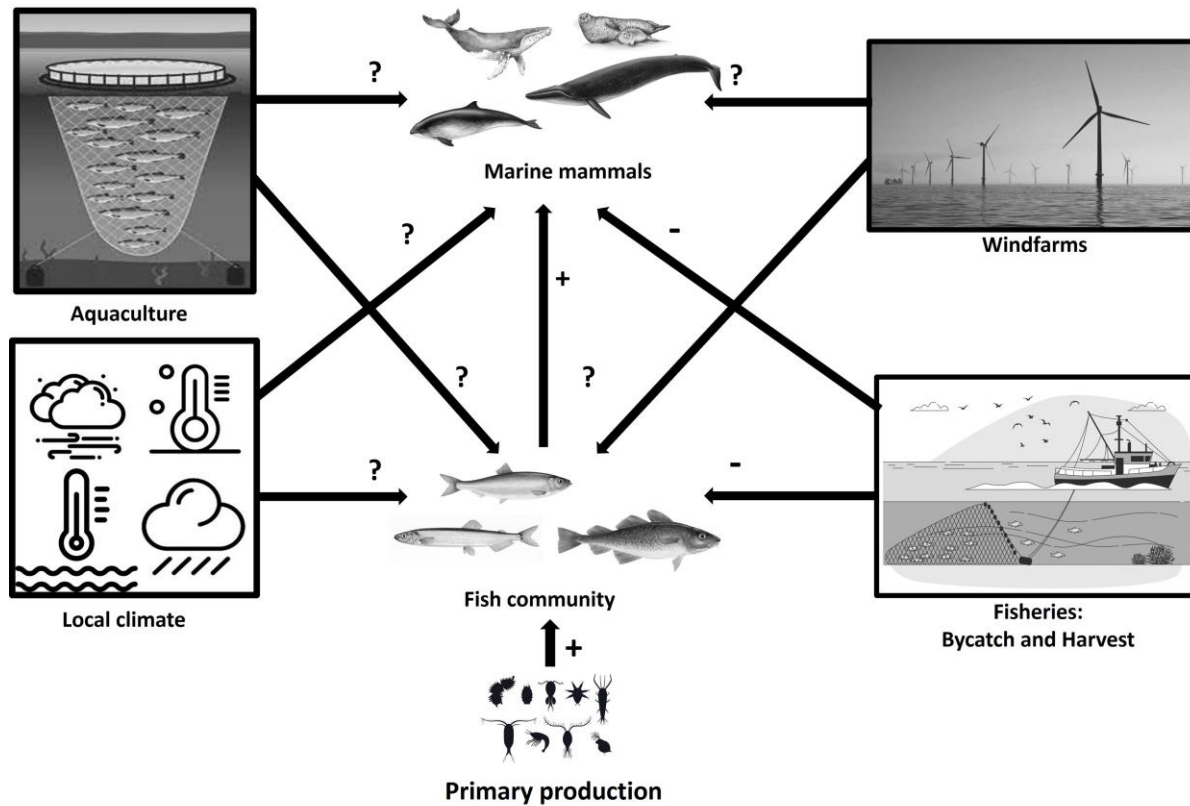
## ➤ Objective

- Analyse impact of aquaculture on cod abundance and distribution
- H1: Cod abundance is higher at trawl stations closer to active fish farms
- H2: Cod distribution shifts towards fish farms over time
- H3: Cod abundance decreases in fjords with a higher number of fish farms

## ➤ Data

- Resource data from coastal survey (1995-2023)
- Aquaculture data (1991-2023)

# Food-web approach to study marine mammals interactions



## Gompertz models

$$\ln(N,t) = a + b \cdot \ln(N,t-1) + c \cdot \ln(\text{Clim},t) + d \cdot \ln(\text{Prey},t) + \ln(F,t-1) + \varepsilon t$$

## Drivers:

- Climate (Clim)
- Prey availability (Prey)
- Fisheries (F)
- Other antropogenic effects (Aquaculture and windfarms)

# Managing resources in Norwegian coastal ecosystems requires an ecosystem-based approach

