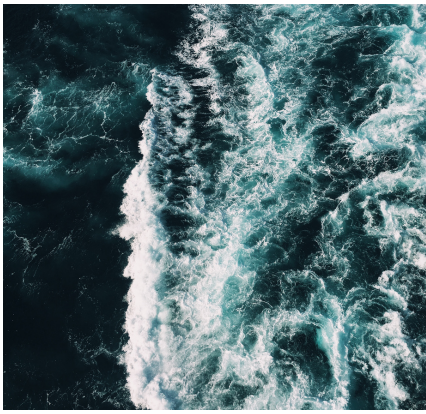
Implementation Scenarios for Marine Nature-based Solutions (NBS)

This document introduces scenarios and seeks specific input from stakeholders on their perceptions of regional aspects most important to be contrasted in FutureMARES activities. Project activities include projections of spatial ecological impacts, social-ecological risk assessment, and bioeconomic analyses. This work is performed using different implementation scenarios of NBS and Nature-Inclusive Harvesting.







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1 Nature-based Solutions (NBS)

Actions inspired by nature to provide environmental, social and economic resilience to change.

The European Commission defines Nature-based Solutions (NBS) as 'solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.' NBS must benefit biodiversity and support the delivery of a range of ecosystem services.[1] Nature-based Solutions have also been defined by the IUCN as 'actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively, and adaptively, simultaneously providing human well-being and biodiversity benefits.'[2]

Three closely-related activities in marine / coastal areas are Habitat Restoration (NBS), Marine Conservation (NBS), and nature-inclusive Seafood Harvesting (aquaculture and fisheries).

FutureMARES has developed contrasting future narratives on the implementation of these activities. This brochure explains how we use scenarios and is a guide for stakeholders to provide their regional perspectives. Seeing how these scenarios might work in different regions helps to plan our research.

Marine NBS/activities and the ecosystem services they provide (listed below)	**Habitat Restoration**	**Marine Conservation**	**Seafood Harvesting**
Reduce coastal erosion and flooding (stabilise shorelines, reduce storm surge)			
Increase water quality (combat eutrophication)			
Mitigate climate change (sequester carbon, reduce emissions)			
Increase productivity of food from the sea (fish nurseries, growth of shellfish / kelp)			
Maintain / increase biodiversity (make natural areas more resilient against change)			
Support tourism and cultural heritage (increase aesthetic and economic value)			

NBS: Habitat Restoration

Marine habitats include seagrasses, salt marshes, mangroves, kelp forests, coral and shellfish reefs, which form natural coastal protection and help to adapt to increased storminess, rising sea levels and floods resulting from climate change. Expanding vegetated habitats also mitigates climate change by developing carbon sinks, like afforestation. These habitats also support biodiversity by forming key nursery areas, and providing natural refuges and feeding grounds. They also improve seawater quality and clarity, and sustain tourism and cultural activities.

NBS: Marine Conservation

Effective conservation considers effects of climate change on habitat suitability for flora & fauna. Strategies explicitly consider the range of impacts of climate change and other hazards on habitat suitability for flora and fauna. Strategies explored include preserving the integrity of food webs and sustaining population connectivity across networks of climate refugia where biogeophysical conditions are stable or changing slowly over multiple spatial and temporal scales (i.e. from site-specific marine protected areas to conservation strategies for certain large marine species such as turtles or dolphins).

Seafood Harvesting

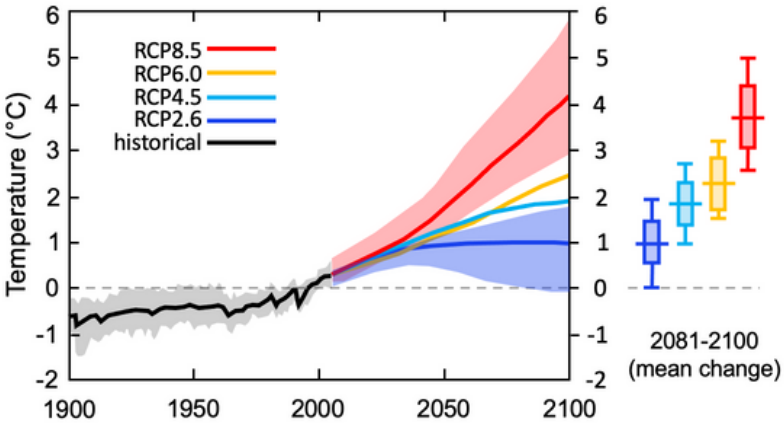
Sustainably harvesting seafood from fisheries and aquaculture should be flexible, adaptive and managed according to each ecosystem. Addressing the impacts of climate change requires ecosystem-based management and a multi-species approach that can adapt to shifts in productivity, distribution and species interactions and also limit the disturbance of the seafloor. Harvesting strategies must consider potential trade-offs among multiple users, economic sectors and ecosystem services such as cultural heritage for effective Blue Growth. It has a strong connection to restoration and conservation efforts.

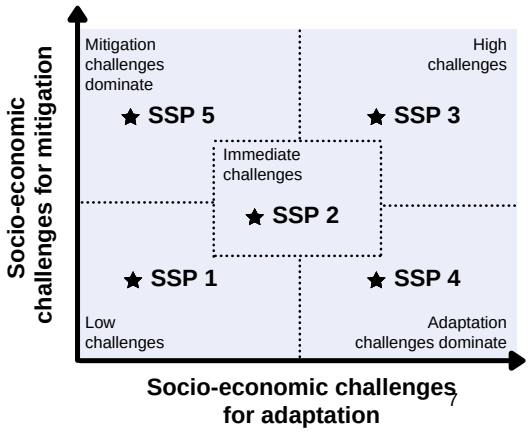
2 What are Scenarios?

Scenarios are imagined 'futures', that are not necessarily 'visions' or 'plans.'

Scenarios can help guide strategy and are created in sets of plausible and coherent alternatives. Scenarios can help define the scope for adaptation by characterising the responses of various stakeholder groups (policymakers, conservationists, business owners, and the general public) under each future scenario.[3]

The Intergovernmental Panel on Climate Change (IPCC) has developed two types of complimentary scenarios. The first describes how the concentration of CO_2 and other greenhouse gasses may rise or fall in the future, so-called Representative Concentration Pathways (RCPs). The second are Shared Socio-economic Pathways (SSPs), which describe how future changes in society (population growth, gross domestic product, international cooperation, etc.) can influence how easy it is for countries to enact climate adaptation or climate mitigation policies. The SSPs (social-economic, geo-political) and RCPs (amounts of global warming) were designed to be used together and, although not specifically matched, some RCP-SSP combinations are more likely to happen than others.[3,4] The figures on the left illustrate the RCPs with their mean temperature changes until the year 2100 (top) as well as the SSPs with different socio-economic challenges for climate change mitigation and adaptation (bottom).[5,6]





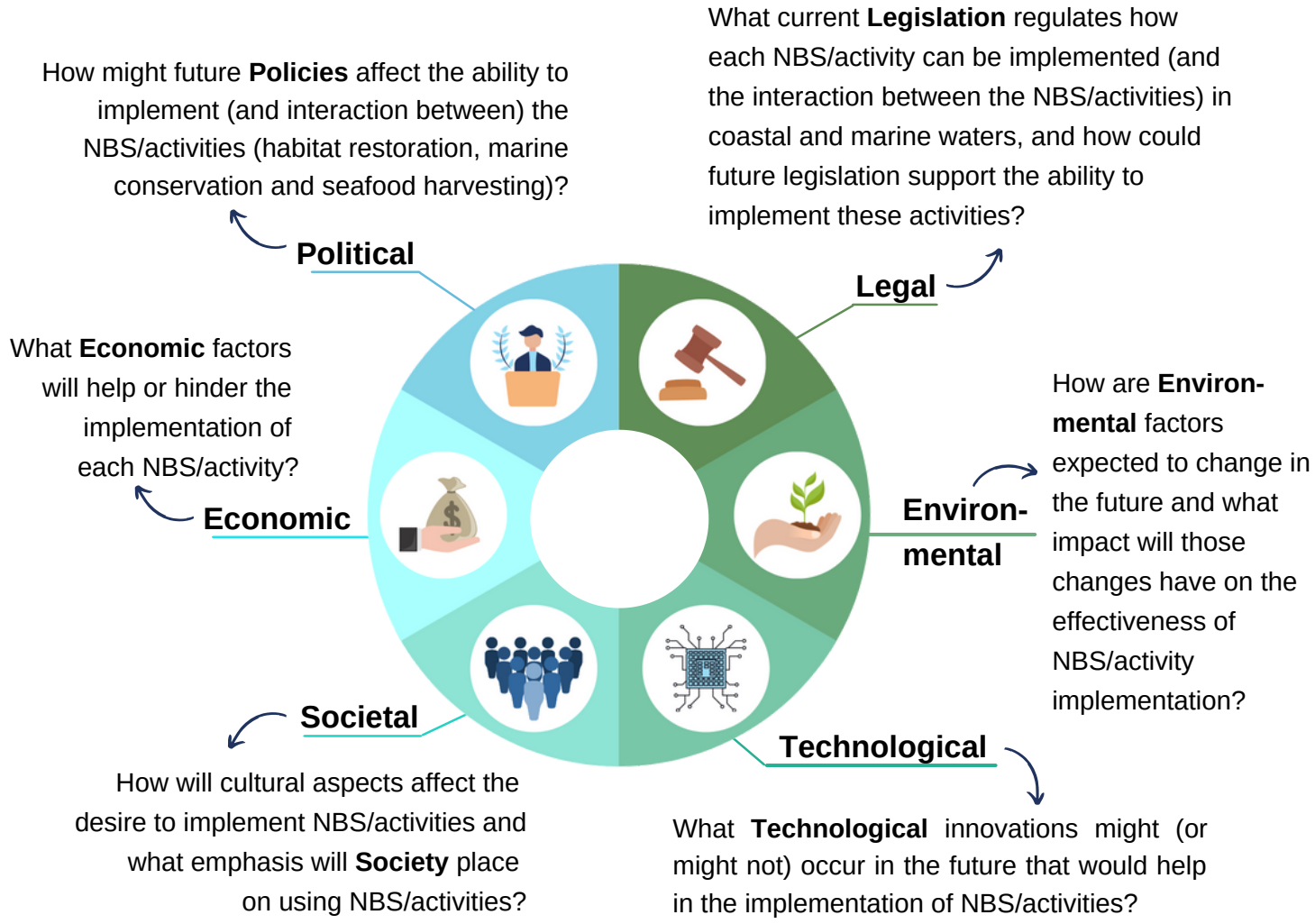
Global temperature change (left)[7] and SSPs (right).[5,6] Global temperature change is illustrated relative to 1986–2005 for the SRES scenarios run by CMIP3 and the RCP scenarios run by CMIP5, with the number of models in brackets.

>>> Scenarios are also guiding the work of the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) to recommend actions (such as NBS) to halt the alarming loss of biodiversity occurring around the globe. These scenarios specifically address the future of nature and nature's contributions to people.[8] <<<

3 The PESTLE Approach to developing scenarios

PESTLE is a mnemonic which in its expanded form denotes P for Political, E for Economic, S for Social, T for Technological, L for Legal, and E for Environmental.

PESTLE is a way to look at all the potential factors that may influence planned actions. Although PESTLE analysis stems from the business community, it was used to explore future scenarios for EU aquaculture and fisheries in the CERES project.[3,9] To help guide stakeholders in providing more detailed, region-specific information for each PESTLE element, the following illustrates general questions to ask when building contrasting scenarios for NBS impementation.



4 The FutureMARES Scenarios

How society tackles climate adaptation and mitigation in three plausible scenarios.

FutureMARES will develop policy-relevant scenarios with stakeholders across the world. These scenarios are based on commonly used IPCC frameworks including SSPs and RCPs.

Global Sustainability (RCP2.6, SSP1)

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 (RCP8.5, SSP3)

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 (RCP8.5, SSP5)

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.

More details: futuremares.eu/futurescenarios

5 Habitat Restoration: PESTLE Table

Element	 **Global Sustainability** (RCP2.6, SSP1)	 **National Enterprise** (RCP8.5, SSP3)
P	A collaborative, international atmosphere exists and governments (e.g. UN, EU) provide strong, consistent leadership to support restoration. Habitat restoration is supported through consistent policies at regional, national and international levels.	Lack of agreement between nations leads to inconsistent and smaller-scale (within EEZ) application of policies for NBS/activities. Restoration strategies differ among countries. Restoration is relatively low on national policy agendas as opposed to meeting energy demands.
E	Less severe, climate-driven changes and shifts in suitability of habitats. Large-scale habitat restoration and recovery increases ecosystem services (e.g. carbon capture). Recovery is fostered by reductions in pollution (plastics, eutrophication) and other habitat stressors.	Stronger climate-driven changes in the suitability of habitats to support local species increase shifts and add uncertainty to regional NBS/activities implementation. Large areas set aside for food production may pose carrying capacity issues; Biodiversity declines due to little restoration of habitat-forming species.
S	High awareness of the importance of well-functioning marine habitats & ecosystems supported by education programs. Protecting natural capital is priority. Increased demand for restored habitats for recreation and leisure and to meet ethical concerns.	Restoration is not a priority particularly of habitats (e.g. saltmarshes) that take up valuable farmland. Restoration targeted to iconic species / habitats and those protecting assets (resilience of coastline).
T	Increased investment in technology leads to breakthroughs in low-cost, efficient environmental monitoring (e.g. satellite, drones). Biodegradable techniques for effective restoration and long-term monitoring of habitats. Biotechnology (e.g. assisted evolution) increases resiliency of restored species.	Concentration on locally-developed technologies and knowledge to restore habitats or species (little learning from elsewhere). Using technology to restore native habitats that have cultural meaning.
L	International commitments to agreed goals (e.g. Paris Climate Agreement) are fully embedded within legal frameworks in each country (including CBD, IPCC, IPBES). Regulations include severe penalties to ensure programmes are respected / effective. Habitat restoration is compulsory; Restored habitats play role in carbon capture for Nationally Determined Contributions (NDCs).	International commitments to UN policies are poorly implemented and depend on national interests.
E	Citizens and industries prepared to pay for restoration (either directly for access or via taxes). Sustainable, green business practices are norm. High revenue from ecotourism.	Local/regional investment in restoration and conservation shifted to sectors that create jobs/ have higher economic relevance. Restoration targeted to high-value harvestable species (shellfish).

Political, Environmental, Societal, Technological, Legal, and Economic Dimensions of the future.

World Markets
(RCP8.5, SSP5)

The EU falls apart as a political force, and there is no unified strategy for national environmental policies, with environmental goals less valued than economic growth.

Restoration largely abandoned or conducted for production (profit) or if cheapest way to protect coastal assets.

Warming leads to changes in suitability of waters to support historical, natural habitat; Increased habitat degradation from short-term profit-driven activities.

International trade leads to decline in biodiversity in developing counties; well-established populations of invasive species can compromise restoration efforts.

Full support for restoring marine ecosystems that produce market valuable resources (e.g. cheap protection of coastal assets) or services; Network of harvesting artificial created habitats - blue farms; Poor ocean and climate literacy.

Promotion of bio-engineering in restoration (i.e. assisted evolution, active restoration, etc.) in habitats considered profitable; low ethical constraints on technological development; Potential use of artificial habitats instead of traditional species.

International commitments and agreements on environment/ocean heath objectives are abandoned; National legislation for MPA programmes is weak in favour of investment in sectors that create jobs.

Conflicts arise in marine spatial planning due to economic vs. conservation objectives; Increased international trade conventions, including CITES, with little legal focus on habitat restoration if deemed non-profitable.

High cost effectiveness of restoration actions (e.g. for blue carbon); Biodiversity banking possible to support restoration; Private sector may increase investment in restoration; Focus on short-term wealth generation – degradation in long term.

What is the next step?

FutureMARES needs to add more detail to these three scenarios for habitat restoration in your region. This stakeholder input helps define the work to be performed.

→ See page 12 for example questions.

6 Marine Conservation: PESTLE Table

Element	 **Global Sustainability** (RCP2.6, SSP1)	 **National Enterprise** (RCP8.5, SSP3)
P	A collaborative, international atmosphere exists and governments (e.g. UN, EU) provide strong, consistent leadership to support conservation. MPAs planned as a precautionary approach (not only based on cost-effectiveness), their size meets current 2030 targets (e.g. EU >30%, >10% integral reserves). Trans-national Marine Spatial Planning creates climate-ready conservation.	Lack of agreement between nations leads to inconsistent and smaller-scale (within EEZ) implementation of policies for the NBS/activities. MPAs used to protect species of national importance / value and compete for space with energy and food provision. Conservation policy is not high on the political agenda. Lack of coordinated policies for (trans-boundary) species.
E	Less severe, climate-driven changes and shifts in suitability of habitats Large-scale (in some cases trans-national) conservation efforts allow rehabilitation of sensitive ecosystems and associated species.	More severe, climate-driven changes in the suitability of habitats to support local species increasing shifts and adding uncertainty to site-specific and regional NBS/activities implementation. Smaller, regional conservation efforts with limited scope for planning MPAs based on large-scale connectivity patterns and other conservation actions.
S	Increased awareness of the importance of well-functioning marine habitats and ecosystems supported by education programs. Protecting Natural Capital is a priority. Improved MPA effectiveness by local community support. High value and legitimacy of local and indigenous knowledge. Education supports local ownership and engagement with conservation initiatives.	MPA effectiveness improved by local community suppor.; High value and legitimacy of local and indigenous knowledge. Education supports local ownership and engagement with conservation initiatives. A mosaic of societal attitudes on conservation. Some countries highly concerned - others - main focus on production.
T	Increased investment in technology leads to breakthroughs in low-cost, efficient environmental monitoring (e.g. satellite, drones). Advanced tools support connectivity planning.	Little or no technological advancement. Intensive monitoring of nationally important assets.
L	International commitments to agreed goals (e.g. Paris Climate Agreement) are fully embedded within legal frameworks in each country (including CBD, IPCC, IPBES). Regulations include severe penalties to ensure programmes are respected / effective.	International commitments to UN policies are poorly implemented and depend on national interests. Arguments and legal disputes between countries about transboundary issues and who is to blame for decline in vulnerable species. Weak conservation legislation.
E	Environmental conservation seen as economically beneficial with emphasis on valuation of Natural Capital and Ecosystem Services but not for profit (MPAs freely accessible perhaps via government funding).	Less financial support for monitoring and enforce-ment of conservation; Potential subsidies to protect valuable assets. Investment diverted to sectors that create jobs/ have higher economic relevance.

Political, Environmental, Societal, Technological, Legal, and Economic Dimensions of the future.

World Markets
(RCP8.5, SSP5)

The EU falls apart as a political force, and there is no harmonised strategy for national environmental policies, with environmental goals less important than economic growth.

Political agendas are driven by global economic interests, omitting conservation and environmental needs.

Warming continues and loss / shifts of some keystone species may decrease ecosystem functioning.

International trade leads to decline in biodiversity in developing counties; in some areas, well-established populations of invasive species compromise restoration efforts.

Full support for the conservation of marine ecosystems that produce market valuable resources or services; Poor ocean and climate literacy; Loss of traditional knowledge and cultural values associated with conservation effectiveness in MPAs.

Technological advances increase efficiency of monitoring and enforcement and better of MPAs deemed to support economic growth; Assisted evolution to support MPAs; Investment in MPAs with artificial habitats.

International commitments and agreements on environment/ocean heath aims are abandoned; National legislation for MPA programmes is weak in favour of investment in sectors that create jobs.

Conflicts arise in marine spatial planning due to economic versus conservation objectives; Increased international trade conventions, including CITES, with little legal focus on pure conservation.

Entrance fees to MPAs to support profitable ecotourism and/or exploitation of marketable ecosystem services such as harvesting, blue carbon, etc.; Biodiversity banking in MPAS.

Macroalgae & seagrass

Habitat-forming corals

Sea turtles

What is the next step?

FutureMARES needs to add more detail to these three scenarios for marine conservation in your region. This stakeholder input helps define the work to be performed.

→ See page 12 for example questions.

7 Seafood Harvesting: PESTLE Table

Element	 **Global Sustainability** (RCP2.6, SSP1)	 **National Enterprise** (RCP8.5, SSP3)
P	A collaborative, international atmosphere exists and governments (e.g. UN, EU) provide strong, consistent leadership to support sustainable harvesting. International treaties ensure sustainable fisheries management, including strong, cohesive trans-boundary regulations; High ecosystem considerations such as balanced harvesting, protecting large female fish.	Lack of agreement between nations leads to inconsistent and smaller-scale (within EEZ) implementation of policies for NBS/activities. Strong political tension among nations regarding shared resources, particularly highlight migratory species or those experiencing range shifts.
E	Less severe, climate-driven changes and shifts in suitability of habitats for harvested species. Long-term increases in fish stock sizes lead to recovery of top predators (marine mammals); Ecolabels focus on reducing environmental impact (e.g. 'dolphin safe', low carbon emissions).	More severe, climate-driven changes in the suitability of habitats to support local species increasing shifts and adding uncertainty to site-specific and regional NBS/activities implementation.
S	Increased awareness of the importance of well-functioning marine habitats and ecosystems supported by education programs. Protecting Natural Capital is a priority. Increased desire for culture and consumption at the base of the food web (seaweeds and bivalves). Only sustainable fishing practices are permitted.	Large support of traditional fisheries to sustain cultural heritage and employment at the national level.
T	Environmentally-friendly fishing gear (low bycatch); large-scale culture of lower trophic level species (seaweeds, bivalves).	Pace of fishing and aquaculture innovation slows in some countries without international exchange and harvesting sector continues to operate as now; Depending on national priorities, some countries may have a large investment in technology for food security; High investment in innovation to monitor infringements into EEZ (investments in drone and remote sensing technology).
L	International commitments to agreed goals (e.g. Paris Climate Agreement) are fully embedded within legal frameworks in each country (including CBD, IPCC, IPBES). Regulations include severe penalties to ensure programmes are respected / effective. Fisheries shifts towards balanced harvesting and/or ecosystem-based management; High enforcement of regulations.	International commitments to UN policies are poorly implemented and depend on national interests; focus on protectionism (import / trade laws).
E	Stock rebuilding may reduce fishing & profits. Subsidies provided to support alternative employment. Wild fish price low, cultured fish price increases.	Depending on national priorities, subsidies may support traditional fisheries; fish price increases due to international trade barriers.

Political, Environmental, Societal, Technological, Legal, and Economic Dimensions of the future.

World Markets
(RCP8.5, SSP5)

The EU falls apart as a political force, and there is no harmonised strategy for national environmental policies, with environmental goals less important than economic growth.

Management based on maximum economic yield and not maximum sustainable yield.

Warming continues and some stocks collapse or shifted also due bio-invasions – new assemblages offer opportunities to be exploited.

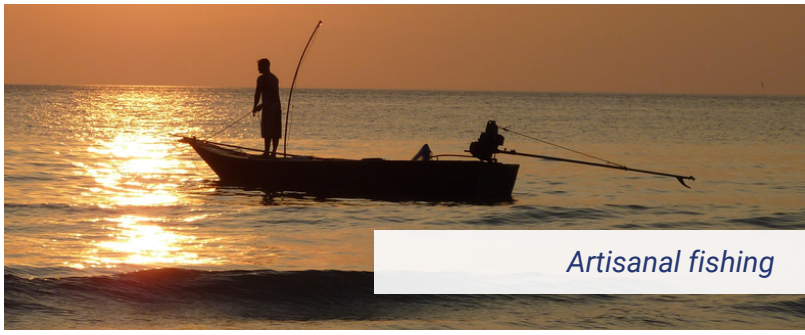
Migration and marginalisation of artisanal / traditional fishers and farmers continues to degrade coastal communities dependent on those activities; loss of traditional knowledge, local identities and cultural values linked to fisheries due to economic rights; Increased reliance on aquaculture for protein security.

Investment in high-tech aquaculture, fish feed rations decrease, increased efficiency / profitable (fish meal replacement) with little investment in offshore (deep water) solutions.

Promoting management harvested species to maximum economic yield; GATT style trade agreements may take precedence over conservation and environmental legislation; Open trade for seafood and seafood processing.

Profit driven efficiency of harvesting but not based on minimising pollution; private access rights to fisheries, and tradable permits.

Huge multinational companies allow fish to be obtained from cheapest sources worldwide (both for fishing and mariculture) benefiting a few countries; Market-based incentives dominate with no subsidies.



What is the next step?

FutureMARES needs to add more detail to these three scenarios for seafood harvesting in your region. This stakeholder input helps define the work to be performed.

→ See page 12 for example questions.

8 Questions for Stakeholders

Political	
NOW	At the local / regional level, which governmental agency(ies) or body(ies) establish environmental regulations and manage activities related to habitat restoration, marine conservation and/or seafood harvesting? If there are multiple agencies/bodies, can you provide examples of how these have interacted to impact (either help or hinder) the implementation of marine habitat restoration, conservation and/or sea food harvesting?
IN THE FUTURE	The extent of implementation of NBS/activities and, more generally, national goals for climate adaptation and mitigation, will differ among the three scenarios. Given these differences, what goals might be set by specific governmental agencies / bodies with respect to climate-ready environmental policies and how might these goals impact marine habitat restoration, marine conservation and/or sea food harvesting?
Environ-mental	
NOW	At the local/regional level, in your view what are the most relevant environmental threats faced by marine species and/or habitats important for marine habitat restoration, marine conservation and/or sea food harvesting? What changes have you observed in marine habitats and/or species in the last decades and what do you think has(have) been the main cause(s) of those changes?
IN THE FUTURE	Climate change will continue to interact with other human-made stressors (e.g. habitat destruction, pollution, invasive species) to impact marine habitats and species but the magnitude of these and other threats differs among the three scenarios. How might these environmental threats change in each of the scenarios?
	What important environmental losses or gains might occur in these three scenarios that will impact marine habitat restoration, marine conservation and/or sea food harvesting?
Societal	
NOW	In your community or region, how do coastal and marine habitats play a role in your cultural values and identity? What cultural activities in your community depend on the health of coastal and marine habitats? Do you see conflicts among different activities if one attempt to implement each of the NBS/activities in your region?
IN THE FUTURE	Depending on the scenario, the type and strength of connection that people have to marine habitats and species may markedly differ. Given the differences in NBS/activities implementation in the three scenarios, in your view, what specific, traditional activities may be impacted (improved or worsened)?
	If you perceive that conflicts or tradeoffs exist now in terms of marine habitat restoration, marine conservation and/or sea food harvesting, how might these change in each of the three future scenarios?

Techno-logial	NOW	In your region, what has/have been the most important technological advance-ment(s) that has influenced the implementation of habitat conservation, restoration or sea food harvesting?
	IN THE FUTURE	What technological advancement might (or might not) take place in the scenarios that will influence the implementation and effectiveness of NBS/activities? The ability to measure and monitor changes in marine habitats and species will impact the effectiveness of each of the NBS/activities. Given the differences among the scenarios, how might environmental monitoring change in the future?
Legal		In your region, what legal instruments exist that have had a strong (either positive or negative) influence on marine habitat restoration, marine conservation or sea food harvesting?
	NOW	Are you aware of transboundary (across regional or national jurisdictions) agreements or conflicts that are important for marine habitat restoration, marine conservation or sea food harvesting?
	IN THE FUTURE	Cooperation between nations, such as trans-boundary agreements, differs considerably among the scenarios. How might this difference impact the effectiveness of habitat restoration, marine conservation and/or sea food harvesting?
Among the three scenarios, the level of protection and conservation of habitats and species may markedly differ. In your opinion, what level of protection will sensitive/important habitats or species be afforded in each scenario (relative to the present-day situation)?		
Economic	NOW	Marine and coastal habitats and species provide both direct and indirect economic benefits to various sectors. In your opinion, what are the primary economic incentives or activities in your region driving changes in marine habitat restoration, marine conservation and/or sea food harvesting?
	IN THE FUTURE	What economic changes might be expected in each of the three scenarios that will impact on the implementation of marine habitat restoration, conservation and/or sea food harvesting?