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MSPACE

Recommendations

Marine Plan for Northern Ireland

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MSPACE
Marine Spatial Planning
Addressing Climate Effects

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Marine Plan for

Northern Ireland

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MSPACE
Marine Spatial Planning
Addressing Climate Effects

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1

What is MSPACE?

The Marine Spatial Planning Addressing Climate Effects programme (MSPACE) is a highly integrated, multidisciplinary and co-created research initiative, driving forward capability in designing and implementing economically viable and socially acceptable climate-smart marine plans (MSP) (i.e. marine plans that promote climate change adaptation and mitigation). MSPACE was designed to support the ambitions of government policy, the industrial sector, and communities to ensure sustainable management of marine resources and improve the marine environment for the next generation.

We co-created and explored with end-users alternative spatial management scenarios through which changes in marine space uses could enable climate change adaptation (and mitigation) for nature and people. Scenarios focused on actioning opportunities for climate-resilient conservation, fisheries and aquaculture, within the broader lens of marine planning and the many objectives for use of marine space held within the four MSPACE case study planning regions, as well as the wider push to deliver net zero in the UK.

2

Projected climate change impacts and opportunities in Northern Ireland

Supported by the UK Marine Climate Change Impacts Partnership (MCCIP, 2023), MSPACE first delivered a UK-level synthesis of projected impacts and opportunities that climate change will bring to our marine and coastal waters (Queirós et al., 2024). We assessed state-of-the-art climate change modelling projections for marine species and habitats, to help identify possible climate change adaptation (and mitigation) pathways for UK waters. We considered these results alongside the current distribution of seabed effects by sectors such as fisheries and dredging based on analyses undertaken in the UK for OSPAR and ICES (Sciberras et al., 2023). We also carried out a technical evaluation of our confidence in all modelling datasets used (Kay et al., 2023). We were then able to make recommendations for marine planning and other planning mechanisms in the UK, towards climate-resilient management of fisheries, aquaculture and marine conservation. Those results are detailed [here](#), and spatial datasets reflecting the main can be found [here](#). Based on those findings, the following were seen as potential **opportunities to help address climate change through the management of marine space in Northern Ireland’s marine and coastal waters** (NI):

- Strengthening conservation measures in several designated conservation areas which were projected to be climate resilient in NI, to ensure these contribute to an effective UK MPA network as our seas change into the future. Identified sites include horse mussel (*Modiolus modiolus*) beds and ocean quahog (*Arctica islandica*), within areas already proposed for protection under the UK’s Marine and Coastal Access Act (Proposed Marine Conservation Zones, or pMCZs).
- Sites where the provision of “climate services” (i.e. potential for carbon sequestration) was found to be climate resilient could be further protected to deliver ocean-based climate change mitigation and help the UK meet its net-zero target.
- Sites where potential for climate-resilient seafloor aquaculture were identified (off the coast of Co. Down) could be considered for development of this sector. This was seen as creating the opportunity to counter potentially important losses to the NI blue economy resulting from projected loss of demersal and pelagic fisheries captures, and of water column aquaculture harvest, driven by estimated climate change effects in the region.

3

Exploration of alternative spatial management futures for Northern Ireland's marine and coastal waters in support of climate change adaptation and mitigation

With a view to explore how spatial management could be used to deliver climate change adaptation and mitigation in identified areas of opportunity in NI (Queirós et al., 2024), MSPACE co-created and explored 4 alternative spatial management scenarios with end-users. The latter are part of the NI Department of Agriculture, Environment and Rural Affairs (DAERA) and the Agri-Food and Biosciences Institute (Table 1, Talbot et al. (2025)), which have statutory responsibility for marine planning in NI and provide advice to this process, respectively. We started with:

Business as Usual: this scenario represents the current distribution of marine activities and conservation in the planning area, for which climate impacts were estimated (Queirós et al., 2024). This scenario is contrasted here with the **Baseline**, for which estimates are also provided, and which also reflect the current distribution of marine activities and conservation in the planning area, but exclude projected climate change.

Three more climate-smart scenarios were co-created and explored: these used climate change refugia (areas where particular sectors are estimated to have low sensitivity to climate change, Section 2) and targeted the development of regional opportunities for climate change adaptation or resilience for particular sectors, as well as climate change mitigation, based on changes in use of marine space (i.e. interventions).

- **Conservation:** changes in spatial uses maximise adaptation outcomes for conservation
- **Food Provision:** changes in spatial uses maximise adaptation for fisheries and aquaculture
- **Compromise:** considers outcomes for marine conservation, fisheries and aquaculture together, balancing overall adaptation goals in the region. This scenario was informed by prior assessment of the priorities of regional stakeholders with regard to marine space (Talbot et al. 2025).

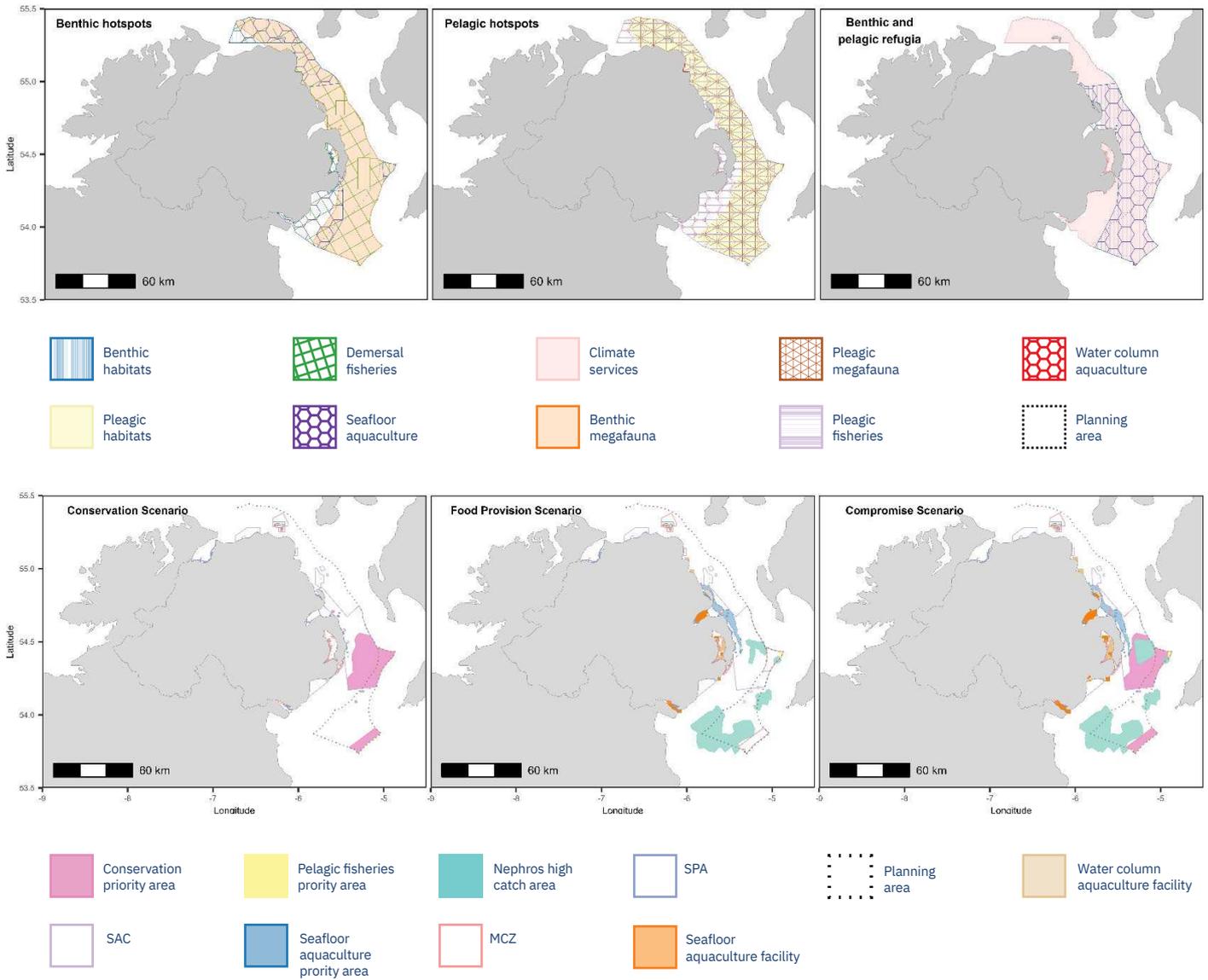


Figure 1: Business as Usual (BAU) scenario (top row) in the NI Marine Plan Area, showing the location of benthic (left) and pelagic (middle) climate change hotspots as well as all refugia (right), for different groups of species, ecological function or sectors, where there is high agreement between the two considered emissions scenarios. Climate-smart scenarios co-developed are shown in the bottom row of figures, highlighting identified priority areas for different sectors in different scenarios (titles). A summary of co-created interventions to support adaptation (and mitigation) is given in the table overleaf.

C1: Avoid, minimise or mitigate activities which could be incompatible with the conservation of priority areas for benthic habitats identified in Outer Belfast Lough and Queenie Corner MCZs, and North Channel and Pisces Reef Complex SACs

C2: Avoid, minimise or mitigate activities which could be incompatible with the conservation of priority areas for climate services identified in Queenie Corner and South Rigg MCZs, and North Channel SAC.

FP1: Avoid, minimise or mitigate proposals for uses that may be incompatible with access by the pelagic fleet to currently unfished areas, identified as pelagic fisheries priority areas.

FP2: Avoid, minimise or mitigate proposals for activities that could limit the development of seafloor aquaculture in the identified priority area for this sector.

CM1: Avoid, minimise or mitigate activities which could be incompatible with the conservation of priority areas for benthic habitats identified in Outer Belfast Lough and Queenie Corner MCZs, and North Channel and Pisces Reef Complex SACs.

CM2: Avoid, minimise or mitigate activities which could be incompatible with the conservation of priority areas for climate services identified in Queenie Corner and South Rigg MCZs, and North Channel SAC.

CM3: Avoid, minimise or mitigate proposals for uses that may be incompatible with access by the pelagic fleet to currently unfished areas, identified as pelagic fisheries priority areas.

CM4: Avoid, minimise or mitigate proposals for activities that could limit the development of seafloor aquaculture in the identified priority area for this sector.

A summary of co-developed scenarios and their spatial interventions is given in Figure 1 and is described in detailed narrative in Talbot et al (2025). Areas where changes to spatial management could lead to climate change adaptation for particular sectors (or mitigation) are hereafter referred to as **Priority Areas**, and specific proposed changes in spatial management in those areas referred to as **Interventions** (Figure 1).

The performance of the BAU and of each climate-smart scenario was then estimated using environmental, economic and social criteria, which could be used to compare them using a common set of metrics. These estimates can be seen in Table 1, where criteria estimates reflect projected change in each criterion relative to the Baseline, given the projected regional impacts of climate change (BAU), and any additional changes in spatial management designed to promote climate change adaptation and mitigation. A detailed narrative and methodological description for these analyses can be found in Roca Florido et al. (2025) and [Talbot et al \(2025\)](#).

We found that although climate change hotspots (areas sensitive to climate change) were widespread for most sectors, climate change refugia (areas resilient to climate change) did provide opportunities to conserve climate services, benthic habitats, and to have resilient seafloor aquaculture and pelagic fisheries.

We found that strengthening conservation measures where those sites occurred in areas already designated could be easy wins for spatial management to help promote climate change adaptation and climate change regulation or mitigation.

Accordingly, the **Conservation Scenario** (Figure 1) aimed to exploit climate services and benthic habitats conservation refugia. We found that strengthening conservation measures where those sites occurred in areas already designated could be easy wins for spatial management to help promote climate change adaptation (**Intervention C1**, Figure 1) and climate change regulation or mitigation (**Intervention C2**, Figure 1). Specifically, Intervention C1 (Figure 1) could support the recovery and climate-resilience of benthic habitats of conservation interest in the NI planning area, as well as helping fulfil the conservation objectives of the MPAs within which they sit. **Intervention C2** (Figure 1) may limit direct carbon release and degradation (avoided emissions) of important carbon stocks from sediment disturbing activities such as trawling. When compared to the BAU, small economic losses attributed to interventions **C1** and **C2** were estimated to be much smaller than those estimated to be driven by climate change along (i.e. BAU versus the Baseline, Table 1; Talbot et al. (2025), Marcone et al. 2025).

Interventions FP1 & F2 (Figure 1) co-created under the **Food Provision Scenario** could help support climate-change adaptation in for fisheries and aquaculture in NI. Increases were projected for ocean-based jobs, wages and the Gross Value Added of the NI blue economy (GVA) under this scenario, relative to the BAU, predominantly driven by increases in aquaculture production (Table 1; [Talbot et al. \(2025\)](#), Marcone et al. 2025).

Interventions CM1 to CM4 (Figure 1) co-created under the **Compromise Scenario**, combined interventions from the other two climate-smart scenarios to deliver a balance between climate change adaptation, mitigation and other regional objectives (Talbot et al., 2025). Linked to this balance of aims, we estimated benefits for marine conservation, fisheries and aquaculture, including increased numbers of ocean-based jobs, wages and GVA relative to the BAU, though to a lesser extent than in the Food Provision (Table 1; [Talbot et al. \(2025\)](#), Marcone et al. (2025)).

4

Social acceptability of hypothetical alternative spatial management scenarios

We tested the social acceptability of climate-smart scenario interventions (Figure 1) through online surveys of marine planning stakeholders, as detailed in Reinhardt (2026). A link to take the survey was shared widely via stakeholder networks and institutional social media networks, and each respondent was required to enter their name and organisation name to ensure no one took the survey more than once. Once collected and validated, respondent names were deleted from the files and cannot be traced to their answers. During the survey, **respondents were able to access detailed information about the project and of co-created scenarios and their outcomes** (Table 1; [Talbot et al. \(2025\)](#), [Marcone et al. 2025](#)). Of 112 unique and validated respondents, 30 answered the questions that relied on reading the information given, and 3 of these identified as being active in the Marine Plan for Northern Ireland's area. Their responses are summarised here, having been analysed using parametric and non-parametric methods in Reinhardt (2026).

This small number of NI specific responses does not enable us to draw statistically significant estimates of differences or trends across respondents at the time of writing. However, examining the average responses and response differences across the 4 scenarios, and between responses provided with and without access to socio-economic outcomes (Table 1, below, as well as further evidence in Reinhardt (2026)) we observe that:

- On average, respondents have a clear preference for climate-smart scenarios to the BAU (acceptance scores ranging from 6-7.5 out of 10).
- On average, respondents found the **Compromise Scenario** the most acceptable alternative to the BAU, regardless of whether they only had information on the ecological outcomes of the scenario, or whether they could see ecological, economic and social outcomes (7.0 +/- 4.0 (7.5 +/- 0.7), mean +/- standard deviation, with (without) social-economic evidence).
- Respondents did not display a strong difference in acceptability between **Food Provision** and the **Conservation Scenarios**, as alternatives to the BAU, when they could not see the economic or social outcomes of scenarios (both scored 6 out of 10 on average).
- When social and economic outcomes of scenarios relative to the BAU was considered alongside ecological effects (Table 1), respondents now found both the **Conservation** and the **Compromise Scenarios** to be equally acceptable alternatives to the BAU (both scored 7 out of 10), whilst the Food Provision Scenario was also acceptable but had a lower score than the other two (Food Provision = 6.0 +/- 1.4).

These results suggest that whether or not presented with social and economic information (alongside environmental information) about the hypothetical scenarios co-developed in the project to promote climate change adaptation and mitigation (Table 1), stakeholders polled in the Northern Ireland area would more likely accept climate-smart alternatives to the BAU, with a preference for the Compromise or Conservation scenarios. The fact that the Compromise Scenario ranking did not fall far when social and economic outcomes of the scenarios were presented to stakeholders alongside environmental outcomes (Figure 1 and Table 1) suggests that, for these respondents, the economic cost and social outcomes of hypothetical adaptation interventions for nature and marine sectors do not affect stakeholder acceptability of scenarios sufficiently to change their support for a climate-smart alternative to the BAU. These results indicate that what and how information about specific alternatives for marine planning are presented to stakeholders matters. Importantly, support for adaptation for nature increased (i.e. Conservation Scenario became one of the more acceptable alternatives to the BAU) when evidence on social and economic outcomes was made available (leading to small economic losses relative to the BAU, Table 1). This result, in turn, suggests that pre-conceived notions about spatial interventions to support climate change adaptation in nature can be challenged when evidence is presented and makes a case for the use of economic and social evidence alongside ecological evidence in consultation processes affecting marine spatial management.

5

Multiple criteria decision analysis

Multi-criteria decision analysis (MCDA, Marcone et al., 2026) was used to help establish indirectly how the performance of co-created scenarios (Figure 1) aligns with the intrinsic preferences of key marine planning stakeholders (who had previously engaged with MSPACE) over the assessed list of criteria (Table 1).

First, an online MCDA survey was used, mainly targeting experts already involved in MSPACE and marine planning in NI, who were individually contacted by email. During an online interview, respondents were presented with background information about the project and the survey objectives, and answered questions designed to understand their preferences on the criteria list. Importantly, respondents answered questions *without knowing how co-created scenarios performed on assessment criteria (Figure 1, Table 1)*. The MSPACE team then estimated scenario performance on each criterion, which were combined into the scenario performance matrix (Table 1; Marcone et al. 2025). The scenario performance matrix was then analysed together with preference information collected through the MCDA survey to rank scenarios accordingly (Table 1). Details about MCDA carried out on these data, leading to the scenario rankings listed in Table 1 can be found in Marcone et al. (2026).

Overall, the intrinsic preferences of Northern Ireland respondents were found to be better aligned with the **Compromise Scenario** (rank=1), and were consistently less aligned with Conservation scenario (rank = 4), with the compromise and BAU scenarios with intermediate ranks (Table 1). Based on these results, it is suggested that marine planning stakeholders in Northern Ireland support adaptation to climate change, and prefer interventions that deliver adaptation across sectors. These results are consistent with the results indicated by the survey of hypothetical scenarios in Section 4, above.

| Assessment criteria | | | | | Baseline* | Scenario performance matrix (% change on Baseline) ** | | | | |
|---|-----------------------------|------|--|--------------|-----------|--|-----------------|------------|-----------|--------|
| | Short name (used in survey) | Unit | Scenario design | BAU | | Conservation | Food provision | Compromise | | |
| ENVIRONMENTAL | 1 | a.1 | Climate-resilient MPA | km2 | maximise | 3201.44 | -80.9 | -66.4 | -100.0 | -70.8 |
| | 2 | a.2 | Climate-resilient fishery area | km2 | maximise | 5156.27 | -99.8 | -99.8 | -99.8 | -99.8 |
| | 3 | a.3 | Climate-resilient aquaculture area | km2 | maximise | 18.90 | -100.0 | -100.0 | 1007.2 | 1007.2 |
| | 4 | a.4 | Total greenhouse gas emissions | kt CO2e/yr | minimise | 38.45 | -37.4 | -60.1 | 16.8 | -5.7 |
| | 5 | a.5 | Potential for marine renewable energy | MW | maximise | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 |
| SOCIAL | 6 | b.1 | Jobs in the food production sector | nr of jobs | maximise | 183.95 | -20.3 | -31.2 | 452.3 | 441.5 |
| | 7 | b.2 | Job in the recreation and tourism sector | nr of jobs | maximise | 9.32 | -38.0 | -51.4 | 143.0 | 129.7 |
| ECONOMIC | 8 | c.1 | Economic contribution of the food production sector (GVA) | £ (millions) | maximise | 23.43 | -36.3 | -52.6 | 126.7 | 110.5 |
| | 9 | c.2 | Income in the food production sector (wages) | £ (millions) | maximise | 9.02 | -36.3 | -52.5 | 126.8 | 110.6 |
| | 10 | c.3 | Economic contribution of the recreation and tourism sector (GVA) | £ (millions) | maximise | 0.19 | -36.8 | -52.6 | 147.4 | 131.6 |
| | 11 | c.4 | Income in the recreation and tourism sector (wages) | £ (millions) | maximise | 0.13 | -38.5 | 153.8 | 153.8 | 138.5 |
| Scenario ranking based on stakeholder acceptance of climate-smart scenario relative to BAU (without/with social-economic evidence, Section 4) | | | | | | | joint 2/joint 1 | joint 2/2 | 1/joint 1 | |
| Aggregated Scenario ranking based on implicit stakeholder preferences (Section 5) | | | | | | | 3 | 4 | 2 | 1 |

*Baseline values give the current distribution of marine activities and ignore the impacts of future climate change.

** Percent change on Baseline is calculated as: % = (100*(Scenario criterion estimate /Baseline criterion estimate)) - 100.

Table 1. Criteria used to assess the performance of co-created alternative spatial management scenarios, and the mean acceptability (Section 4) and implicit preference of stakeholders of said scenarios (Section 5). "GVA" stands for Gross Value Added of a given sector.

6

Recommendations

6.1. Stakeholders of the Northern Ireland Marine plan want climate change adaptation

We recommend, based on our stakeholder surveys and knowledge co-creation, that the spatial management interventions developed during the MSPACE scenario co-creation could help address climate change in Northern Ireland. Of particular relevance are interventions developed under the Compromise Scenario (Figure 1, above):

- **Intervention CM1** could be used to inform priority setting by DAERA and statutory conservation bodies, which could be further supported by marine plan policies within the Marine Plan for Northern Ireland. Such measures could help promote climate change adaptation in identified priority areas for benthic habitats in the Outer Belfast Lough and Queenie Corner Marine Conservation Zones, and in the North Channel and Pisces Reef Complex Special Areas of Conservation.
- **Intervention CM2** could also be used to inform priority setting by DAERA and statutory conservation bodies, which could be further supported by marine plan policies within the Marine Plan for Northern Ireland. Such measures could help deliver climate change regulation and potentially mitigation, by prioritising for conservation or avoidance of activities creating impacts in seabed habitats exhibiting the potential to deliver climate resilient carbon sequestration within Queenie Corner and South Rigg Marine Conservation Zones, as well as within the North Channel Special Areas of Conservation.
- **Interventions CM3 and CM4** could be used to help inform Fisheries Management Plans and be considered also as marine plan policies, towards promoting climate change adaptation pelagic and demersal fishers, as well as for a potentially developing seabed aquaculture sector.

Surveyed stakeholders supported these hypothetical measures addressing climate change above the current status-quo (BAU). Their perspectives are a good reflection of the Draft Marine Plan for Northern Ireland's Objective to "contribute towards climate change mitigation and adaptation measures" (DAERA, 2018). Our research suggests there is an appetite for this, and the type of climate change evidence produced in MSPACE (ecological, economic and social) can support the design of such measures.

6.2. Translating climate change evidence into metrics stakeholders can relate to is key to gather buy-in for adaptation and mitigation through management of marine space

We recommend presenting NI planning stakeholders with specific, alternative spatial management options (including the status-quo, i.e. Business as Usual) during consultations on marine planning (Figure 1). We also recommend presenting estimates of the environmental, economic and social effects estimated for the spatial management alternatives consulted upon, as shown here in Table 1. This allows stakeholders to give informed, evidence-based views about specific changes

to spatial management that may be under consideration (Section 4), rather than just expressing general views about which topics matter the most to them (Section 5). MSPACE found that by exploring concrete options for spatial management and estimates of ecological, economic and social effects can help challenge pre-conceived notions individuals may hold about the cost or impact of addressing climate change to them or their sector. This also presents a fairer and more transparent way to help decision-makers assess which decisions may best represent the interests of stakeholders, and thus what changes to spatial management that could help address climate change may be best suited to their region.

6.3. Wider marine planning for climate change adaptation and mitigation in Northern Ireland

We co-created alternative spatial management interventions with planning stakeholders to support climate change adaptation and mitigation in Northern Ireland (Figure 1), and we measured that these interventions are seen by planning stakeholders in NI as preferable to the status-quo (Reinhardt 2026, Marcone et al. 2026). Such interventions are not currently regulated by Marine Plans across the UK, and their potential actioning is further complicated in Northern Ireland due to the challenging landscape that surrounds the Stormont Government. However, as we look to the future, the current review of the UK Marine Policy Statement, and the current momentum for more spatial prescription in Marine Plans emerging from DEFRA's Marine Spatial Prioritisation Programme may allow for more explicit considerations of these strategies, as and when, the draft Marine Plan for Northern Ireland receives ministerial approval and comes into force. That momentum is likely to be an important enabler of the Climate Change Act (Northern Ireland, 2022), which requires that nature-based solutions must be considered in climate action plans. Nature-based solutions, were also recognised within the United Nations Framework Convention on Climate Change's Glasgow Climate Pact 2021, which emerged from the Convention of Parties 21 hosted in the UK, and which the UK is a signatory party to. The Pact highlighted interlinkages between climate change and biodiversity, with biodiversity providing both climate change adaptation and mitigation benefits. Interventions which seek to improve the adaptation and mitigation potential of the marine environment, as discussed in this document, while protecting critical biodiversity, may therefore also contribute to Northern Ireland's legally binding target of achieving net zero greenhouse gas emissions by 2050.

The landscape of planning mechanisms is developing across the UK (e.g. Fisheries Management Plans (Joint Fisheries Statement, 2022)), and new opportunities are emerging for the designation of conservation sites as a consequence of compensatory measures to support the delivery of net-zero (Department for Energy Security & Net Zero, 2025; Ward, 2022). In this context, we recommend that these different planning mechanisms must be well integrated with each other and with policies such as the Marine Plan for Northern Ireland: this integration will be key to ensure that mutual objectives on adaptation and mitigation, across policies and across the UK nations are supported well. Indeed, recent research by this team highlighted that siloed approaches to policy and governance, across sectors and across nations, are key stumbling blocks limiting opportunities to deliver climate action through the management of marine space (Queirós et al., 2025). The MSPACE project invested in the co-creation of potential solutions to help address climate change in Northern Ireland and the UK as a whole. These solutions have the best chance of becoming actionable through an enabling and well integrated marine planning policy and governance landscape across the UK nations.

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Marine Spatial Planning Addressing Climate Effects (MSPACE) was a highly integrated, multidisciplinary research project, designed to drive forward the capability of the four UK nations in designing and implementing economically viable and socially acceptable climate-smart marine plans. The project was co created with UK governments, the policy community, marine industries and communities to ensure sustainable management of UK marine resources and improve the marine environment for the next generation.

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The MSPACE initiative continues as an endorsed UN Ocean Decade Action, helping deliver the vision of the UN Decade of Ocean Science for Sustainable Development 2021-2030.



MSPACE
Marine Spatial Planning
Addressing Climate Effects