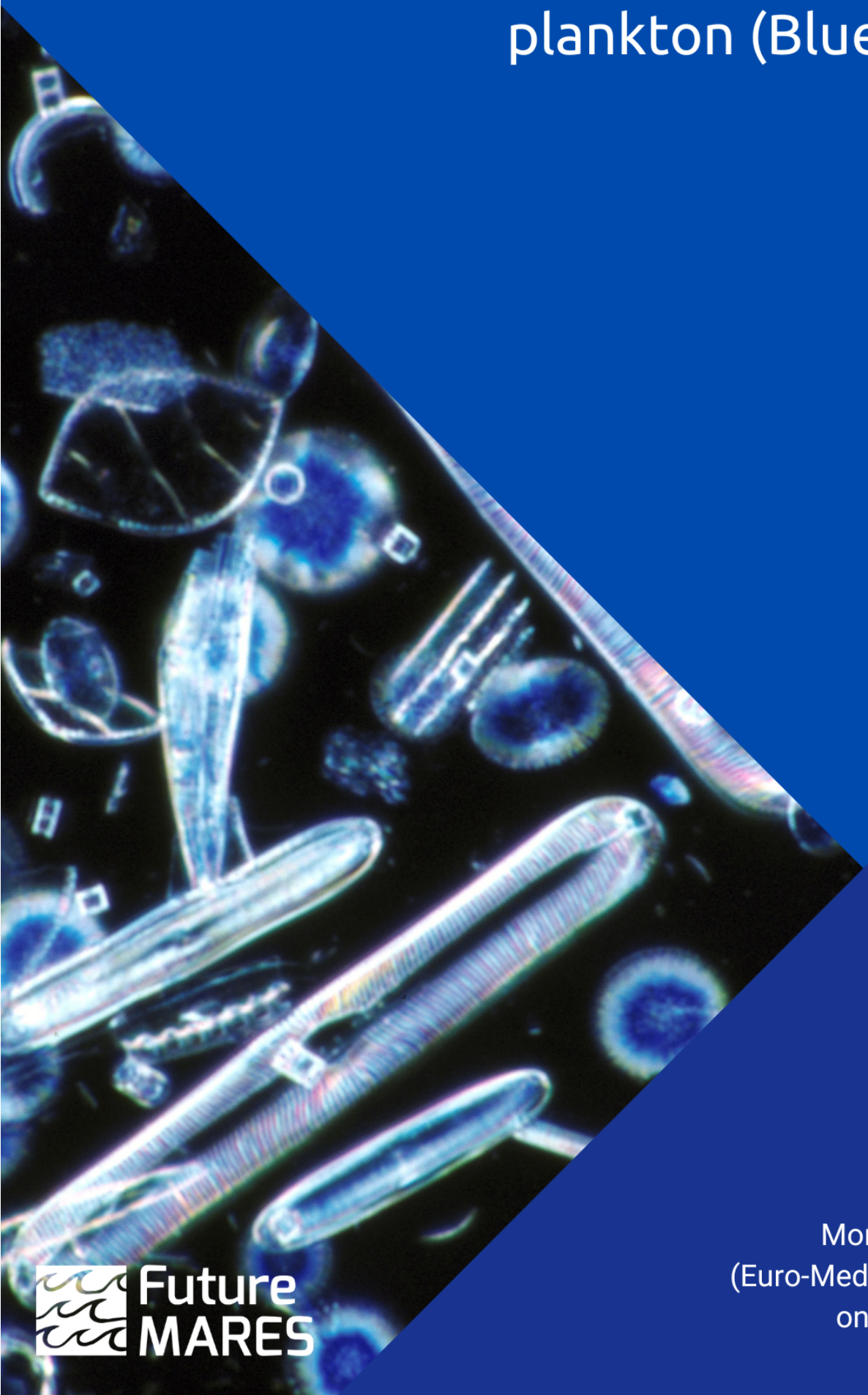
Offshore European Seas: plankton (Blue Carbon)

Storyline 37



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Introduction

The EU Horizon project FutureMARES (2020-2024) was designed to develop science-based advice on viable actions and strategies to safeguard biodiversity and ecosystem functions to maximise natural capital and its delivery of services from marine and transitional ecosystems in a future climate. The program investigates effective habitat restoration, conservation strategies and sustainable harvesting at locations across a broad range of European and other marine and transitional systems. The restoration of habitat-forming species (plants or animals) and habitat conservation (e.g. marine protected areas, MPAs) represent two nature-based solutions (NBS) defined by the EU as "resource efficient actions inspired or supported by nature to simultaneously provide environmental, social and economic benefits that help to build resilience to change". A third action that will interact with these two NBS and have positive effects on marine biodiversity is nature-inclusive harvesting (NIH) such as the sustainable farming of plants and animals at the base of marine food webs and ecosystem-based management practices for traditional (artisanal) and commercial fisheries. FutureMARES will advance the state-of-the-art forecasting capability for species of high conservation value, explore new and less carbon intensive aquaculture production methods, perform modelling analyses geared towards informing the development of climate-smart marine spatial planning approaches, and provide an assessment of ecosystem services based on scenarios of climate change and the implementation of NBS and NIH.

This document provides a multi-disciplinary summary of activities conducted in FutureMARES in a specific area on specific NBS and/or NIH. The activities include work across various disciplines including marine ecology (analyses of historical time series and experiments performed in the field and laboratory), climate change projection modelling (future physical, biogeochemical and ecological changes), economic analyses, social-ecological risk assessments. Many of these components and analyses, including NBS / NIH scenarios tested, were co-developed with local and regional stakeholders through regular engagement activities. The work presented in these Storylines represent activities conducted by a large number of FutureMARES project partners. Broader comparisons and syntheses (across regions and/or topics) are provided in the FutureMARES deliverable reports (www.futuremares.eu) submitted to the European Commission.

NBS regional context

European Seas are characterised by a variety of habitats under a wide range of environmental conditions leading to substantial variability in exposure and vulnerabilities ranging from the intertidal zone to open-ocean offshore regimes. The deteriorating effect that climate change has on marine habitat conditions threatening biodiversity at the large scale is increasingly evident (IPCC AR6 WG2). A couple of attempts have been made to quantify the relationship between changing oceanic habitat conditions and marine biodiversity using various approaches mostly focusing on individual pressure, often restricted to temperature as the main driver (Beaulieu et al., 2015). At the same time there is increased recognition of the importance of the impact of multiple pressures on the marine ecosystem and the non-linear behaviour of antagonist and synergistic combinations of these (Gruber et al. 2021).

In this storyline machine learning approaches will be explored to link changing habitat in multiple pressures (warming, acidification, deoxygenation) to decreases in biodiversity potential, training neural networks by mapping environmental conditions of the recent past (e.g. from Copernicus reanalysis products or integrated observational data-sets) to biodiversity records (e.g. CPR records), in order to establish the relationship of predictor variables and predictand. These relationships will then be projected into the future taking full advantage of the FutureMARES ensemble physical and biogeochemical key variables developed in WP2 Changing habitats to provide estimates of future biodiversity.

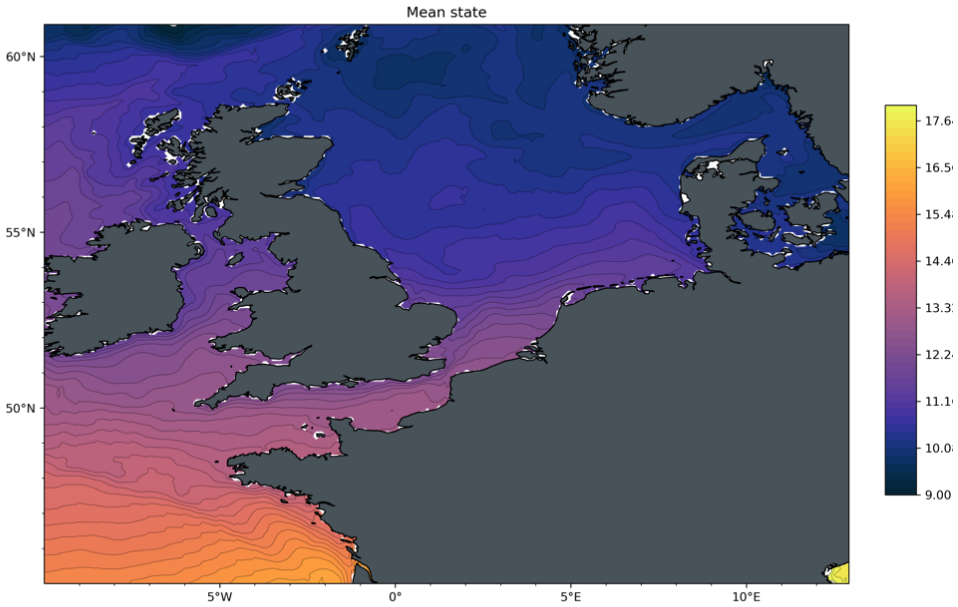

Figure 1: Sea Surface Temperature (degrees C) under present day conditions (1995-2014) over the North-West European Shelf. Credit: Momme Butenschon

Projected impacts of climate change

European Seas are exposed to significant alterations of habitat conditions under climate change (Figures 1 to 4). The heterogenic character of the temporal-spatial patterns of environmental conditions together with the non-linear synergistic or antagonistic combination of pressures like warming, acidification and deoxygenation, lead to variable responses of the natural system at the regional to local level, depending on the resilience of The approach followed in this storylines provides the means of estimating the combined response of local ecosystems to cumulative pressures identifying hot-spots and refugia of marine biodiversity under various projections of changing climate.

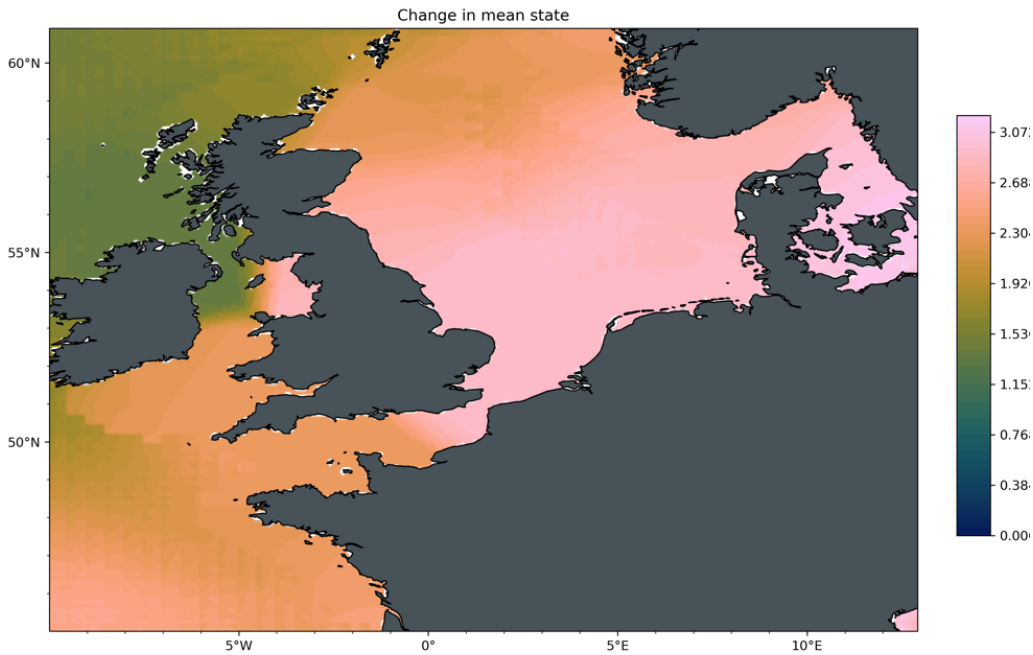

Figure 2: Change in Sea Surface Temperature (degrees C) by the end of thecentury (2080-2099) over the North-West European Shelf under Scenario SSP5-8.5. Credit: Momme Butenschön

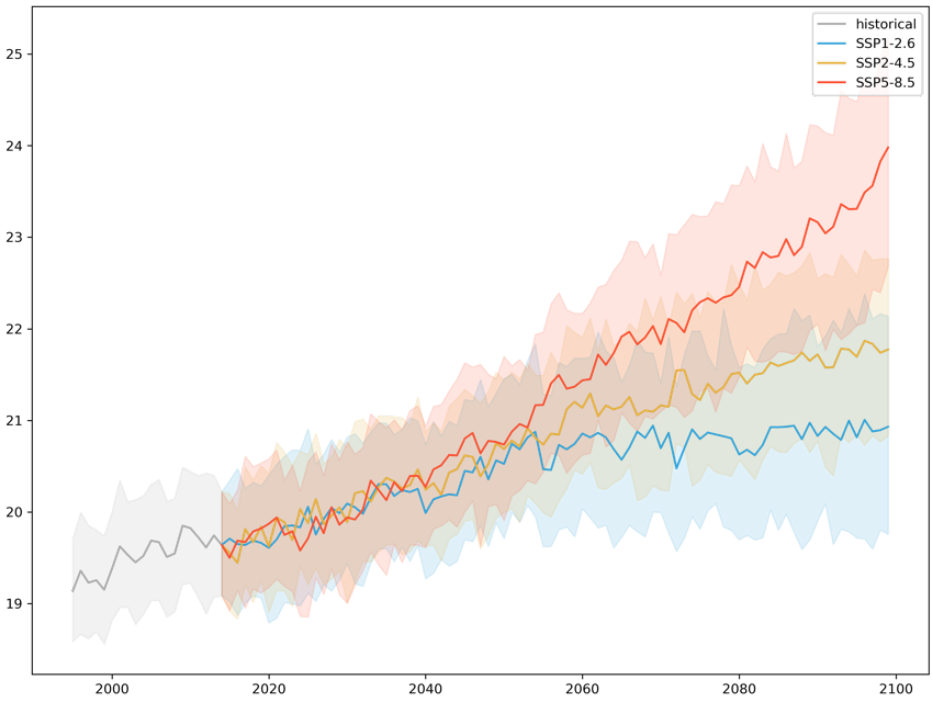

Figure 3: Basin average Sea Surface Temperature (degrees C) of the Mediterranean Sea for the recent past and three different future projections. Credit: Momme Butenschön

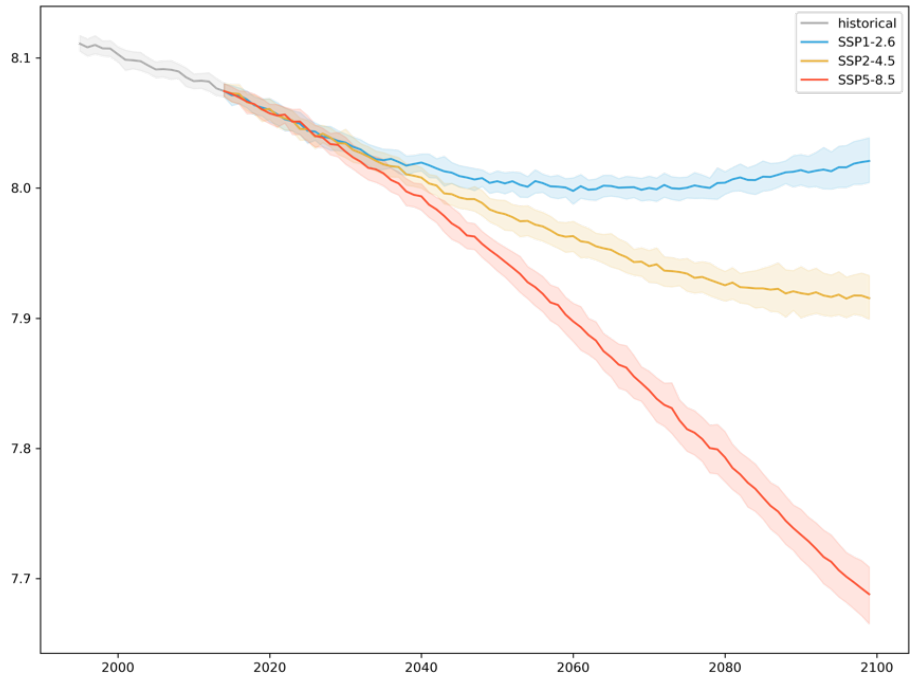

Figure 4: Basin average pH of the Mediterranea Sea for the recent past and three different future projections. Credit: Momme Butenschon

Scenarios describing future society and economy

FutureMARES will develop policy-relevant scenarios based on commonly used IPCC frameworks including SSPs and RCPs. These broad scenarios are regionalised based on stakeholder perspectives to guide activities such as model simulations in specific Storylines. Each of these scenarios has implications for the three NBS examined in this program (effective restoration, effective conservation, sustainable seafood harvesting):

Global Sustainability (SSP126) - Low challenges to mitigation and adaptation

The world shifts gradually but pervasively to a more sustainable path, emphasising inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, investments in educational and health accelerate lower birth and death rates, and the emphasis on economic growth shifts to an emphasis on human well-being. Societies increasingly commit to achieving development goals and this reduces inequality across and within countries. Consumption is oriented toward lower material growth, resource and energy intensity.

National Enterprise (SSP385) - High challenges to mitigation and adaptation

A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to focus on domestic or regional issues. Policies shift over time to be oriented more on national and regional security. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Investments in education and technological development decline. Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. Population growth is low in industrialised countries and high in developing ones. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.

World Markets (SSP585) - High challenges to mitigation, low challenges to adaptation

The world increasingly believes in competitive markets, innovation and participatory societies to produce rapid technological progress and train and educate people for sustainable development. Global markets become more integrated and strong investments in health, education, and institutions are made to enhance human and social capital. The push for economic and social development is coupled with exploiting abundant fossil fuel resources and adopting resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary.

Figure 5: Representation of three, broad scenarios to be regionalised to guide activities such as model simulations in FutureMARES project. Credit: FutureMARES

FutureMARES research needs

While a limited amount of information is available on individual pressures, very little is known about the comprehensive exposure and effects of multiple pressures that may combine synergistically or antagonistically to form hot spots and refugia of climate change. In addition, while a comparatively large amount of data and information is available on temperature, comparatively little is known about near coastal and intertidal zones that are crucial for a huge variety of ecosystem services.

FutureMARES research (T = Task – see program structure at futuremares.eu)

- T1.4 Utilize IPCC SSP-RCP scenarios for ease of comparing the findings here and those from other regions where plankton change is being projected
- T2.1: Collection of physical-biogeochemical data for current status and future projection of environmental pressures - ongoing
- T2.2: Uncertainty envelopes for environmental pressures - started
- T2.3: Broad scale biodiversity and hotspot/refugia maps
- T5.3: Vulnerability assessment
- T6.1: Feedback of information to Storylines conducted at smaller spatial scales;
- T8.1: Engagement with cross-regional stakeholders (e.g. international – OSPAR, EU DG Environment, IPBES).

Storyline Contact

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References

Beaugrand, G, et al. (2015) Future vulnerability of marine biodiversity compared with contemporary and past changes. Nature Climate Change 5, 695–701. https://doi.org/10.1038/nclimate2650

Gruber, N, et al. (2021) Biogeochemical extremes and compound events in the ocean. Nature 600, 395–407. https://doi.org/10.1038/s41586-021-03981-7