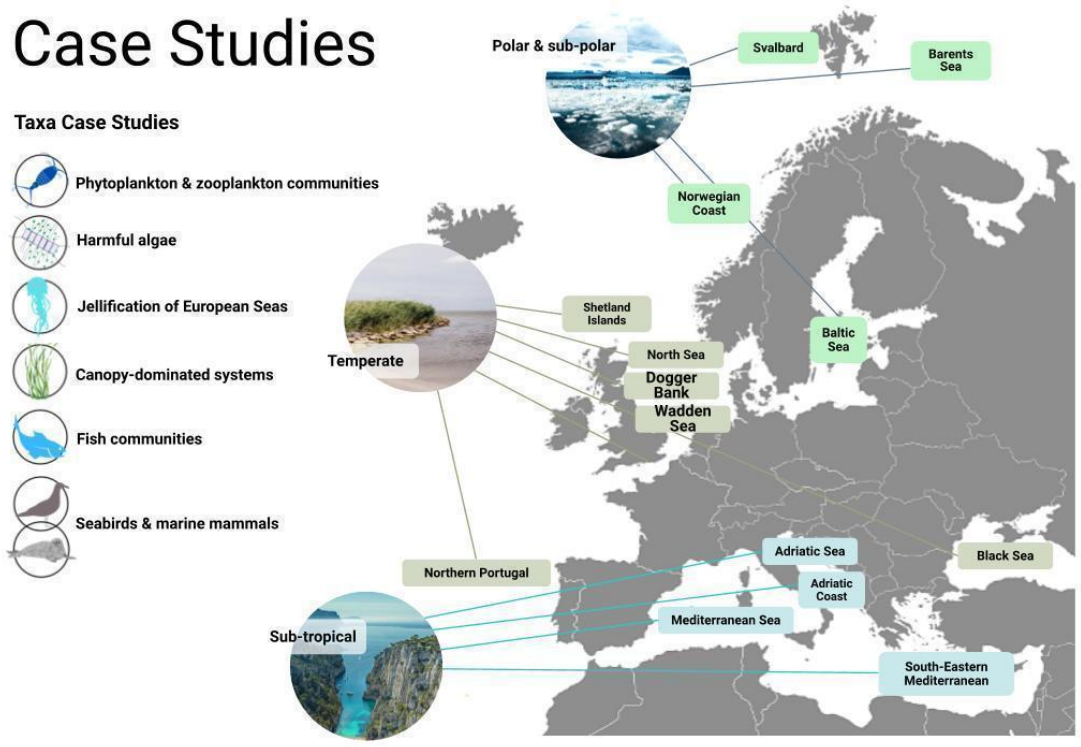
Case Study 9
Sub-tropical

South Adriatic & Tyrrhenian Seas Marine Animal Forests and Posidonia oceanica meadows



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 9: South Adriatic & Tyrrhenian Seas Marine Animal Forests

Leader

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Contributors

CMCC

Description

The Mediterranean Sea is the largest semi-enclosed sea on the planet, and one of the main reservoirs of marine biodiversity; it contains between 4 to 18% of identified marine species while covering only 0.82% of the global ocean surface. However, at EU scale it is also the region with the strongest evidence of habitat loss, although with limited knowledge of the key drivers. The CSs in the sub-tropical area will test the effects of multiple drivers on iconic groups of marine habitat formers and jellyfish under different ecological contexts from shallow habitats to the mesophotic. The threats and opportunities involved in the conservation/management of key species (macroalgal forests, marine animal forests composed by corals, sponges, gorgonians and *Posidonia oceanica* meadows) and their ability to provide Ecosystem Services will be examined by identifying the responses and tolerance thresholds of these habitat-formers to multiple drivers.

Regional Context

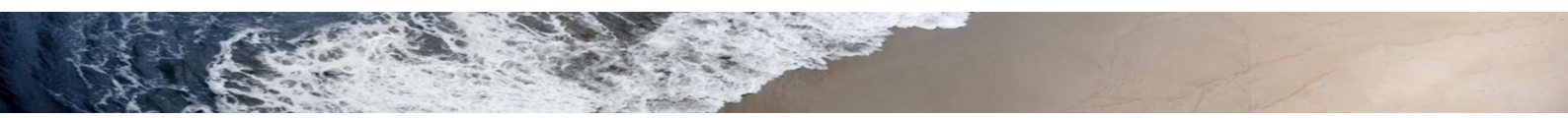
The Mediterranean Sea is recognized as a biodiversity hotspot, home to a diverse range of cold-temperate and subtropical species. Despite accounting for a small portion of the total ocean volume, its unique geomorphological history has resulted in exceptionally high biodiversity, with a significant percentage of known marine species and many endemic species. Moreover, the Mediterranean Sea is expected to be among the regions most vulnerable to the impacts of climate change, particularly due to ocean warming. Renowned as a valuable model, the Mediterranean Sea serves as a crucial site for assessing the ecological impacts of climate change on marine biodiversity. It also functions as an experimental platform for exploring potential adaptation and mitigation strategies that could be applied globally. *Posidonia oceanica* meadows and coralligenous communities are both key structuring endemic habitats within the Mediterranean Sea, hosting high levels of biodiversity, acting and provisioning, supporting, regulating and cultural ecosystem services. Their traits combination makes them unique and crucial for the proper functioning of the ecosystem, but at the same time, vulnerable to anthropogenic stressors.

Research Needs

Different correlative and manipulative experiments in the lab and in the field will be performed by using specialised and innovative technologies for measuring habitat and species responses to changing environmental conditions. Last generation micro-respirometers will be used to measure metabolism of small organisms or life stages (larvae and/or polyps) in the laboratory under different multiple stressor treatments; while benthic chambers will be use in the field to measure metabolic (RR, GCP, NCP, etc) and photosynthetic performance of key structuring species (seagrasses meadows, macroalgae forests and coralligenous components).

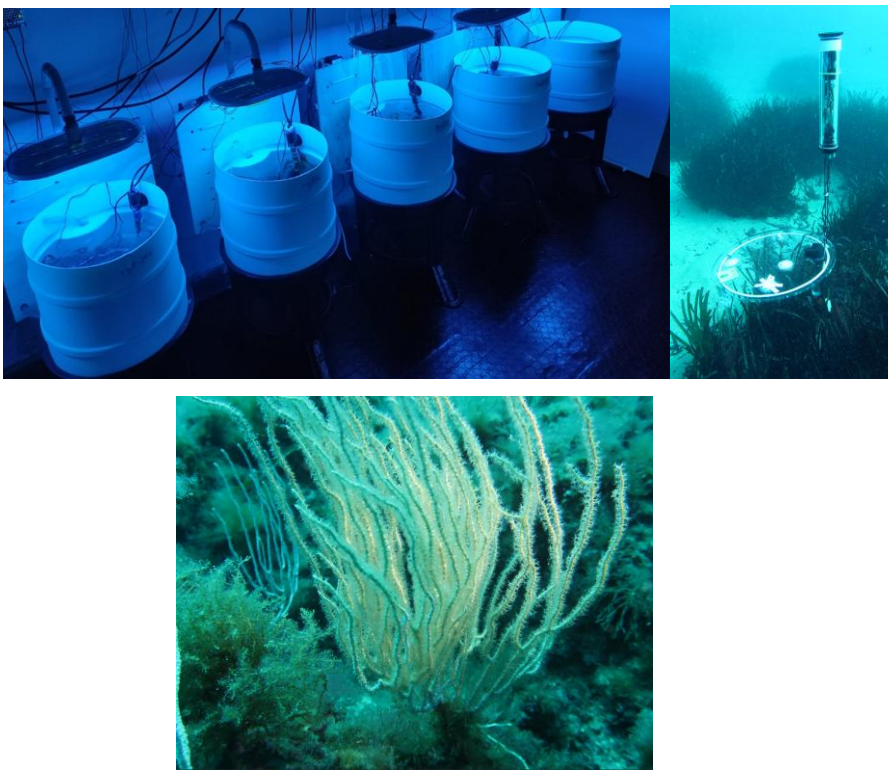
Research Planned in ACTNOW

Changing temperature, turbidity, salinity and extreme climatic events, such as MHW, are some of the stressors to be tested in the correlative and manipulative experiments in the field and in the lab that CONISMA and collaborators are planning in the framework of the project. The effect of turbidity on the thermal tolerance of *Posidonia oceanica*, the functioning of seagrasses and gorgonian forests including their ability of acting as C sink under extreme climatic events (MHWs), or the metabolic responses of key structuring shallow benthic species to interacting stressors (such as warming and invasive species predation risk), are some among the ongoing and future experimental work conducted within ACTNOW project.



● **T2.1** Different field and laboratory experiments on these habitats are planned: i) experiments on the effect of interacting temperature and turbidity on *Posidonia oceanica* performance. ii) Correlative field experiment (in the MPA of Capo Gallo - Isola delle Femmine (Palermo, Sicily, IT) on *Posidonia* meadows functioning at community level that allow upscaling this information to the ecosystem services ability of the habitat under different climate change scenarios. iii) Field samplings and measurements before and after summer period on the reef-forming species *Eunicella singularis* meadows will be performed to study the role and functioning of this habitat under climate change conditions. At the same time, experiments on the sponge *Chondrilla nucula* responses to climate change are planned.

Pictures, graphs and maps



Experimental tanks used in the multiple stressors experiments with *P. oceanica* and coralligenous (top-left); prototype of benthic chamber on *P. oceanica* (top-right); and white gorgonian colony within the study area of Capo Gallo - Isola delle Femmine MPA (down)

Services

Posidonia oceanica meadows, along with coralligenous bio-construction, are endemic Mediterranean habitats that offer various ecosystem services:

REGULATING ES: **carbon sequestration**: *P. oceanica* acts as a carbon sink, sequestering carbon dioxide in its biomass and sediments. also coralligenous formations store carbon in their calcareous structures, helping to climate change mitigation. **Coastal protection**: both prevent erosion and reduces wave energy, protecting shorelines from storms and flooding. **Water quality improvement**: they also traps sediments and cycles nutrients, enhancing water clarity and quality. **Oxygen production**: P. oceanica habitat produces oxygen through photosynthesis, contributing to the oxygenation of the marine environment

PROVISIONING ES: these habitats support the productivity of commercial and artisanal **fisheries** by providing habitats and nursery grounds for marine species. Moreover, many coralligenous species are a source of novel compounds and biological resources that can be used in pharmaceuticals, biotechnology, and other industries.

CULTURAL ES: both habitats are of high **recreational, aesthetic and cultural importance**. They enhance the beauty of the Mediterranean coastline, supporting tourism and recreational activities like snorkeling and diving, as well as, offering opportunities for environmental education and awareness, contributing to cultural and educational significance.

Supporting: both are **biodiversity hotspots** offering habitat, shelter, feeding and nursery grounds to many marine species.

Interacting Drivers of Biodiversity Change

Posidonia oceanica meadows and coralligenous habitats present several interacting drivers of biodiversity change that can significantly impact these vital ecosystems. These drivers often amplify each other's effects, leading to more severe biodiversity loss.

2. **Climate Change**: **rising sea temperatures** and **ocean acidification** can stress *Posidonia oceanica* and coralligenous habitats dealing with habitat loss. When combined with **physical habitat destruction** from coastal development or trawling, the resilience of these ecosystems is further compromised. Moreover, climate change can create conditions that favour **invasive species** expansion, which can outcompete native species inhabiting these habitats.
3. **Pollution**: increased water **temperatures** due to climate change can enhance the toxicity of pollutants, leading to more severe impacts on marine organisms. In addition, nutrient runoff from agriculture can cause **eutrophication**, leading to algal blooms that reduce water quality dealing sometimes with **anoxic events**. This is exacerbated by **overfishing**, which removes species that might help control algal populations.

4. **Interaction with Habitat Degradation**: overfishing can deplete key species that maintain ecosystem balance. Bottom trawling, a common fishing method, physically damages *Posidonia* meadows and coralligenous structures, leading to habitat degradation. Removing top predators through overfishing can allow **invasive species** to proliferate, altering the structure and function of these habitats.
5. **Coastal Development**: coastal development often increases runoff of **pollutants** into marine environments, affecting water quality and the health of Posidonia and coralligenous habitats. Moreover, sea level rise and increased storm frequency, driven by **climate change**, can cause more erosion and physical damage to these habitats, exacerbated by coastal development that often removes natural buffers.

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