Saltmarsh, seagrass and kelp habitats in the North Devon UNESCO World Biosphere Reserve

Storyline 11

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Future MARES

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

The coastal area of North Devon is a key component in the North Devon UNESCO World Biosphere Reserve. The length of coastline extends over 90 km and includes a variety of habitats of circalittoral rocky reefs, large sandflats backed by extensive dune systems and the estuary with extensive intertidal mudflats and saltmarshes. The tidal range varies from 7.9 metres at Appledore to 9.3 metres at Ilfracombe along the coastline, as the tidal wave propagates up the Bristol channel to the east.

Within the estuarine areas of this biosphere reserve, there has been a range of reports and investigations carried out to understand the likely future evolution of the estuary in terms of geomorphology (regime model by J Pethick) and composition of marsh habitats (Sea level and Marsh management model, by A Bell). This work has helped indicate where intertidal area may need to be created and their impacts on the system. There have also been a range of small to moderate size projects to recreate new intertidal areas over the last 20 years.

As a UNESCO Biosphere Reserve, a marine natural capital plan was produced in 2020 (https://www.northdevonbiosphere.org.uk/mncp.html). From this plan, the key ecosystem services that local stakeholders wish to enhance are carbon sequestration, provision of wild fisheries, flood defence and good quality tourism.

Addressing this ambition, FutureMARES, will develop new tools that enhance the ability to design and implement effective restoration (NBS1) of the extent and quality of

- saltmarshes (for flood defence, carbon sequestration, and fish nursery habitat)
- kelp beds (for carbon sequestration, and fish habitats wave attenuation) on the open coast
- seagrass (carbon, wave attenuation and fish habitat) either intertidally and or sub-tidally

Information on the potential viability of farming of kelp is also currently being explored (NBS3). Most of this activity will take place in the context of marine protected areas within the Biosphere Reserve.

Projected impacts of climate change

Climate-related impacts impacting the presence and health of kelp, saltmarsh and seagrass in this UNESCO Biosphere Reserve can be classified into two challenges:

Challenge a: SLR impact on marsh distribution: It is understood that most saltmarshes will not be able to accrete at a pace to match SLR (Crosby et al. 2016, Jayathilake & Costello 2020). Globally, the loss of saltmarsh habitat due to SLR and coastal squeeze has been estimated as high as 80% (Horton et al. 2018). Where coastal squeeze occurs, it is also likely that the relative composition of saltmarsh types will also become biased towards communities at lower (more often submerged) tidal limits.

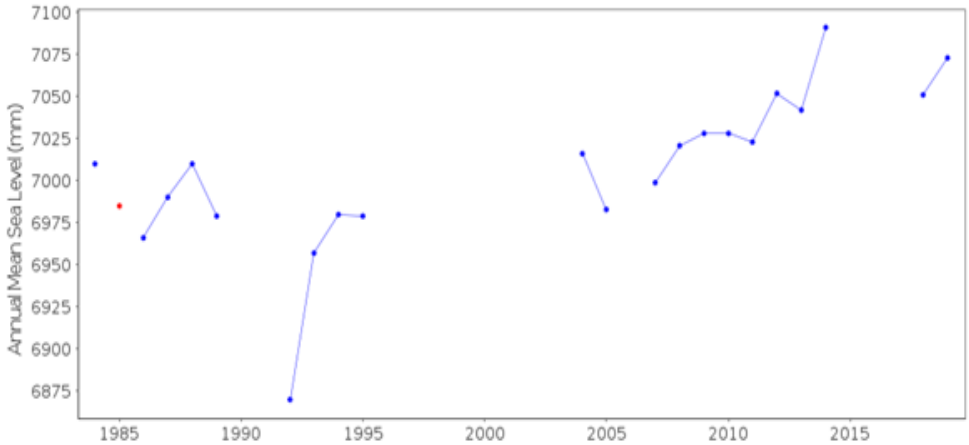

Figure 1: Tide gauge information at Ilfracombe indicates a RSL in the order of 3mm per annum. Consequently, the extent of saltmarsh is reducing within the estuary due to coastal squeeze, against the flood defence that was the former railway line circumscribing the estuary. Credit: https://www.ntslf.org/products/sea-level-trend-charts?name=Ilfracombe

Challenge b: Impact of changes in T, nutrient & profiles on seagrass & kelp: The accelerating pressure of long-term and extreme warming (Smale 2020), as well as human-driven increase in coastal turbidity and changes in nutrient profiles and salinity are re-distributing kelp and seagrasses globally (Duarte et al. 2018, Blain et al. 2021). Whilst there are clear patterns at the equatorial (trailing) edges of species distributions, where previously dominant species are disappearing, it seems increasingly likely that regionally-specific adaptation potential is a key determinant of distributional effects in other parts of the biogeographical ranges of both groups. Indeed, populational differences are typically observed in studies assessing the impacts of different types of global stressors on marine organisms (Calosi et al. 2017), and challenge our ability to accurately predict species distributions, and thus biodiversity patterns and the services they underpin, under possible future ocean conditions (IPCC 2021).

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

FutureMARES research needs

NbS a: Outputs from the current global model (SLAMM - Sea Level Affecting Marshes Model) used to simulate wetland conversion and shoreline modification for the purpose of habitat vulnerability assessment and decision making needs to be refined so that they better resolve upper, middle and lower salt marsh zones based on the topography of the estuary. This will advance our understanding of the natural mix of saltmarsh types that could be achieved through restoration despite SRL and how to retain the ecosystem services they provide in this ecosystem (and other locations with similar geomorphology and flooding regime).

NbS b: Given the current range of projected warming and other changes in the UK EEZ and elsewhere, as well as growing reliance on seagrass and kelp to mitigate climate change by sequestering carbon (Hoegh-Guldberg et al. 2019), it is increasingly important to capture variability in responses and adaptive potential to climate change and other pressures in the tools we use to project the future distribution of these habitat-forming species (IPCC 2021). Existing tools are correlative and not mechanistic (e.g. Jayathilake & Costello 2020) and their projections are too uncertain (Kearney & Porter 2009) to inform real-life conservation and restoration actions supporting these species as well as the carbon sequestration, wave attenuation, and provisioning services these habitats provide in support of climate change adaptation and local fisheries productivity.

FutureMARES research

- **T1.3** Identification of ecosystem service indicators that may underpin the contribution of different marsh types to climate change adaptation and mitigation;
- **T3.2** Conduct experiments on key kelp species to identify the sensitivity of locally important populations to extreme heat-wave events, and explore the potential to mitigate those effects thought active management;
- **T4.1** Make projections of the distribution of key kelp, seagrass and marsh species under climate change and other processes, to inform the choice of areas where kelp bed/seagrass/saltmarsh extension may be most successful;
- **T4.4** Explore the impacts of restored kelp beds on the productivity of fishes targetted by local fisheries;
- **T6.1** Provide a spatial assessment of the climate resilience of habitats at the heart of restoration work;
- **T6.2** Perform economic (input/output) modelling of climate-driven changes in kelp as a carbon sequestering habitat and one that supports local fisheries in the North Devon UNESCO World Biosphere Reserve.

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