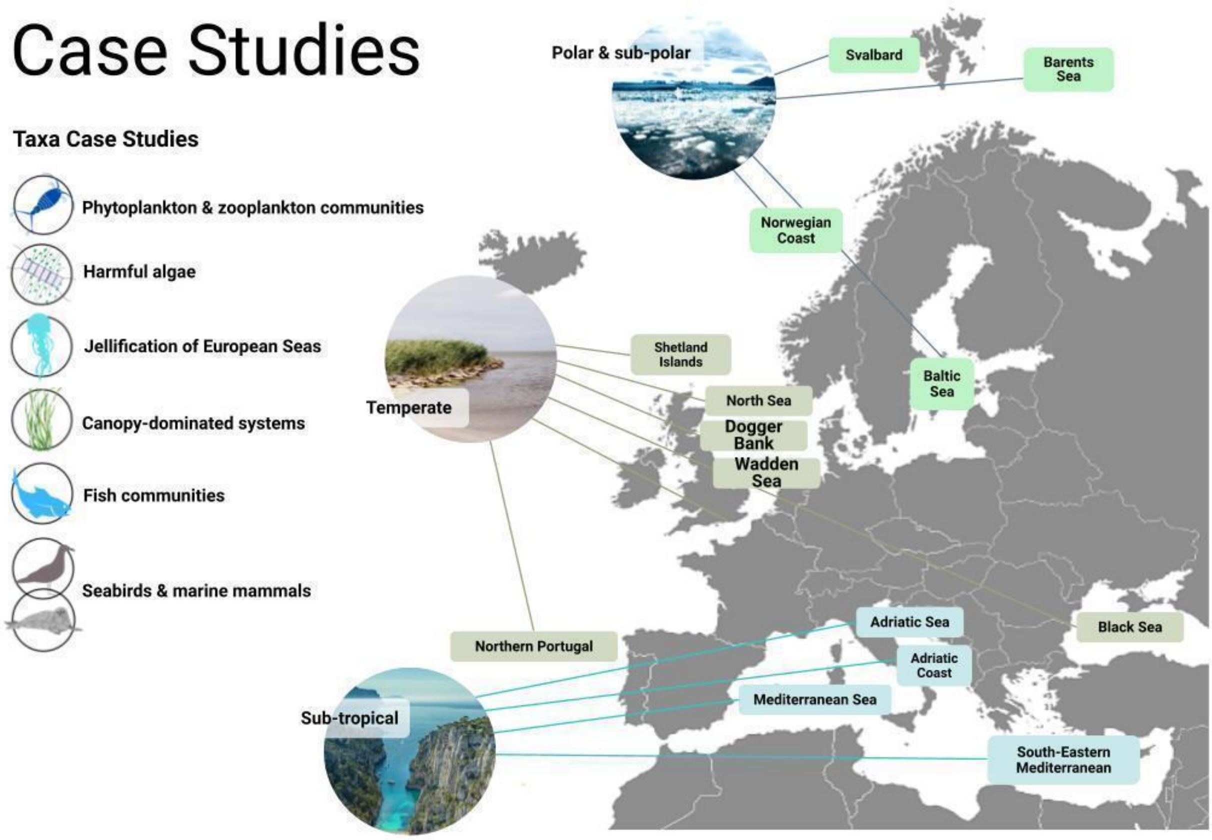
# Case Study 8
# Temperate

# Northern Portugal Kelp Forests



## 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, 11 are regional CSs while 6 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.

# 1. Case Study 8: Northern Portugal Kelp Forests

## Leader

Francisco Arenas

## Contributors

Marina Dolbeth, Emilio Salas-Leitón, Isabel Sousa Pinto, João Rodrigues.

## Description

Marine forests are complex, multi-layered habitats formed by large brown seaweeds that play a similar ecological role in coastal habitats as trees do in terrestrial environments (Wernberg and Filbee-Dexter, 2019). Recent estimates suggest that marine forests cover approximately 1.5 million km² (Jayathilake and Costello, 2020) to 2.03 million km² (Duarte et al., 2022), making up about one-quarter of the world's shorelines and constituting the largest coastal vegetated habitat (Krumhansl et al., 2016).

The coast of northern Portugal hosts the southernmost North Atlantic seaweed forests of several cold-adapted species, including Laminaria hyperborea, Saccharina latissima, Ascophyllum nodosum, and Fucus serratus. The Iberian upwelling is likely crucial for maintaining these northern communities at these latitudes, as it provides cold, nutrient-enriched oceanic waters during the summer season. In the northern littoral region, these seaweeds have traditionally been used to fertilize orchards with stranded seaweeds ("masseiras") for centuries.

However, recent climate change has led to an abrupt local extirpation and fragmentation of these populations, threatening their important benefits. Understanding the causes driving their decline is urgently needed to promote effective management and restoration actions. These efforts are especially crucial given that this region, located in the northwest of the Iberian Peninsula, may host unique genetic poosl of marine forest species that are at risk of being lost.

## Services

Marine Forests offer a good variety of services to coastal communities. Kelps and other marine forests species are ecosystem engineers and their three-dimensional structure provides habitat for a variety of organisms such as apex predators (sea mammals and seabirds), fish, invertebrates and other seaweeds (Steneck et al. 2002), (Smale et al. 2013)) and support complex food webs in coastal zones, promoting healthy artisanal fisheries (Bertocci et al. 2015, Eger et al. 2023b).

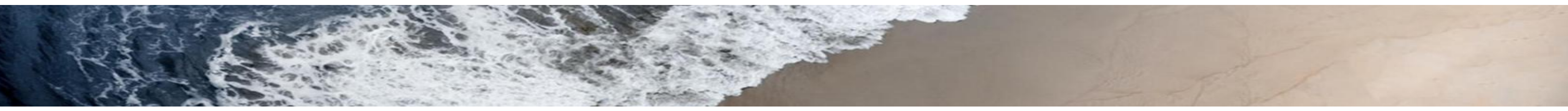
Marine forests also play a key role in primary and secondary productivity within coastal ecosystems. Renowned for their photosynthetic capacity and high productivity, marine forests export large amounts of dissolved and particulate organic materials, which enter coastal food webs (Paine et al. 2021) or is exported to adjacent habitats. This exported macroalgal carbon may reach deep-sea sediments and be sequestered for centuries (Krause-Jensen and Duarte 2016). In fact, macroalgae-derived carbon supports higher carbon sequestration rates than all of the other blue carbon ecosystems combined, with an estimated value of 173 TgC yr-1 (Krause-Jensen & Duarte, 2016).

## Interacting Drivers of Biodiversity Change

Marine forests face imminent threats from climate change and human activities, particularly those tied to the flourishing ocean economy. For example, extensive global research indicates that 40-60% of the world's kelp forests have declined in recent decades (Steneck et al 2008, UNEP 2023).
Multiple interacting stressors acting at various scales are responsible for these declining trends. Ocean warming, heat waves, storms, grazing and direct human activities such as eutrophication, harvesting and pollution are recognised threats to marine forests (Wernberg et al 2019).

## Regional Context

In the area of this CS we identified around 75 square kilometers as suitable macroalgae forest habitat. *Laminaria hyperborea* occupied one-quarter of these suitable reefs. In contrast, *Saccorhiza polyschides* were more prevalent, covering half of the space. Historical data on the past extension of *Laminaria* forests suggest that this species has lost more than 50 % of its abundance in the last decade. Evidence of an intense tropicalization process are now emerging (De Azevedo et al 2023).



## Research Needs

Long-term in situ quantitative measures of drivers/stressors is missing. We have accessed to satellite data for the upwelling information and SST. There is a large need of ecosystem level information to build models included

## Research Planned in ACTNOW

- T1.1 Creation of regional what-if Scenarios
- T1.2 Identification of ecological indicators for
- T1.3 Collection of long term data available for the area (
- T2.1 Field experiments with habitat forming species
- T2.3 Physiological experiences for DEB models
- T2.4 Continuous traits assessment for seaweeds
- T3.1 Development of a joint-species distribution mode (HMSC) for the marine forest in Portugal
- T3.2 Implementation of an EwE model fro kelp forest
- T4.1 Bayesian Network analyses of biodiversity trends in kelp forests
- T4.2 Biodiversity rick assessment with UVIGO
- T5.2 Creation of regional-scale biodiversity policy tools
- T6.1 Stakeholder engagement meetings at regional scale
- T6.3 Outreach activities

## Pictures, graphs and maps

Subtidal marine forest in North Portugal (@  F Arenas).

Fucus serratus intertidal northernmost populations in Viana do Castelo (PT) @F Arenas

Ascophyllum nodosum, an intertidal marine forest @F Arenas

Drying seaweeds for the masseiras in the north of Portugal @Marina Dolbeth

## References

Wernberg, T., K. Krumhansl, K. Filbee-Dexter, and M. F. Pedersen. 2019. Chapter 3 - Status and Trends for the World's Kelp Forests. Pages 57-78 in C. Sheppard, editor. World Seas: An Environmental Evaluation (Second Edition). Academic Press.