Future MARES

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Policy Brief 3

NATURE-BASED SOLUTIONS DECREASE CLIMATE RISKS TO MARINE HABITATS AND ECOSYSTEM SERVICES

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HIGHLIGHTS

Nature-based solutions (NBS) are low-cost management tools inspired by the functioning of natural systems that can enhance our resilience to climate change by preserving or restoring the structural integrity of habitats.

The potential of NBS has raised the attention and there is an increasing demand from managers to understand their application, advantages and potential drawbacks. In this context, building consistent and comparable methods to gauge NBS effectiveness is an important step towards understanding and communicating the benefits of NBS.

FutureMARES evaluated more than 30 examples of the implementation of NBS (effective conservation and restoration), and Nature-inclusive Harvesting (NIH) using novel Climate Risk Assessment (CRA) methodology (Bueno- Pardo et al., 2024).

Based on expert opinion and environmental analysis, this method measures the amount of risk a NBS can reduce. The risk reduction due to NBS intervention provides an approximation of the NBS effectiveness from the perspective of different species, ecosystem services and social groups.

This policy brief provides a general overview of how risk is calculated considering NBS and introduces an online risk tool to perform the assessment. Examples of outputs from the **FutureMARES** project are provided to illustrate the effectiveness of marine NBS and/or NIH in reducing climate-driven risks to marine habitats and species.

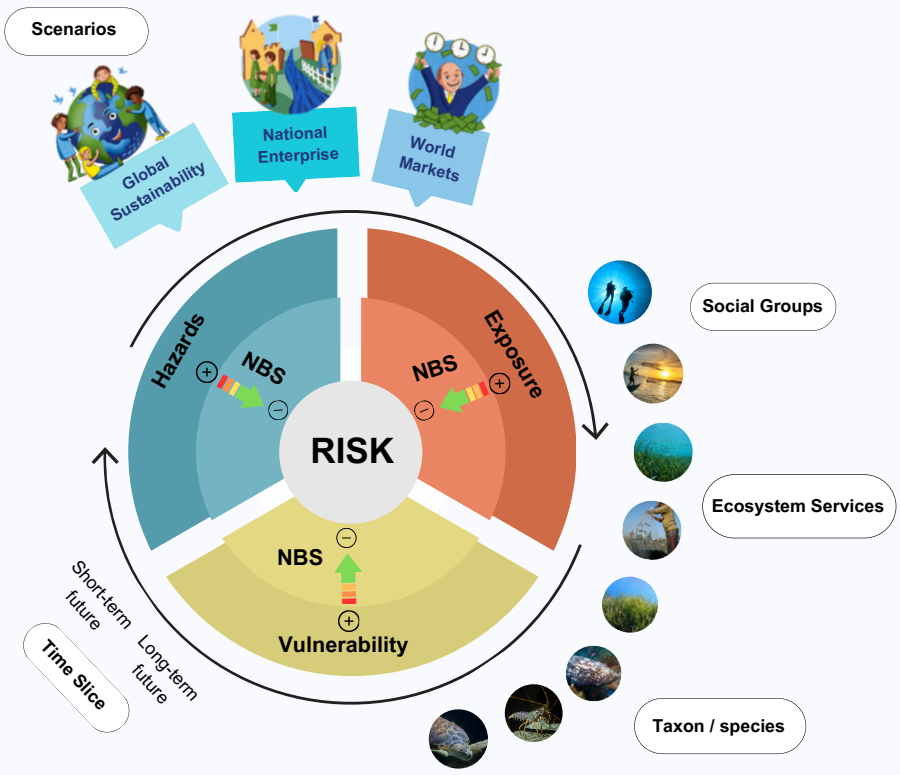

Figure 1. Climate risk assessment framework adapted from the IPCC (2022) to measure the effectiveness of NBS. The NBS can potentially lower each dimension of risk (Hazards, Exposure and Vulnerability) for different components of the marine system (species, ecosystem services and social groups) under different future scenarios and timeframes.

KEY STATEMENTS

- A novel methodology was developed to measure the effectiveness of NBS using climate risk assessments, adapting the conceptual framework developed by the Intergovernmental Panel on Climate Change (IPCC, 2022).
- Risks are estimated for contrasting futures: socio-ecological scenarios, and NBS interventions, allowing us to estimate the effectiveness of marine NBS and/or NIH.
- An online freely available **tool** was created to support decision making based on estimates of future risks to ecological assets and social groups that rely on marine ecosystem services**.** The tool gauges the potential effectiveness of NBS and provides all the necessary content and materials to perform the analysis and explore some potential results.
- Climate change risks have been assessed for 30 different NBS examples across European waters within **FutureMARES**.

The following general results were found:

- Conservation NBS such as Marine Protected Areas (MPA) had the greatest effect in reducing the risks of the most threatened species.
- Restoration NBS applied to habitat-forming species had the greatest effect in reducing the risks to non-threatened species/low risk species.
- The effect of conservation in risk reduction was similar across socio-political scenarios, pointing to its effectiveness under different futures.
- Restoration effectiveness tended to decrease towards the end of the century regardless of the scenario evaluated and was lower under the two scenarios with higher emissions.
- Restoration practices are likely more responsive to short-term compared to long-term policy decisions or environmental changes.

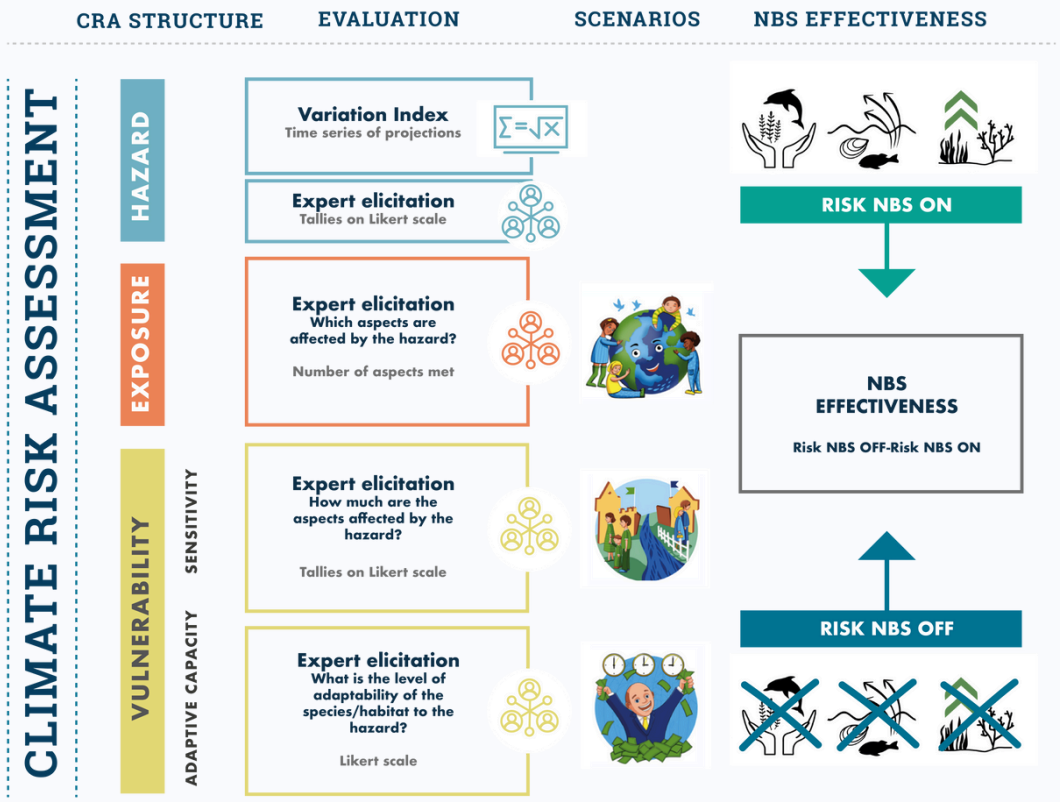

Figure 2. Framework for the assessment of NBS effectiveness, combining climate projections and expert-based data on a climate risk assessment with the NBS and without it.

CONTEXT & BACKGROUND

Both the activities and cultural expressions of any human society depend, to a greater or lesser extent, on the material and immaterial goods and benefits provided by ecosystems, the so-called "ecosystem services". This relationship implies that the correct functioning of ecosystems is fundamental to maintaining the benefits to society as we know them. Likewise, any disruption of ecosystem functioning or structure, might cause changes that impact society entailing cultural and economic aspects.

In a climate change context, with significant threats to marine ecosystems and their services, NBS offer a range of low-engineering and low-cost management options to favor the natural resilience of socio-ecological systems. Hence, NBS seek to keep or restore the natural diversity and balance of ecosystems, preserving the functions of each component, and providing sustainable strategies for climate change adaptation.

Managers of natural spaces and decision makers show a growing interest in developing these actions due to their low carbon footprint and price. However, we still lack comparable methodologies to understand in which contexts NBS are more suitable and/or effective, considering also the limitations posed by climate change.

The NBS effectiveness was assessed from the perspective of **49 species** (fish were the most represented group followed by algae, sea urchins and seagrasses), **ecosystem services** (seeds and other vegetation collected for maintaining population, gamete dispersal, carbon sink protection, nursery provision and cultural), and **social groups and activities** (supervisors of environmental permits, environmental outreach center, recreational fishing, traditional fishers, scuba diving, snorkeling, diving-school center). (**FutureMARES, D5.1**)

To explore the potential of NBS to lower climate risks of marine ecosystems and their services, we developed a methodology that conducts and compares two climate-risk assessments: one applying and one not applying NBS (**Figs. 1 & 2**). The difference in risk between both assessments (NBS risk reduction) constitutes a good estimate of the effectiveness of NBS.

KEY RESULTS

1) Equinoderms, sea turtles and macro algae bare the highest climate risks among species.

By applying the CRA tool to more than 40 marine species across Europe, the echinoderms (*Arbacia lixula*), sea turtles (*Caretta caretta, Chelonias mydas*) and some macroalgae (*Corallina spp*) from Greece were the ones at higher risk. (**FutureMARES, D5.1**)

2) Artisanal fishers bare the highest risks among users of marine ecosystem services.

For the social groups, the artisanal fishers from Spain and Portugal were the ones at higher risk, mostly due to their high exposure to climate hazards and stronger dependence on resources at risk. (**FutureMARES, D5.4**)*.

3) Conservation is more effective than Restoration for species at higher risk.

For high-risk species, the capacity of the NBS to reduce risk was more evident for conservation than for restoration. This might have consequences for decision making as it implies that conservation measures would be more effective than restoration measures for species at higher risk.

Nevertheless, the effect of the restoration has been mostly assessed for fish species in contexts of seagrass restoration in Spain. Trends may change when risk assessments are performed on other types of organisms and in a wider array of socio-ecological contexts. In addition, the effect of restoration and conservation together has not been assessed despite its potential benefits.

*Deliverable 5.4 has been submitted but not yet approved by the European Commission.

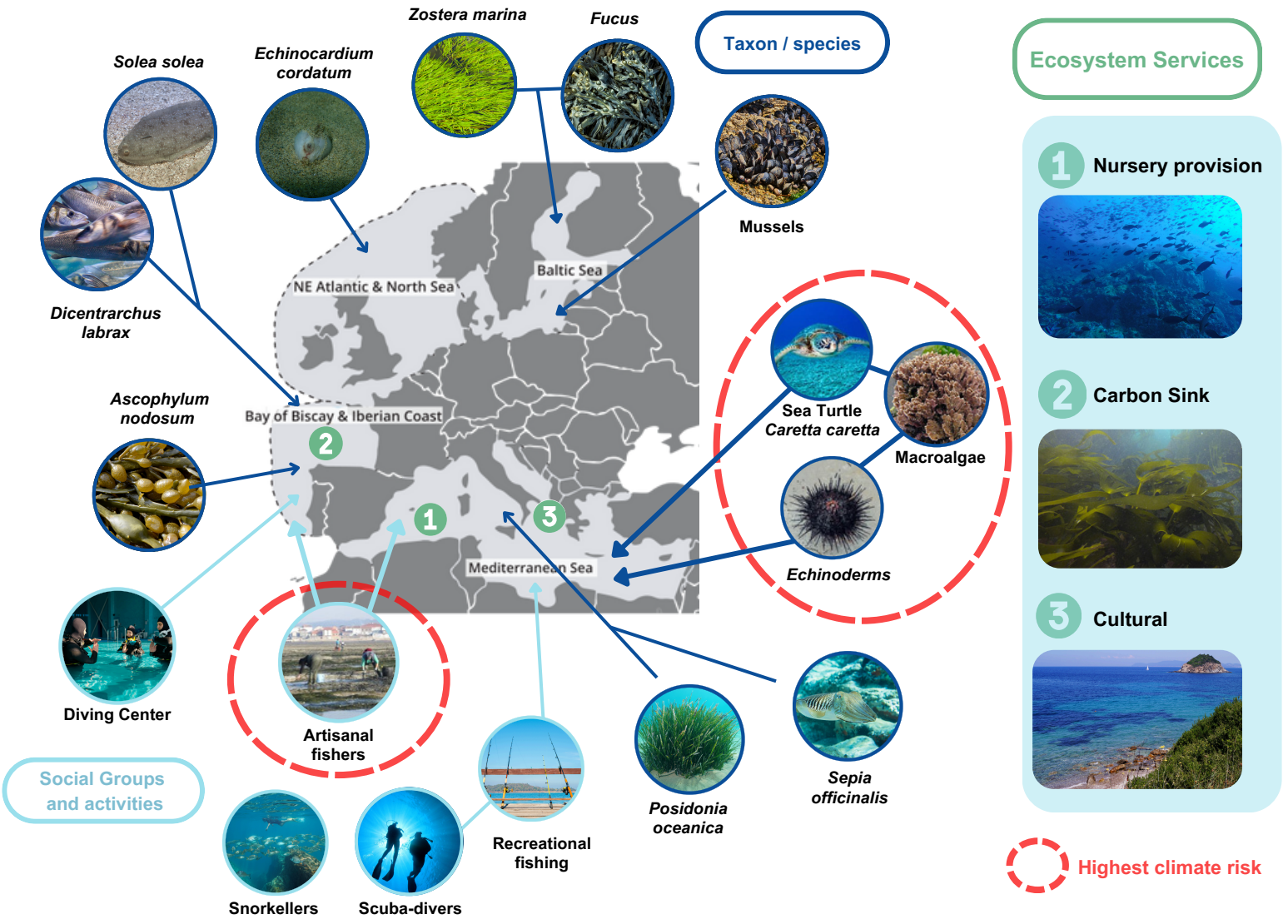

Figure 3. Map shows the areas where the CRA was performed, also some examples of species, social groups, activities and ecosystems assessed. In red circle, categories with the highest risk.

4) Climate change poses higher risks for restoration than other NBS.

When considering different scenarios, the effect of marine conservation in reducing risk was similar across different climate futures, while restoration was clearly less effective in higher emission scenarios (World Markets and National Enterprise).

This finding might reflect the need for sustained socio-political support to make restoration effective, but also that the success of restoration itself might be more sensitive to climate change impacts than other NBS.

5) Disparity of conservation effectiveness on ecosystem services and social groups.

Effective conservation efforts showed a positive effect by decreasing risks to ecosystem services but have little impact on the risks to social groups. This suggests that conservation measures decrease risks not only to species but also to the services they provide. However, risks to social systems linked to marine realms may be more complex and may greatly depend on social and economic factors beyond the NBS.

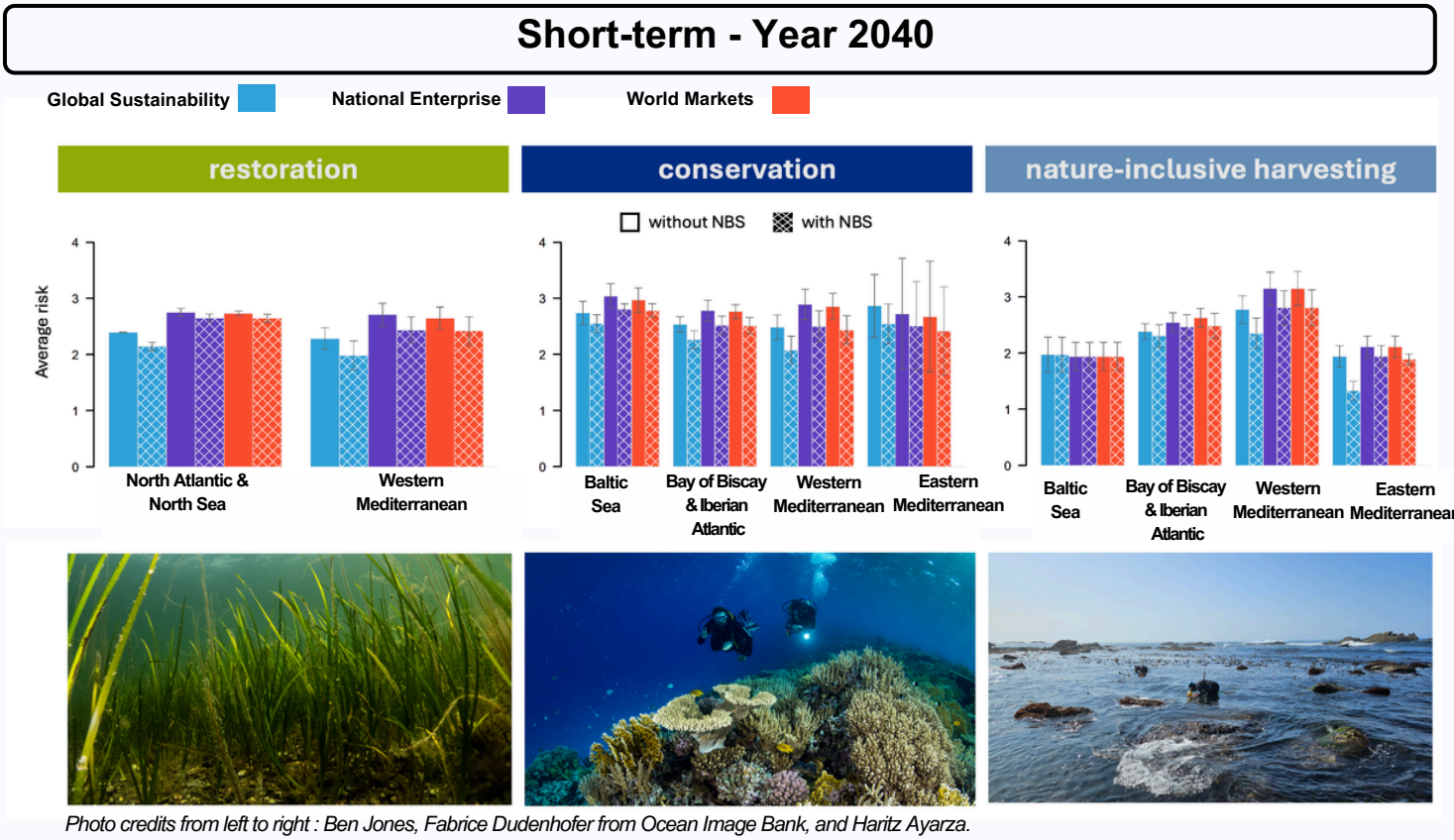

Photo credits from left to right : Ben Jones, Fabrice Dudenhofer from Ocean Image Bank, and Haritz Ayarza.

Figure 4. The results of effective restoration, effective conservation, and nature-inclusive harvesting measure the average risk of species in the short-term (2040). The panels show the risk on species evaluated in the framework of **FutureMARES** through different European regions. The solid bars represent the risk of the species when the NBS (or NIH) are not implemented, the hashed bars when NBS (or NIH) are considered, and the difference between these is a proxy for the effectiveness. NBS always decrease risk, and NIH decreases risk in three of the four regions.

Policy Recommendations

- This new methodology for NBS climate risk is ready to use across species, habitats, ecosystem services and social groups. The methodology is available as an online tool and ready to support future research programs. (https://futureoceanslab.shinyapps.io/NBS-CRA/)
- General conservation measures, such as the creation of Marine Protective Areas (MPA), have potentially deeper, more positive impacts on ecosystems and communities than local restoration practices, implying that conservation should be a priority for high-risk species.
- Combining restoration practices with large-scale conservation efforts can address both the most at risk species and the species with lower risk.
- The benefits of marine conservation measures are also evident for reducing the risks of social groups such as artisanal fishers. Conservation is, therefore, fundamental in the relationship between marine natural spaces and the human societies they support.
- Scenarios of higher emissions might lower the effectiveness of NBS, especially in the long-term (2080). Policies that help decrease global greenhouse gases emissions are essential to safeguard marine ecosystems and their services in the future.
- Conservation actions benefit all the components of social-ecological systems: species, habitats, ecosystem services, and social groups across Europe. However, specific research needs to be conducted to better understand the complex relationships and external factors (i.e. educational, economic, cultural) that underpin social risk reduction.

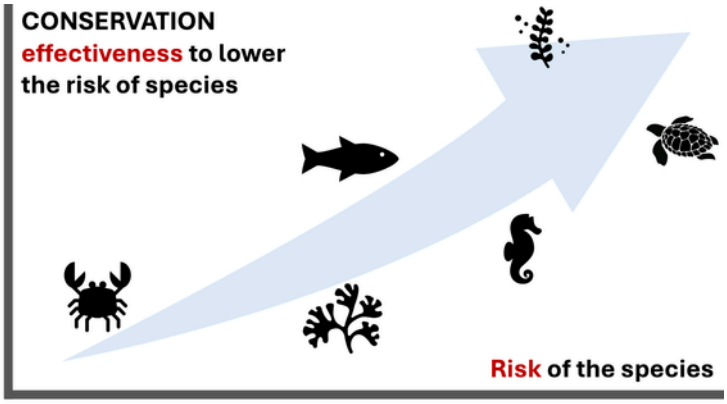

Figure 5. Positive relationship between the estimated risk of species across the European seas, and the effectiveness of conservation measures to decrease the risk. Sea turtles (*Caretta caretta, Chelonias mydas*) and some macroalgae (*Corallina spp*) have the greatest risks and also higher conservation effectiveness.

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