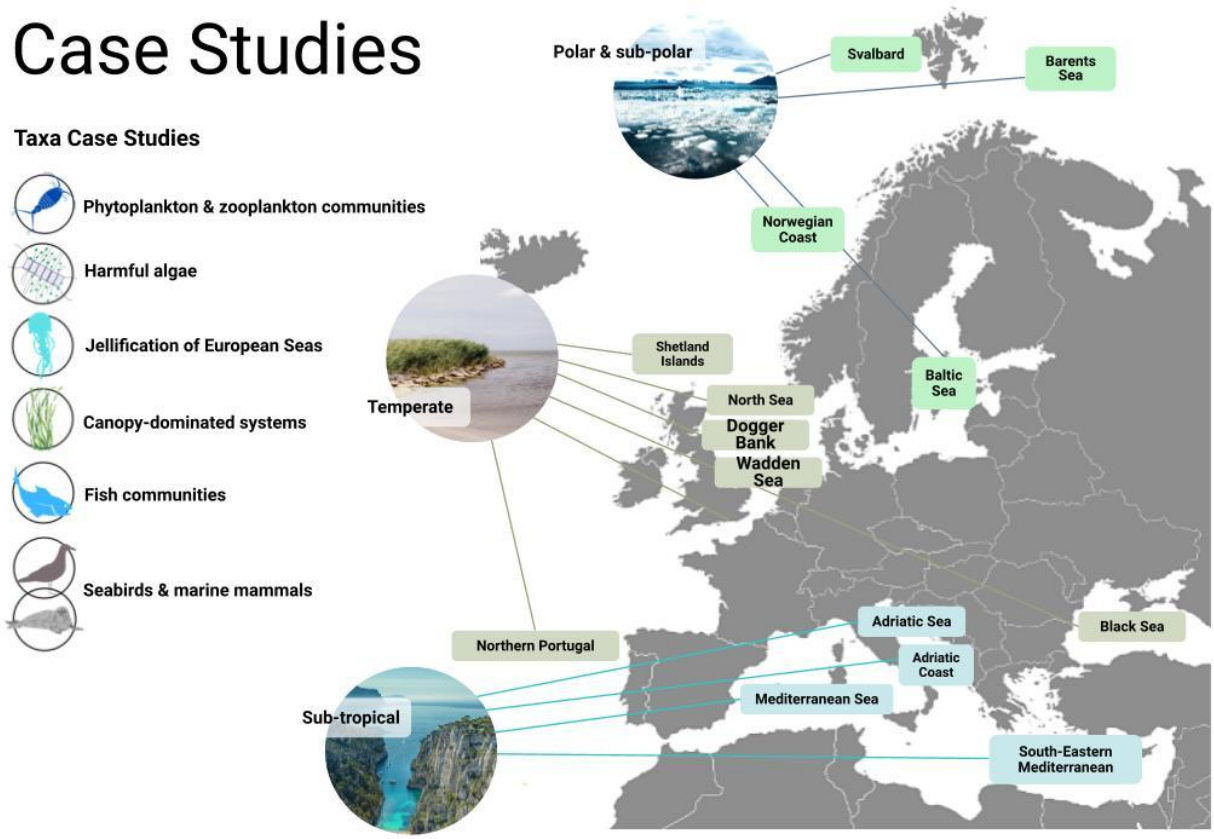
Case Study 1
Polar & Sub-Polar

Arctoboreal benthos and fish communities



ACTNOW

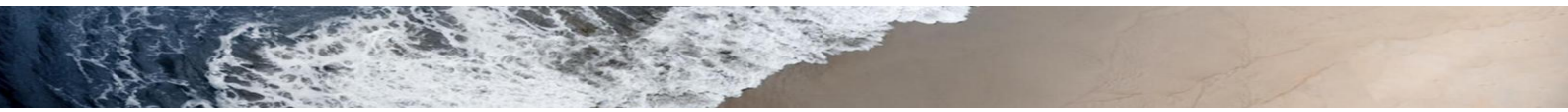
ACTNOW is an EU-funded research project aimed at understanding the cumulative impacts on European marine biodiversity, ecosystem functions, and services for human wellbeing. The project equips regulators and decision-makers with essential knowledge and tools to combat biodiversity loss in coastal and marine habitats threatened by climate change and other regional drivers.

Conducted across various Case Study Regions in Europe, ACTNOW focuses on delivering scientific support for adaptation and mitigation measures, sustainable blue economy expansion, and contributions to the UNFCCC.

The project is structured into six Workpackages: WP1 (Data, Indicators and Scenarios), WP2 (Marine Organisms under Multiple Drivers), WP3 (Community, Food-Web and Ecosystem), WP4 (Cumulative Risks & Biodiversity Assessments), WP5 (Synthesis, Impacts & Solutions Options), and WP6 (Communication and Dialogue).

Objectives include developing 'what if' scenarios, understanding combined impacts on ecosystems, employing advanced biologging and molecular methods, and enhancing awareness of the links between marine biodiversity and human health.

ACTNOW has 17 CSs, 14 are regional CSs while 3 are pan-European (group / taxon) CSs. All are designed to deliver a cause-and-effect understanding, build predictive capacity in models, and to develop indicators and tools for decision-makers charged with the stewardship of European marine biodiversity under threats from multiple drivers (stressors in call) (see fig below). In each case, drivers examined represent the local/regional priorities from regulators who co-create what-if scenarios of interacting drivers including envisioned management actions.



- **Case Study 1: Arctoboreal benthos and fish communities**

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Description

In ACTNOW there are 3 case studies in sub-polar and polar regions. A CS in Svalbard (CS1), the Barents Sea (CS2) and the Norwegian coast (CS3) cover a region spanning a gradient from 65oN to 80oN that supports some of the world's largest fisheries. CS1 and CS2, discussed here, investigate multi-driver impacts on the Barents Sea ecosystem, including NE Atlantic cod *Gadus morhua,* and polar cod *Boreogadus saida*.

Services

Ecosystem services provided within case study 1 include:

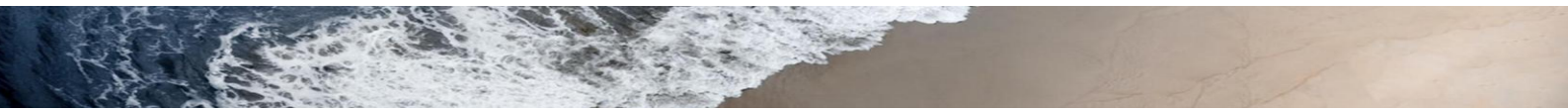
- **Regulating:** Fishing quotas, marine protected areas, cross-sectorial management plans
- **Provisioning:** Coastal and offshore fisheries that provide food for humans and livestock, materials used for industry, energy, habitats, transport routes
- **Cultural:** Sense of place, coastal and marine tourism, cultural value for coastal communities, educational values
- **Supporting:** Habitat for a large range of species, including polar species, biomass production

The information in this document could help inform key stakeholders in the Barents Sea on taking decisions on ecosystem management.

Interacting Drivers of Biodiversity Change

In this project, we focus on the oceanic region, and not so much on the activities that are taking place close to the coast. Among the drivers that can affect the ecosystem over a temporal and spatial scale we find (Hansen et al., 2022):

Climate change: The arctic is among the fastest warming regions in the world (e.g. Rantanen et al., 2022, Shu et al., 2022), and for the Barents Sea this includes rising sea temperatures, possibilities of marine heatwaves and a disappearing summer sea ice cover (Ingvaldsen et al., 2021, Gerland et al., 2023).



Extraction of biomass: There are large multinational fisheries for demersal fish in the Barents sea, which, although sustainably managed, have an impact on the population structure of these stocks.

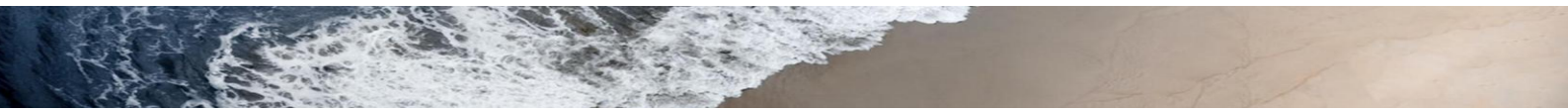
Noise: Although ecosystem effects of noise are difficult to establish and describe, as most studies are on individuals and the uncertainty therefore is relatively high (Hansen et al., 2022b, Skartsætherhagen et al., 2024). Noise associated with increased anthropogenic activities (Aniceto et al., 2022) might have an impact on the ecosystem structure and function in the Barents Sea. Most marine sectors, including fisheries, shipping and oil and gas, generate noise that may impact marine life.

Pollution: The main sources of pollution is long-range transport, acute releases from local activities and emissions from shipping (ICES Ecosystem Overviews). In a recent paper by Jalkanen et al (2021) from the Baltic Sea, ship traffic from different sectors is shown to contribute considerably to the total level of contamination released to the marine environment. Similar estimations of total release of contaminants from shipping in the Barents Sea is not yet available. Studies connecting pollution with other stressors (such as climate change and fisheries) is necessary to better understand possible cumulative impacts on the ecosystem of increasing anthropogenic activities in the region.

Regional Context

The Barents Sea is a highly productive shelf sea with a mean depth of 230 m, but with deeper areas of up to 500m. It is highly diverse, with a boreal environment in the south, transferring to an Arctic environment in the north (Loeng, 1991). Due to strong temperature gradients, the Barents Sea displays zoogeographic differences in composition and diversity of fish and benthos communities (Fossheim et al., 2015, Frainer et al., 2021). Such differences in biodiversity are associated with sharp distinctions in functional characterization and food-web configuration, which affect ecosystem structure and function (Kortsch et al., 2019, Frainer et., 2017, Pecuchet et al., 2022). By redistributing species, climate change impacts ecosystem organization in the Arctic (Ingvaldsen et al., 2021). In the warming period until 2015 and then again over the last three years, an overlap between boreal species and arctic species has taken place. More recently, decreasing temperatures have partly reversed the trend, partly due to declining top predator stocks, in particular the Northeast Atlantic cod.

The Barents sea has been fished for more than a 1000 years (Nakken, 1998), and the fishery is important for the communities along the Norwegian coast. Although the number of additional marine sectors present is considerably higher in the southern part of Norway (Hansen et al., 2022a, Aarflot et al. 2024), there is a high level of marine and marine-related sectors that are active in the north, including aquaculture, marine shipping, oil and gas industry, and a growing tourism.



Research Needs

Multiple studies on the risk of negative cumulative impact have shown several knowledge gaps, among others connected to the interaction between multiple pressures (noise, pollution, extraction of biomass, climate change) and the ecosystem structure and function. Currently, there are no regionalized Shared Socio-economic Pathways (SSPs) scenarios for ecological modelling available for the Barents Sea, something that will be provided through ACTNOW.

Research Planned in ACTNOW

● T1.1 Regionalized 'What if' scenarios for the Barents Sea, following the global SSPs, as outlined in the glossy cards (SSP1, 3, 4 and 5).

● T1.2 Indicators used in the cross-sectoral management plans and suggested in work reporting on the ecosystem state of the region will be evaluated through the project, based on observed and simulated data sets.

● T1.3 Data necessary for the indicator-work (and models) will be compiled. These will be based on observations and historical and future projections from a range of ecosystem models.

● T2.1 A monitoring cruise to Svalbard with RV Heincke has been carried out (HE645) in August 2024, polar cod were caught for further experimental work and field cages installed for a planned field study in Kongsfjorden (Svalbard).

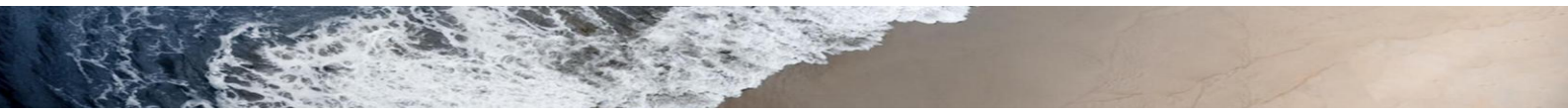
● T2.3 According to the SSP scenarios, heat wave + food level experiments will be carried out in the laboratory (AWI) and a field metabolic study will be set up in Kongsfjorden (Svalbard).

● T3.2 Datasets from observations and models will be used as a test-kit for key indicators of food-web structure of the Barents Sea. Multiple drivers are/will be implemented in the models to evaluate the food web structure of the region.

● T3.3 Several ecosystem models (RCaN, Atlantis, Ecopath) will be applied for the common scenarios. The future projections will be based on the regional downscaling of the Barents sea, further developed from the glossy card scenarios.

● T4.1 We will use data from models and observations to test the performance of the suggested assessment tools, including existing tools from the region.

● T4.2 Strategies, choices of weighing scales from the development of the cumulative risk and biodiversity framework will be used also in regional development of tools to map and assess the risk from cumulative impact.



● T4.3 We have a good overview of the risk of cumulative impact from the range of sectors that are active in the Barents Sea. Among the dominating pressures (which also can be implemented/assessed in the models) are fisheries, noise, contamination and climate change. We will use this, in addition to data from models and observations to apply the cumulative risk and biodiversity framework in the region, alongside tools being developed specifically for the region through communication with the managers.

● T5.1 Projections from ecosystem models (RCaN, Atlantis, Ecopath) will be provided with the aim of identifying key risks to biodiversity, based on the regionally downscaled SSP scenarios.

● T5.2 Modelling datasets from historical and future projections will be provided.

● T5.3 The near (2030) and more distant (2050) futures will be presented to and discussed with relevant stakeholders of the region, as a natural step up from the discussions on the regionalization of the SSPs.

● T6.1 A workshop where the downscaled scenarios will be presented for a larger group of stakeholders, will take place in Tromsø in November 2024. The scenarios will be provided to the stakeholders before the meeting, giving them the possibility to read and reflect upon the described possible futures.

● T6.3 The results from the project, including the downscaled SSPs, will be presented through multiple channels. Project members are in contact with elementary and high schools, introducing the kids to the biodiversity of a local fjord, and explaining the concepts of who eats whom, and how we impact the ocean through anthropogenic activities, including climate change.

Pictures, graphs and maps

Pictures from: 'A day in the intertidal zone'; public school kids and teachers get to learn about biodiversity; who lives where, how and why, what do they eat and how do we humans impact them. In total 50 children and teachers over two days.

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