Sustainable Seafood Harvesting in the Belize EEZ

Storyline 38

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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

The Caribbean region is widely recognised to be a hot spot for marine biodiversity. The area hosts a wide range of habitats and species of conservation and fisheries importance. The main and most economically important fisheries in the area concentrates on spiny lobster (Panulirus argus) and queen conch (Strombus gigas). These species are key to sustain sources of protein intake, livelihoods, and economic trade for local Caribbean communities. These two species have fluctuated throughout the years and their distribution has remained in similar quantities in landings since 2005. The queen conch peaked in 2012 following high sample density and increasing shell length, whilst the spiny lobster has generally remained stable in terms of landings, however there are limited data sets across some years, which have created gaps in the current assessments. The general concept of effort was described by the number of fishing days, which has generally increased from 1990 to 2011. The rate of change in effort from 2006 to 2011 was mirrored by that in queen conch landings, but these values were inverse when compared to the spiny lobster landings, due to limited distribution of conch due to overexploitation. The lack of further fishing days' data precluded any further analysis.

Fishing activities in Belize supports some 15,000 people, fluctuating throughout the years, but overall, this value is largely stable, comprising fishers, fish processers, and salespeople. Belize has a pilot managed access area scheme over the period of 2011-2016 and is being scaled up nationwide from 2017 to revolutionise fisheries management. This work is based on a small-scale, rights-based system. Results of this policy are unclear as well as whether the methodology of partitioning, (i.e., by the use of these reserves). Some areas are designated MPAs and 'no take zones' whilst other are designated marine parks with some usage (e.g. tourisms and seasonal limited extraction of resources).

Some dedicated aquaculture activities are also being explored in the area to complement the fisheries sector, as a potential adaption strategy. Aquaculture has focused primarily on shrimp but the government is encouraging fisheries diversification to tilapia (increasing participation), shore crab and sea cucumber, to benefit any commercial loss to those fishers. The number of licenses is largely unchanged since 2010 but, with the new government and new ministries, there will be new opportunities to continue to explore and protect queen conch and spiny lobster, whether by a remit for Marine Protected Areas (MPA) or under dedicated Nature-based Solutions (NBS) approaches.

Figure 1: A mature spiney lobster (*Palinurus argus*). Credit: Samir Rosado CZMAI ©

Figure 2: A photographic record of the queen conch (*Strombus gigas*). Credit: Silvana Birchenough ©

Projected impacts of climate change

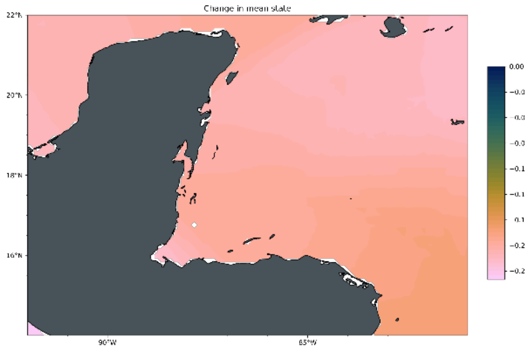
The Caribbean Sea has increased its temperature by approximately 1.5°C over the last century (Palanisamy et al. 2012). Current projections suggest a further warming by an average of 1.4oC by the years 2081–2100 compared to 1986–2005 (Nurse et al. 2014) with the magnitude of warming dependent on which Representative Concentration Pathway (RCP) scenario is applied. These changes in sea surface temperature (SST) closely track increases in atmospheric temperature.

Projected changes will be between 0.5 – 0.9oC by 2100 for the lowest carbon emissions scenario (RCP2.6) and greater than of 4oC under RCP8.5 (Carabine and Dupar 2014).

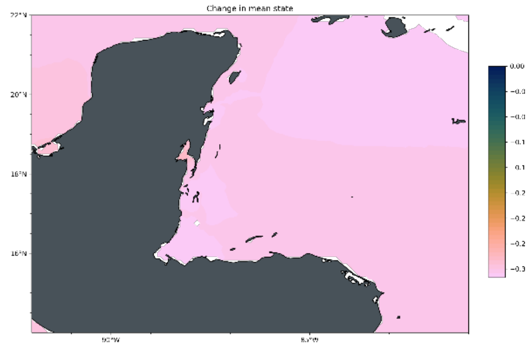
The Caribbean region is also characterized by having a wet and a dry season. There is also evidence that the small annual range in SSTs will continue to decrease from a current average of 3.3oC to just 2.3oC by the end of the century. Therefore, it is expected that there will be a less observed seasonal 'warm' and 'cool' periods in the coming decades.

Increasing temperatures will have repercussions for marine species and habitats and with consequences to the structure and functioning of all marine ecosystems (Llopiz et al. 2014). The variety of fish and shellfish found in these areas are classified under poikilothermic (organisms capable of adjusting their temperature depending on the environment) and ectotherms, whose ability to gain temperature is through their environment. Therefore, these increasing temperatures will have direct physiological effects such as increased metabolic costs and activity which will, in turn, influence ratees of growth and reproduction (Doney et al. 2012). Some of these expected changes could have direct repercussions for increasing growth rates and stock productivity on temperate species. However, the Caribbean region has several species, that may be challenged if additional warming exceeds physiological thermal preferences and optimum ranges. In the Caribbean region, a recorded decrease in the pH of seawater has followed the global trend with a decrease in the aragonite saturation state over the period 1988 – 2012, with a clear variability across time and space (Mumby et al. 2014). Some of these effects could also impact calcifying organisms. There is ongoing research to elucidate how changes in multiple environmental factors (e.g. pH, nutrients and temperature will impact on commercial species in this region (Birchenough et al. in prep).

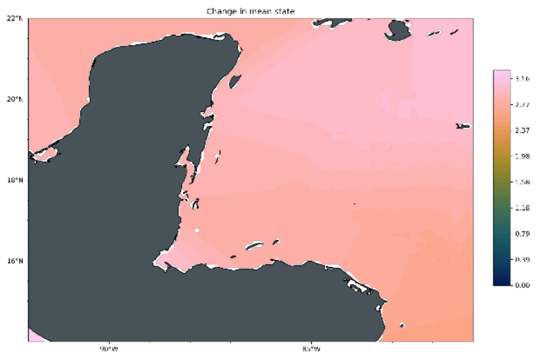
Figure 3: An aerial image displaying the iconic 'Blue Hole' in the Caribbean Sea. Credit: Silvana Birchenough ©



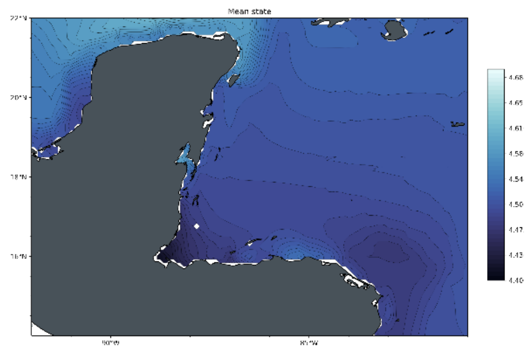
Oxygen (in ml/l) changes in the far future at 5m depth under scenario SSP5-8.5



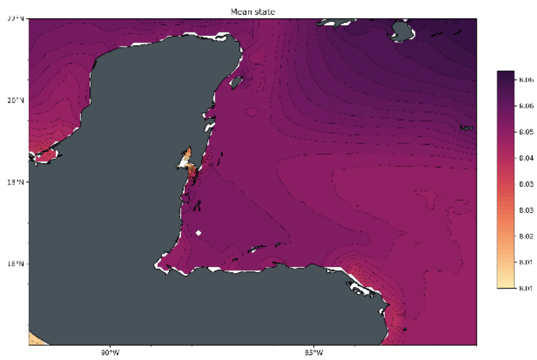
pH changes in the far future at 5m depth under scenario SSP5-8.5



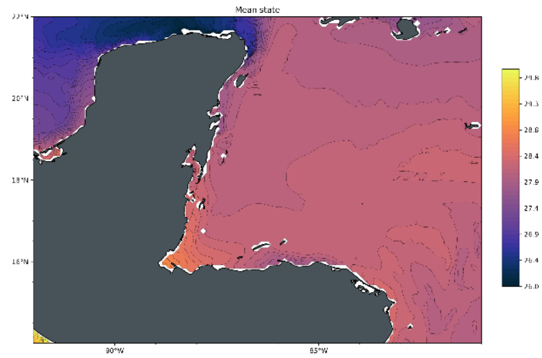
Potential Temperature (in degrees C) changes in the far future at 5m depth under scenario SSP5-8.5



Oxygen (in ml/l) changes in the present day at 5m depth under scenario SSP5-8.5



pH changes in the present day at 5m depth under scenario SSP5-8.5



Potential Temperature (°C) changes at present day at 5m depth under scenario SSP5-8.5

Figure 4: The figures were produced using trend preserving statistical downscaling (Lange, 2019) of a multi-model ensemble Earth System Model historical simulations and future projections from the CMIP6 archive trained on reanalysis datasets from the Copernicus Marine Environment Monitoring Service.

Geographical Maps were extracted from the full dataset by averaging over the following periods, consistent with the periods considered in the IPCC AR6 WG1 report:

- present day: 1995-2014
- near future: 2021-2040
- mid future: 2041-2060
- far future: 2080-2099

Time-series plots were produced averaging over the area of interest for each storyline and show the ensemble mean in the full lines and the range of model responses in the shaded areas as represented by the 2.5 and 97.5 percentiles of the ensemble. Credit: Momme Butenschön, Euro-Mediterranean Center on Climate Change.

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

Birchenough (2017) identified two major climate-related threats impacting the fish and shellfish population which provide the base for commercial fisheries and corresponding knowledge gaps:

(1) Understanding how the rise in surface sea temperature (SST), linked in several studies to cause coral bleaching, could have repercussions for commercial species inhabiting these areas. Moreover, there is a need to assess the combined effects of climate-driven multiple stressors (e.g. SST with pH and oxygen changes) since these could dramatically affect the distribution and productivity of species as well as habitat function and overall ecosystem health.

(2) Understanding how the increase in the frequency of hurricanes, namely of category 4 and 5 in the region, could further damage commercial species and increase coral disturbance and bleaching.

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

- T1.1. Synthesis, analysis and supporting long-term data sets to support commercial species analysis;
- T1.2. Collecting environmental data and s needed to examine climate risk;
- T2.1. Provide the relevant high-resolution temperature, hurricanes, and other relevant series to explore climate driven challenges to commercial species and their environments;
- T2.2. Provide input to estimate ecological climate risk to commercial species and their MPAs (thermotolerance, pH, storms and hurricanes and oxygen data available);
- T2.3. Create spatial maps identifying options for implementing climate-ready conservation for Belize given multiple users, sectors and services (particularly fisheries under their newly developed climate change policy);
- T2.4 Engage local MPA managers to co-develop project activities and present FutureMARES activities to broader, MPA network through other, ongoing programs.
- T2.5 report the overall findings of this work.

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