UK Parliament POST

POSTnote 698

By Hazel Cooley,
Jonathan Wentworth

28 June 2023

Marine Protected Areas and Highly Protected Marine Areas

Overview

- Healthy marine ecosystems provide benefits for human wellbeing. The Government estimate maritime activities contribute £47 billion annually to the economy.
- A Defra 2018 assessment found UK marine ecosystems did not meet Good Environmental Status (GES) requirements for 11 of 15 indicators.
- English Marine Protected Areas (MPAs) are clearly defined geographical marine areas that aim to achieve long-term nature conservation by alleviating pressure from human activities.
- English MPAs are currently multi use sites that only seek to protect certain features within each site.
- Other species and habitats within an MPA are not directly protected.
- English Highly Protected Marine Areas (HPMAs) aim to protect all species, habitats, and associated ecosystem processes within a site boundary.
- Three HPMAs will be designated in English waters in 2023.
- Evidence indicates stakeholder engagement is a significant factor in success; MPAs which do not have support from local communities tend to fail in their conservation goals.
- Climate change is not directly considered in the design and management of the English MPA network but will affect its future effectiveness.

Background

Healthy seas help regulate climate and reduce climate change impacts, provide seafood, and support people's livelihoods and biodiversity.[1–3]

Marine ecosystems in the UK are being degraded by human activities including fishing, aggregate and oil and gas extraction, infrastructure, sewage disposal, pollution, litter, and aquaculture.[1,2,4–7]

Current and future impacts of climate change, including ocean warming and acidification, oxygen depletion, and sea-level rise, may put further pressure on marine environments (PN 604).[8,9]

Defra's 2018 assessment found UK marine ecosystems did not meet Good Environmental Status (GES)[a] in 11 of 15 indicators.[1,11] Evidence indicates that meeting national and international environmental targets will require improved management and protection (Box 1).[12,13]

The UK devolved administrations legislate on environmental policy in their respective waters.[14]

Box 1: National and international commitments

England is committed to protecting the marine environment under the:

- **Environmental Improvement Plan 2023** – "to halt the decline in biodiversity", which includes a specific target "for 70% of designated features in Marine Protected Areas (MPAs) to be in favourable condition by 2042, with the remainder in a recovering condition".[15]
- **UK Marine Strategy** – "to achieve Good Environment Status" by 2024.[10]
- **Commonwealth Blue Charter –** "to sustainably manage, protect and preserve oceans through a coordinated approach".[16]
- **OSPAR Convention** to protect the marine environment of the North-East Atlantic.[17]
- **United Nations Convention on Biological Diversity framework 2022**[18,19] which includes protecting 30% of oceans by 2030, known as "30by30".

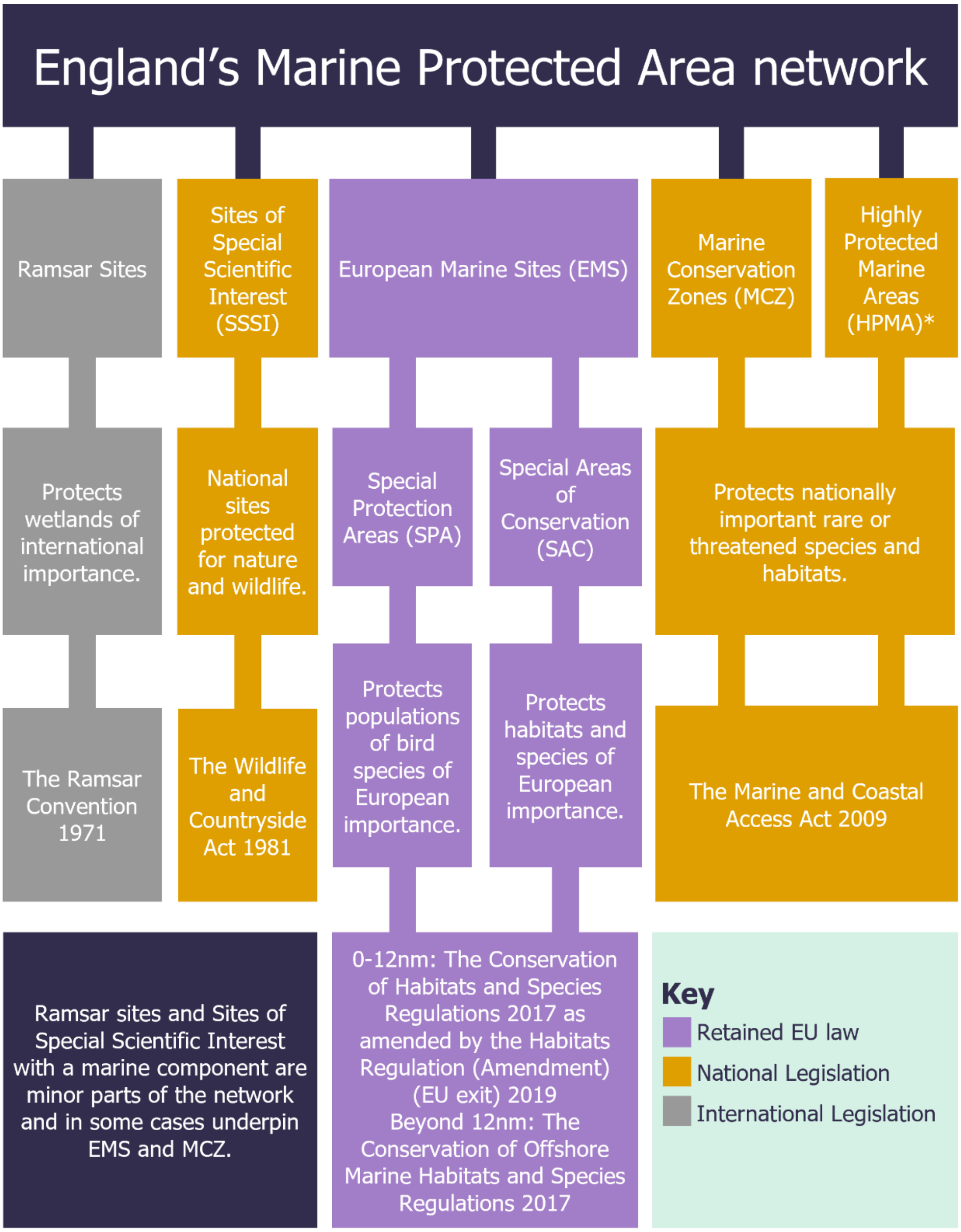
Marine Protected Areas (MPAs)

Marine Protected Areas (MPAs) are clearly defined geographic areas of the marine environment that aim to achieve long-term nature conservation.[20] MPAs can alleviate

[a] Good Environmental Status (GES) is a qualitative description of the state of the seas that the UK Marine Strategy requires the UK to achieve or maintain.[10]

pressure on marine environments by restricting activities to conserve and protect certain features.[21] Evidence shows that with adequate resourcing and effective management, [22–24] MPAs are effective conservation tools for increasing the physical size, abundance and diversity of marine species.[25,26]

Figure 1: Types of MPA in England, criteria for designation and underpinning legislation



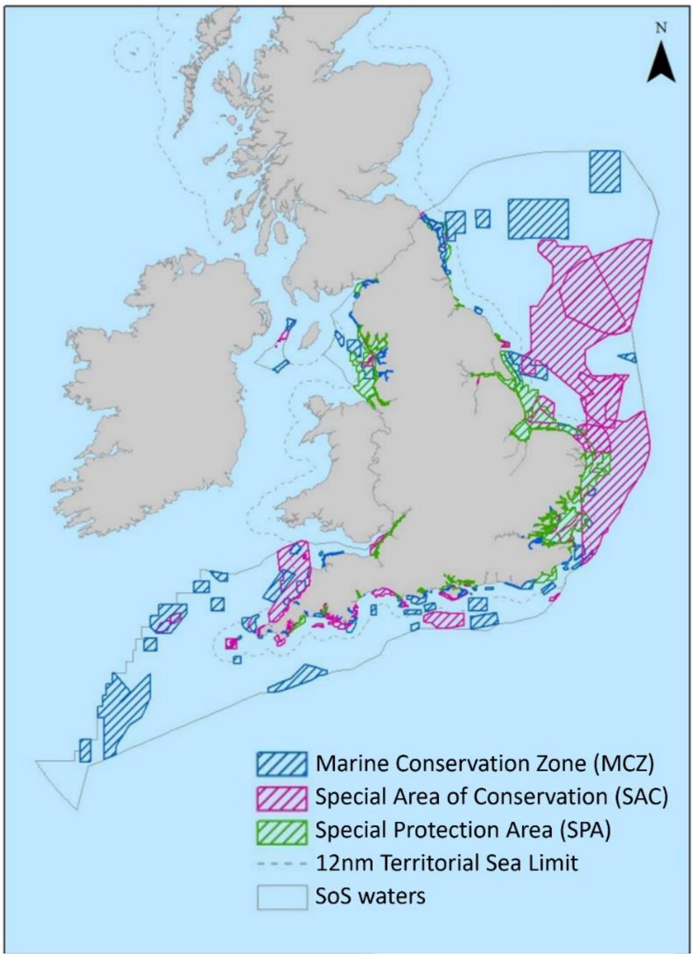
Source: Based on information from the Joint Nature Conservation Committees[20,27–32] and the Association of Inshore Fisheries and Conservation Authorities[21]. *HPMAs protect the whole site from the outset. Some EMS and MCZ also have whole site protection but are initially provisioned feature-based protections.[33]

Building England's MPA network

MPA is an umbrella term covering sites designated under national and international legislation (Figure 1).[20] The first English MPAs were designated in the 1980's, and were all inshore[b] sites. The first offshore[c] sites were established in 1999 in line with legal commitments (Box 2).[36] In 2013, the first English Marine Conservation Zones (MCZ) were designated to create a coherent network of MPAs that represents the full variety of regional ecosystems and allows adult organisms and larvae to move between sites (PN 437).[37,38]

There are currently 178 MPAs in English waters, covering 51% of inshore and 37% of offshore waters (Figure 2).[40] These figures only include European Marine Sites (EMS)

Figure 2: English MPA network map (2022)



Source: Defra's Biodiversity Marine Target Detailed Evidence Report (2022)[39].

[b] Inshore MPAs are protected coastal areas that extend up to 12 nm from land.[34] Most MPAs are inshore as these areas are often under greater pressure from a variety of human activities.[35]

[c] Offshore MPAs are protected areas that are beyond 12nm from the coastline.[34]

and MCZ. Ramsar sites and Sites of Special Scientific Interest (SSSI) are minor components which may underpin EMS and MCZ (Figure 1).[39,40]

Box 2: Legislative framework

The most relevant pieces of legislation for MPAs are the Marine and Coastal Access Act (2009) for MCZ and HPMAs, and the Habitats Regulations for EMS (SAC and SPA, see Figure 1).

The Marine and Coastal Access Act (2009) and the Habitats Regulations contain derogation provisions whereby potentially feature-damaging activities are permitted to occur in sites as a last resort, if there are no alternatives, if the public benefit of proceeding with the activity outweighs the environmental damage, and if compensatory measures are taken.[38,41,42]

However, the Habitats Regulations are more stringent for sites hosting 'priority' species or habitats, allowing only reasons related to human health, public safety, or beneficial consequences of primary importance to the environment within the definition of public benefit. Public authorities also have more discretion when assessing the implication of an activity on an MCZ to allow damaging activities without following scientific advice from the statutory nature conservation bodies.[38,42]

Designing sites

Site designation criteria differs depending on the supporting legislation (Figure 1).[43] MCZ were designated through a regional approach that considered stakeholder views and avoided areas of conflict. European Marine Site (EMS) designation is based solely on ecological criteria without considering social and economic concerns (PN 437).[44]

MCZ and EMS confer protection on defined features within MPAs.[45] These features can include specific species (such as grey seals), species assemblages (such as seabird colonies), habitats (such as carbon sequestering sea grass beds), or geological features (such as reefs).[46] The conservation objectives of MPAs are either to maintain features in a "favourable condition" or to recover features to a "favourable condition".[47] Each feature has defined attributes (such as extent, distribution, structure, function and supporting processes, such as water quality) that are measured to determine their health or 'favourability'.[39] However, academics and NGOs have raised concerns about unambitious objectives based on the often current degraded state of features rather than historical condition or potential.[13,48,49] The feature-based approach aims to balance, environmental, social and economic considerations.[50]

Stakeholder criticisms of the feature-based approach include:

- environmentally damaging activities can occur in MPAs if they do not directly affect known protected features (Box 2)[51]
- it does not allow for ecosystem wide recovery of ecological processes and ecosystem functions on which species and habitats depend[45]

- only habitats with available data on abundance and location can be assessed and protected as a feature, neglecting 'data deficient' marine habitats[52]
- it limits restoration, growth or migration of features, and their range[53]

Academics and NGOs are calling for a whole-site approach to protection that protects wider ecosystems, enables nature restoration, and allows for safe migration of mobile species.[13,45,50,53,54] A whole site approach does not necessarily require all extractive activities to be banned. For example, the whole site of an MPA could be protected from seabed trawling but still allow other forms of fishing.[54] The Governments 25-year environment plan stated whole site approaches would be taken for sites of "greatest biodiversity interest".[55]

Highly Protected Marine Areas

Highly Protected Marine Areas (HPMAs) aim to prohibit all "extractive, destructive and depositional" human activities within a site boundary.[27]

"No take zones" prohibit fishing but are not considered HPMAs as potentially damaging human activities may still be permitted.[56] There are three "no take zones" already in place in England located in Flamborough Head, Lundy Island and the Medway Estuary.[57–59]

The Benyon Review[d] (2020) recommended that establishing the first HPMAs, as part of the MPA network in Secretary of State Waters, "was both desirable and feasible".[56]

The evidence base, outlined in the Benyon Review[56] and the Cefas 'Review of Highly Protected Marine Areas',[61] showed that HPMAs:

- provide greater conservation benefits than partially protected areas[62]
- allow potential for undisturbed growth and ecological recovery across the entirety of the site[63]
- allow for the reestablishment of ecologically important processes, structures, and functions[64]
- could increase density, biomass, and breeding potential of species[65]
- make sites more resilient to climate change impacts[e] [63,68]
- provide social and cultural opportunities and educational, recreational and public health benefits[69,70]

[d] A 2019 Government commissioned review of the potential role of Highly Protected Marine Areas, led by Lord Richard Benyon.[60]

[e] Climate change impacts could include extreme weather-related events like marine heatwaves (prolonged periods of warm seawater), which can significantly impact ecosystems, biodiversity, and fisheries.[66] Global sea surface temperature reached a record high in April and May 2023, with sea temperatures off the north-east coast of England and west of Ireland increasing by several degrees.[67]

Research by UK Government suggests initial socioeconomic costs of HPMA designation will be outweighed by future benefits.[61,71] In 2022, Defra launched a public consultation on five candidate HPMA sites. After considering responses and evidence, three of the proposed sites will be designated as HPMAs by 6th July 2023 (Box 3).[72]

Box 3: Summary of HPMA public consultation responses

Candidate sites that will be designated:

Allonby Bay, an inshore site in the Irish sea covering 28 km^2, protects rich sediments, mussel beds, intertidal rocky habitats that attracts sea birds, and blue carbon[f] sites (PN 651). Following consultation, site boundaries were revised to accommodate recreational angling (which will not be permitted in HPMAs). However, The Angling Trust has said that these do not reflect the needs of the local Angling community.[77] Stakeholders have raised concerns about the potential economic impacts on recreational fishing-based tourism affecting local businesses.[78] 76% of respondents supported HPMA designation.[78]

Northeast of Farnes Deep, an offshore site in the Northern North Sea covering 492 km^2, protects high biodiversity and complex seabed habitats, including spawning and nursery habitats for up to ten commercially important species. Fishers noted non-UK effort was greater than UK effort inside the site and raised concerns of "spatial squeeze"[g], displacement and increased gear conflict.[74] 69% of respondents opposed HPMA designation.[78]

Dolphin Head, an offshore site in the Eastern channel covering 466 km^2, protects feeding and nursery grounds of many important commercial species and ecologically important habitats. Fishers raised concerns of impacts on non-UK fishing vessels, "spatial squeeze", displacement, and increased gear conflict.[74] 97% of respondents supported HPMA designation.[78]

Candidate sites that will be not designated:

Lindisfarne, an inshore site located in the Northern North Sea, will not be designated due to: high level of dependency of local communities on existing activities; concerns if fishing families were forced to find work elsewhere the island could de-populate; and the cultural importance of fishing to the area.[74] 83% of respondents strongly opposed HPMA designation.[78]

Inner Silver Pit South, an offshore site located in the Southern North Sea, will not be designated given the productivity of commercial fishing on site. Fishers assert that current activity was low impact (mostly potting) and raised concerns of "spatial squeeze" and displacement. 59% of respondents supported HPMA designation.[78]

Issues have arisen in the consultation process, with stakeholders concerned by designation of fewer than the Benyon review recommended minimum of five HPMA

---

[f] Blue carbon refers to carbon stored in marine ecosystems, such as in sediments or plants like seagrass (PN 651).

[g] The ABPmer report on displacement uses the term 'spatial squeeze' to refer to growing spatial demands in the marine environment from a range of sectors including offshore wind and cabling, MPAs, aquaculture, aggregate extraction, oil and gas, and fishing.[79]

pilot sites.[56,73–75] Defra intends to collect ecological and socioeconomic baseline data for HPMA sites within the first year of designation, further details are yet to be specified.[76]

Site condition and monitoring

Compared to terrestrial sites, monitoring marine environments is challenging and expensive,[53] particularly in offshore sites that may require use of research vessels.[80] Consequently, MPAs often lack baseline condition data against which to benchmark recovery and assess management intervention effectiveness. Cefas budget resources allow for monitoring of 4 to 6 of the 178 English MPAs each year (via observations and sample collection).[81]

The Office for Environmental Protection stated that "without regular condition monitoring on site there can be limited confidence in the successful design of MPA policy interventions".[82] For example, successful adaptive management requires long term MPA monitoring of responses to changing environmental conditions to ensure progress against biodiversity conservation objectives.[13,83–86]

It can take several years to generate and analyse data to inform condition assessments.[81] In the absence of condition assessments, 'vulnerability assessments' are conducted. These estimate exposure of protected MPA features to pressures from human activities known to be occurring, and to which features are considered sensitive.[39,47] Vulnerability assessments will be used to determine if the English target, of 70% of MPA features in a favourable condition by 2042, is reached.[39,87,88] A recent Defra assessment (based mostly on vulnerability assessments) estimated that 44% of MPA protected features are in a favourable condition.[39,89]

Managing human activities

Although in practice they are managed equivalently,[90,91] under existing legal frameworks EMS could be legally entitled to better environmental protection than MCZ (Figure 1, Box 2).[42] When an MPA is designated, potentially damaging activities are not automatically prohibited but are considered on a case-by-case basis. For some activities, there can be a significant time lag between designation and implementation of management measures.[40] NGOs have called for potentially damaging activities in MPAs to be prevented until they are shown to be compatible with MPA designation.[92,93] MPAs can also be subject to threats external to their boundaries, this can include plastic pollution, oils spills, and eutrophication[h].[95–98] Protecting MPAs (and the wider ocean) from these threats requires more widely applied measures.[99–101]

Managing marine licensable activities

The MMO (Table 1) manages potentially environmentally damaging activities like

---

[h] Eutrophication is the build-up of rich nutrients in a body of water which causes a dense growth of plant life (in seas this is often algal blooms). The causes of eutrophication include run-off from agricultural fertilisers (PN 661) and sewage deposition.[94]

Table 1: MPA regulatory bodies

Authority	Remit
Marine Management Organisation (MMO)	Executive non-departmental public body sponsored by Defra, which manages and issues licences to all marine licensable activities, marine non-licensable activities between 0-12nm, and UK fishing activities between 6-200nm.
Inshore Fisheries and Conservation Authority (IFCA)	Committees or joint committees of local authorities made up of representatives from local authorities, fishers, environmental groups, researchers, and representatives from the MMO, Natural England and the Environment Agency. There are 10 IFCAs in England which manage fishing activities and conservation between 0-6 nm for their districts. IFCA proposals must be endorsed by the MMO to ensure consistency across 6-12nm and beyond 12nm boundaries.
Joint Nature Conservation Committee (JNCC)	Statutory advisor, providing scientific advice to UK Government and devolved administrations on MPAs in UK offshore waters beyond territorial waters, and on the UK MPA network.
Natural England	Statutory advisor, providing conservation advice for all MPAs within English territorial waters.
The Crown Estate	National landowner, formed by an Act of Parliament, that manages the seabed and much of the coastline around England, Wales, and Northern Ireland. The Crown Estate works closely with Government, Statutory Nature Conservation Bodies (SNCBs), industry, and wider stakeholders to understand the potential implications of the coastal and seabed activities that they lease and licence.

Source: Based on information from the Marine Management Organisation[102], the Association of Inshore Fisheries and Conservation Authorities,[91] the Joint Nature Conservation Committee[20], Natural England[103] and The Crown Estate[104].

construction[i], extraction, or deposition in or near MPAs through the existing marine licensing regime. Once an MPA is designated, a licence is only issued if an activity does not pose a significant risk to conservation objectives, risk is mitigated, or if compensatory measures bring an equivalent environmental benefit.[102,106]

[i] Planning permissions for nationally significant infrastructure projects, like offshore wind, are granted as Development Consent Orders (DCO) under the Planning Act 2008 and consented by the Secretary of State for the Department for Energy and Net Zero. If a DCO is granted, this may include provisions deeming a marine licence to be issued under Part 4 of the Marine and Coastal Access Act 2009. The MMO is responsible for enforcing, post-consent monitoring, varying, suspending, and revoking any deemed marine licence(s) as part of the DCO.[105]

Managing marine non-licensable activities

Marine non-licensable activities are those which do not require a marine license, and includes shore-based activities such as bait collection, beach recreation and water based activities such as sailing and motor boating.[107] The MMO is responsible for management of marine non-licensable activities that take place within MPAs between 0-12nm. The IFCAs (Table 1) manage inshore sea fisheries resources in MPAs, including recreational fishing and bait collection. Non-licensable activities are managed through education and communication (including signage and voluntary codes of conduct), or legally through byelaws or permitting[107]

Managing fishing

Evidence suggests fishing is a principal driver of marine biodiversity loss.[2,12,108–110] Initial (1995) guidance from UK Government (based on the EMS legal framework, Figure 1), suggested that, as it was not a licensable project or plan, fishing was compatible with MPA legal requirements, and would not legally require environmental damage assessments.[111]

Precedent from other areas of Europe and an official legal complaint from NGOs led Government to reconsider this position in 2013.[111,112] A revised fisheries management approach now applies to all types of MPA,[113] implemented by both the IFCAs (for 0-6nm) and the MMO (for 6-200nm).

The revised approach introduced phased risk-based assessment of fishing impacts on MPA protected features on a site-by-site basis.[114,115] As a result, the number of fishing restrictions in MPAs inside of 12nm has increased.[116] Under the EU's common fisheries policy (CFP), restricting fishing activities beyond 12nm (offshore sites) required consensus amongst EU states and no fishing restrictions were agreed for England's offshore MPAs.[49,51,117,118]

Since leaving the EU and the establishment of the Fisheries Act (2020) byelaws can be introduced to manage fishing for conservation reasons in offshore MPAs.[40,119] In 2022, the MMO banned bottom trawling[j] in specified areas of four offshore MPAs and stated intentions to "protect all forty English offshore MPAs from harmful fishing activity by 2024".[122,123] However, NGOs have highlighted that under the feature-based approach, bottom trawling may only be prohibited in the parts of the site where protected at risk features occur, and are deemed at risk, and trawling will still be permitted in MPAs without listed seabed protected features.[51,124,125]

Buffer zones

The Benyon review recommended HPMAs be designated within existing MPAs to create 'buffer zones' for less damaging activity directly around HPMAs, a process referred to as zoning.[56] There is evidence that zoning can:

- better facilitate migration of different development stages of species dispersing across larger catchment zones[126]

---

[j] Bottom trawling is the practise of dragging fishnets across the seabed to catch fish.[120,121]

- protect HPMAs from damaging activities at their borders (which could impact their benefits)[127–129]
- benefit recreational activities, like angling[70,130], and low impact fisheries[131]

If HPMAs overlap with existing MPAs, zoning may happen organically, but this has not been specified by Defra.[76]

Displacement of fishing activity

Demand for ocean space, driven in large part by offshore wind developments, is expected to grow 5-fold by 2050, leading to spatial competition.[132] Marine spatial planning for Belgium estimated that their total demand for ocean space is three times greater than their actual available space.[133]

A report commissioned by the National Federation of Fisherman's Organisation (NFFO) and Scottish Fishermen's Federation (SFF) projected that in a worst-case scenario, demersal trawlers would be displaced from 49% of the UKs EEZ[k], or 38% in a best-case scenario, by 2050.[79] The Marine Conservation Society and RSPB question the validity of these figures.[33,75] If displaced, lower impact, small-scale inshore fisheries are the least likely to be able to relocate due to increased cost, navigational risks, or lack of access, with significant consequences for economically vulnerable coastal communities.[134]

The Wildlife and Countryside Link have recommended that Government address displacement where protection measures "simply push fishing activity elsewhere".[92] Current English marine plans do not directly allocate space to activities, instead providing a policy framework through which to consider individual development applications.[135,136] Defra is leading a cross government programme of work to consider marine spatial prioritisation to "support co-existence between sea users, optimise sea use, and balance the needs of industry and marine protection".[137]

Community and stakeholder engagement

Research has identified a key factor affecting HPMA and MPA success is stakeholder engagement.[138–141] Protected areas that do not have the support of local communities tend to fail in their goals.[139] For success, stakeholders need to be engaged early[142–145] and the evidence base and objectives for sites communicated clearly and transparently.[146,147]

Scotland has an ambition to designate at least 10% of its waters as HPMAs by 2026, aligning with the EU biodiversity strategy.[148] Scottish HPMA plans have so far been met with strong opposition from coastal communities and conservationists have criticised Scottish ministers for failing to engage with stakeholders.[149,150]

Community consent can lead to stewardship, secure support for management measures and deliver greater compliance with regulations.[141] Management of sites also needs to be equitable and adaptable.[151] A case study from the Isle of Man found

[k] The Exclusive Economic Zone is an area of coastal water and seabed to which a country claims exclusive rights for economic activities.

MPAs established in concert with fishers led to beneficial conservation and fisheries outcomes. This co-management approach gave responsibility to fishers, building trust and ensuring success of conservation initiatives.[152] Research suggests bottom-up approaches need to be supported by other diverse governance approaches including collective learning and economic measures.[153]

The IFCAs and MMO are the main MPA regulators[l].[102] The IFCAs have a co-management approach that engages with local communities and stakeholders to balance social, economic, and environmental benefits in reaching conservation objectives,[146,154,155] but have limited resourcing, such as social science expertise.[156] Resourcing issues could be addressed by the development of partnerships that bring together multiple statutory agencies.[140,157–159] Government initiatives like marine net gain, which will require all inshore and offshore developments to leave the environment in a better state than before,[160] could help secure supporting funds for future marine environmental management.[160] Technologies such as Vessel Monitoring Systems (VMS) and Remote Electronic Monitoring (REM) can be used to demonstrate adherence to MPA restrictions.[56]

Management outcomes

Marine ecosystems are complex and dynamic in nature and rates of recovery of an area following pressure removal can differ markedly for similar habitats depending on context.[161] Given this, there is no guarantee as to when or whether desired effects (such as increased biodiversity or commercial fish stocks) will happen.[162]

Recovery time can vary between habitats from a few years to decades, and some slow to recover habitats are considered irreplaceable.[163–165] As areas move towards a more natural state, it may be unlikely that all organisms will increase in abundance.[61] For example, in places that are scallop dredged[m], assemblages of species are those that are fast growing, opportunistic and resilient to disturbance. Prohibiting dredging may lead to decreases in these species and increases in others.[167]

Spillover to commercial fisheries

MPAs are predicted to benefit fisheries either through spillover of adult fish over boundaries or through increased breeding and dispersal of larvae and juveniles to surrounding areas.[168,169] There is evidence globally that commercially important species can increase in size and abundance inside and outside of MPAs and that increased size directly links to increased offspring production[170–173]. However, direct benefits for fishers are harder to predict,[174–177] and evidence for spillover to fishers from protected areas has been challenged.[178,179]

Commercially important species may increase or decrease in MPAs over time, with levels of spillover varying across species and ecosystems.[168] For example, additional protection on the Isle of Arran led to increases in lobster and decreases in brown crabs, as lobsters began to naturally outcompete the crabs.[180] In Lyme Bay, closing

[l] The Marine and Coastal Access Act (2009) provides a basis for MPA engagement of local stakeholders.[38]

[m] Scallop dredging is when a rigid structure is towed along the seabed to collect king scallops.[166]

an area to mobile fishing benefited static fishers and led to increased catches of some species, including scallops.[181]

Commercial fisheries depend on healthy functioning marine ecosystems, and pressures such as climate change threaten the long term productivity of the fishing industry (PN 604).[13] Fishers may oppose MPAs and HPMAs due to loss of fishing grounds following prohibitions or gear restrictions.[171,182,183] While there may be long-term economic benefits,[71] HPMAs may pose an upfront cost for some fishers and fisheries benefits may not always be demonstrated in a timeframe acceptable to the industry.[131,168] The NFFO contend that MPAs and HPMAs should not be presented as fisheries management tools, and that sustainable fisheries management measures are the most effective way of ensuring the long-term sustainability of fisheries (PN 572). [179,184]

Adapting MPAs in response to climate change

As sea-levels and temperatures rise, the specific species, assemblages, or habitats for which an MPA is designated may change.[185,186] Suggestions to adaptively manage MPAs for climate change include:

- locating MPAs inside climate refuge areas; areas where conditions are not changing or are changing slowly, showing resilience to climate change. This could allow time for species to adapt to changes and additional protections could strengthen natural resilience of sites[187]
- locating MPAs inside 'future habitats' by using projections of species future distributions[187]
- increasing and maintaining connections[n] between MPAs to help facilitate species to persist and migrate[187–189]
- minimising cumulative impacts of climate change by reducing impacts from other stressors, such as fishing or eutrophication[187,190]
- creating 'dynamic MPAs' whose boundaries move over time as species ranges shift[187,191,192]

The regulatory framework for MPAs is driven by protection of habitats and species and not specifically climate-focussed objectives.[193] Although permissible under current legislation, adaptive MPA management in response to climate change will not be possible without regular monitoring.[38,41,42,194] HPMAs are important for climate resilience, and can act as scientific reference sites in long term research, including to inform assessments of management effectiveness, and to understand the wider network effects of climate change.[63,68,195] Regular monitoring of these reference sites may provide new evidence for how to protect marine ecosystems, which can be applied at greater scales.[196] Rapid mitigation of greenhouse gas emissions is the most effective way of reducing climate change impacts on marine ecosystems.[197]

[n] Ecological connectivity is the degree to which organisms and material can move between ecosystems. High connectivity can improve the resilience (ability to withstand, recover from or adapt to disturbance) of networks, future activities and developments may need to act to avoid restricting MPA connectivity (PN 652).

References

1. Marine strategy part one: UK updated assessment and Good Environmental Status. *GOV.UK*.
2. IPBES secretariat (2019). Global Assessment Report on Biodiversity and Ecosystem Services.
3. Embracing the ocean: a Board of Trade paper (web version). *GOV.UK*.
4. Predominant pressures exerted by human activities - Marine online assessment tool.
5. Laffoley, D. *et al.* (2020). Eight urgent, fundamental and simultaneous steps needed to restore ocean health, and the consequences for humanity and the planet of inaction or delay. *Aquatic Conservation: Marine and Freshwater Ecosystems*, Vol 30, 194–208.
6. How do Humans impact the Ocean? | Positives & Negatives. *Ocean Conservation Trust*.
7. Eastwood, P. D. *et al.* (2007). Human activities in UK offshore waters: an assessment of direct, physical pressure on the seabed. *ICES Journal of Marine Science*, Vol 64, 453–463.
8. Impacts of climate change on UK coasts and seas are highlighted | UK Centre for Ecology & Hydrology.
9. 10 Years experience of science to policy reporting | Marine Climate Change Impacts Partnership.
10. Introduction to UK Marine Strategy - Marine online assessment tool.
11. Summary of progress towards Good Environmental Status - Marine online assessment tool.
12. Environment and Climate Change Committee (2023). Uncorrected oral evidence: Protected areas.
13. Rees, S. E. *et al.* (2020). Emerging themes to support ambitious UK marine biodiversity conservation. *Marine Policy*, Vol 117, 103864.
14. (2020). Guidance on devolution. *GOV.UK*.
15. Department for Environment, Food & Rural Affairs (2023). Environmental Improvement Plan 2023. UK Government.
16. Commonwealth Blue Charter. *Commonwealth*.
17. About OSPAR. *OSPAR Commission*.
18. A new global framework for managing nature through 2030: First detailed draft agreement debuts. *Convention on Biological Diversity*.
19. COP15: Final text of Kunming-Montreal Global Biodiversity Framework. *Convention on Biological Diversity*.
20. About Marine Protected Areas | JNCC - Adviser to Government on Nature Conservation.
21. Marine Protected Areas | AIFCA.
22. Gill, D. A. *et al.* (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature*, Vol 543, 665–669. Nature Publishing Group.
23. Zupan, M. *et al.* (2018). How good is your marine protected area at curbing threats? *Biological Conservation*, Vol 221, 237–245.
24. Hopkins, C. R. *et al.* (2020). Evaluating whether MPA management measures meet ecological principles for effective biodiversity protection. *Acta Oecologica*, Vol 108, 103625.
25. Zupan, M. *et al.* (2018). Marine partially protected areas: drivers of ecological effectiveness. *Frontiers in Ecology and the Environment*, Vol 16, 381–387.
26. Sheehan, E. V. *et al.* (2013). Recovery of a Temperate Reef Assemblage in a Marine Protected Area following the Exclusion of Towed Demersal Fishing. *PLOS ONE*, Vol 8, e83883. Public Library of Science.

27. English Highly Protected Marine Areas | JNCC - Adviser to Government on Nature Conservation.
28. Special Protection Areas | JNCC - Adviser to Government on Nature Conservation.
29. Special Areas of Conservation | JNCC - Adviser to Government on Nature Conservation.
30. Marine Conservation Zones | JNCC - Adviser to Government on Nature Conservation.
31. Ramsar Sites | JNCC - Adviser to Government on Nature Conservation.
32. Guidelines for selection of biological SSSIs | JNCC Resource Hub.
33. Marine Conservation Society (2023). Personal Communication.
34. MPAs: your questions answered. *Marine Conservation Society*.
35. WWF (2005). An overview of Marine Protected Areas in the UK.
36. Marine Conservation Society MPA Reality Check.
37. Bennett, O. (2023). Marine Conservation Zones in England.
38. Marine and Coastal Access Act 2009. Statute Law Database.
39. Defra Biodiversity marine target Detailed evidence report.pdf.
40. MMO (2014). Managing fishing in marine protected areas. *GOV.UK*.
41. UK Government (2019). The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019. Queen's Printer of Acts of Parliament.
42. Pieraccini, M. (2022). *Regulating the Sea: A Socio-Legal Analysis of English Marine Protected Areas*. Cambridge University Press.
43. (2022). Multi-level Regulation of English Marine Protected Areas: An Introductory Map. in *Regulating the Sea: A Socio-Legal Analysis of English Marine Protected Areas*. (ed. Pieraccini, M.) 30–48. Cambridge University Press.
44. Judgement of the Court of 7 November 2000. The Queen v Secretary of State for the Environment, Transport and the Regions, ex parte First Corporate Shipping Ltd, interveners: World Wide Fund for Nature UK (WWF) and Avon Wildlife Trust.
45. Solandt, J.-L. *et al.* (2020). Chapter 9 - Managing marine protected areas in Europe: Moving from 'feature-based' to 'whole-site' management of sites. in *Marine Protected Areas*. (eds. Humphreys, J. et al.) 157–181. Elsevier.
46. The UK MPA Network Features List | JNCC Resource Hub.
47. Defra Marine Protected Areas Network Report 2012-2018.
48. Plumeridge, A. A. *et al.* (2017). Conservation targets in marine protected area management suffer from shifting baseline syndrome: A case study on the Dogger Bank. *Marine Pollution Bulletin*, Vol 116, 395–404.
49. Dunkley, F. *et al.* (2021). Marine Unprotected Areas. Marine Conservation Society.
50. Davies, B. F. R. *et al.* (2022). Ecosystem benefits of adopting a whole-site approach to MPA management. *Fisheries Management and Ecology*, Vol 29, 790–805.
51. Sandison, D. *et al.* (2022). *Greenpeace UK. All at sea: How government inaction makes a mockery of UK marine protection*.
52. Gubbay, S. *et al.* (2016). European Red List of Habitats : Part 1. Marine habitats. Publications Office of the European Union.
53. Solandt, J.-L. (2018). A stocktake of England's MPA network – taking a global perspective approach. *Biodiversity*,
54. The whole-site approach to managing MPAs A Wildlife and Countryside Link briefing.
55. Defra (2018). A Green Future: Our 25 Year Plan to Improve the Environment. HM Government.

56. Benyon, R. *et al.* (2020). Benyon Review Into Highly Protected Marine Areas.
57. Yorkshire Marine Nature Partnership Flamborough Head No Take Zone. *Yorkshire Marine Nature Partnership*.
58. Lundy: A pioneering Marine Protected Area. *Marine Conservation Society*.
59. Medway Swale Estuary Partnership Medway Nursery Area No Take Zone.
60. Benyon Review - Hansard - UK Parliament.
61. Schratzberger, M. *et al.* (2019). Ecological and Socio-Economic Effects of Highly Protected Marine Areas (HPMAs) in Temperate Waters. *Frontiers in Marine Science*, Vol 6, 749.
62. Sciberras, M. *et al.* (2015). Evaluating the relative conservation value of fully and partially protected marine areas. *Fish and Fisheries*, Vol 16, 58–77.
63. Roberts, C. M. *et al.* (2017). Marine reserves can mitigate and promote adaptation to climate change. *PNAS*, Vol 114, 6167–6175.
64. Fenberg, P. B. *et al.* (2012). The science of European marine reserves: Status, efficacy, and future needs. *Marine Policy*, Vol 36, 1012–1021.
65. Kaiser, M. J. *et al.* (2007). Evidence for greater reproductive output per unit area in areas protected from fishing. *Can. J. Fish. Aquat. Sci.*, Vol 64, 1284–1289. NRC Research Press.
66. Oliver, E. C. J. *et al.* (2019). Projected Marine Heatwaves in the 21st Century and the Potential for Ecological Impact. *Frontiers in Marine Science*, Vol 6,
67. Horton, H. *et al.* (2023). 'Unheard of' marine heatwave off UK and Irish coasts poses serious threat. *The Guardian*.
68. Olds, A. D. *et al.* (2014). Marine reserves help coastal ecosystems cope with extreme weather. *Global Change Biology*, Vol 20, 3050–3058.
69. Marine and coastal areas linked with better health and well-being. *GOV.UK*.
70. Chae, D.-R. *et al.* (2012). Recreational benefits from a marine protected area: A travel cost analysis of Lundy. *Tourism Management*, Vol 33, 971–977.
71. Pilot Highly Protected Marine Areas: de minimis assessment. *GOV.UK*.
72. Highly Protected Marine Areas (HPMAs). *GOV.UK*.
73. The Wildlife Trusts (2023). The Government's diminished ambition to restore UK seas is nonsensical.
74. Annex 2: summary of points raised in meetings. *GOV.UK*.
75. RSPB (2023). Personal Communication.
76. Department For Environment, Food & Rural Affairs (2023). Personal Communication.
77. The Angling Trust Personal Communication.
78. Summary of responses: highly protected marine areas pilot sites. *GOV.UK*.
79. ABPmer (2022). Spatial Squeeze in Fisheries, Final Report, ABPmer Report No. R.3900. A report produced by ABPmer for NFFO & SFF.
80. European MSP Platform (2017). Marine conservation challenges and opportunities: the Mediterranean case-study. *The European Maritime Spatial Planning Platform*.
81. Environment and Climate Change Committee (2023). Written evidence from Centre for Environment, Fisheries and Aquaculture Science (CEFAS) (PAE0019).
82. Office for Environmental Protection (2022). Progress in improving the natural environment in England, 2021/2022.
83. A global review of long-term Marine Protected Area monitoring

programmes: Volumes 1 and 2 | JNCC Resource Hub.
84. OECD (2017). Marine Protected Areas: Economics, Management and Effective Policy Mixes. OECD.
85. Katsanevakis, S. *et al.* (2011). Ecosystem-based marine spatial management: Review of concepts, policies, tools, and critical issues. *Ocean & Coastal Management*, Vol 54, 807–820.
86. Environmental Audit Committee - House of Commons Sustainable Seas.
87. Delivering on the Environment Act: new targets announced and ambitious plans for nature recovery. *GOV.UK*.
88. The Environmental Targets (Marine Protected Areas) Regulations 2023. King's Printer of Acts of Parliament.
89. Environment and Climate Change Committee (2023). Written evidence from the Department for Environment, Food and Rural Affairs (Defra) (PAE0009).
90. The Marine Management Organisation (2023). Personal Communication.
91. About Us | Association of Inshore Fisheries and Conservation Authorities.
92. Wildlife and Countryside Link 2022 Progress Report on 30x30 in England.
93. Grorud-Colvert, K. *et al.* (2021). The MPA Guide: A framework to achieve global goals for the ocean. *Science*, Vol 373, eabf0861. American Association for the Advancement of Science.
94. Cefas (2020). Developing new and novel ways to monitor our oceans. *GOV.UK*.
95. Kriegl, M. *et al.* (2021). Marine Protected Areas: At the Crossroads of Nature Conservation and Fisheries Management. *Frontiers in Marine Science*, Vol 8,
96. Boersma, P. D. *et al.* (1999). Limiting abuse: marine protected areas, a limited solution. *Ecological Economics*, Vol 31, 287–304.
97. Sharma, A. (2023). Almost half UK oil spills breach permitted limits: Information request. *Offshore Technology*.
98. ABPmer Impacts of Plastic on Marine Protected Species and Habitats.
99. Eutrophication - Marine online assessment tool.
100. UK leads the way on ending plastic pollution. *GOV.UK*.
101. Marine and Coastguard Agency (2008). The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008. Queen's Printer of Acts of Parliament.
102. MMO (2020). How does the MMO protect MPAs? - Marine developments.
103. Marine conservation advice: project summary. *GOV.UK*.
104. The Crown Estate (2019). Sustainable use of the seabed.
105. (2017). Marine licensing: nationally significant infrastructure projects. *GOV.UK*.
106. Best practice guidance for developing compensatory measures in relation to Marine Protected Areas.
107. MMO (2022). Managing marine non-licensable activities in marine protected areas. *GOV.UK*.
108. Pre-scoping document for the marine regions - ETC/BD Technical paper N°2/2015. *Eionet Portal*.
109. FSC (2015). Tomorrow's Biodiversity - Drivers of Biodiversity Loss. *Biodiversity Projects*.
110. Jaureguiberry, P. *et al.* (2022). The direct drivers of recent global anthropogenic biodiversity loss. *Sci Adv*, Vol 8, eabm9982.
111. Clark, R. *et al.* (2017). Dialectics of nature: The emergence of policy on the management of commercial fisheries in english European Marine Sites. *Marine Policy*, Vol 78, 11–17.
112. Jones, P. J. S. (2012). Marine protected areas in the UK:

challenges in combining top-down and bottom-up approaches to governance. *Environmental Conservation*, Vol 39, 248–258. Cambridge University Press.
113. Revised approach to the management of commercial fisheries in European Marine Sites: overarching policy and delivery. *GOV.UK*.
114. Assessment of Fishing Impacts in MPAS | AIFCA.
115. (2022). Risk-Based Regulation: The Case of the Revised Approach to Fisheries in Marine Protected Areas. in *Regulating the Sea: A Socio-Legal Analysis of English Marine Protected Areas*. (ed. Pieraccini, M.) 74–93. Cambridge University Press.
116. King Fisher Restrictions: View all Restrictions.
117. Additional information: Management of fishing in offshore MPAs. *GOV.UK*.
118. Oceana UK (2023). EXPOSED: UK Government Permits Destructive Trawling in Marine Protected Areas. *Oceana UK*.
119. Fisheries Act 2020. King's Printer of Acts of Parliament.
120. Coleman, C. Marine Protected Areas (Bottom Trawling) Bill [HL].
121. Steadman, D. *et al.* (2021). New perspectives on an old fishing practice: Scale, context and impacts of bottom trawling.
122. Government uses Brexit freedoms to protect our seas. *GOV.UK*.
123. UK takes further action to protect vital marine habitats. *GOV.UK*.
124. MMO (2023). Marine Protected Areas Bottom Towed Fishing Gear Byelaw 2023.
125. Ares, E. *et al.* (2023). Post-Brexit fisheries management.
126. Di Franco, A. *et al.* (2015). Dispersal of larval and juvenile seabream: Implications for Mediterranean marine protected areas. *Biological Conservation*, Vol 192, 361–368.
127. Ohayon, S. *et al.* (2021). A meta-analysis reveals edge effects within marine protected areas. *Nat Ecol Evol*, Vol 5, 1301–1308. Nature Publishing Group.
128. Burns, E. S. *et al.* Finding harmony in Marine Protected Area design guidelines. *Conservation Science and Practice*, Vol n/a, e12946.
129. Salomon, A. K. *et al.* (2002). Modeling the trophic effects of marine protected area zoning policies: A case study. *Aquatic Ecology*, Vol 36, 85–95.
130. Highly protected marine areas. Angling Trust Response to the Benyon Review.
131. Di Franco, A. *et al.* (2016). Five key attributes can increase marine protected areas performance for small-scale fisheries management. *Sci Rep*, Vol 6, 38135. Nature Publishing Group.
132. Spatial Competition Forecast DNV. *DNV*.
133. Marine spatial planning: a step-by-step approach toward ecosystem-based management; IOC. Manuals and guides; Vol.:53; 2013 - 186559eng.pdf.
134. Jones, P. J. S. (2009). Equity, justice and power issues raised by no-take marine protected area proposals. *Marine Policy*, Vol 33, 759–765.
135. MMO (2014). Marine planning in England. *GOV.UK*.
136. Slater, A.-M. *et al.* (2020). Marine spatial planning in the UK: A review of the progress and effectiveness of the plans and their policies. *Environmental Law Review*, Vol 22, 85–107. SAGE Publications.
137. (2022). Minister Pow keynote speech - Coastal Futures 2022. *GOV.UK*.
138. Stewart, B. D. *et al.* (2020). Marine Conservation Begins at Home: How a Local Community and Protection of a Small Bay Sent Waves of Change Around the UK and Beyond. *Frontiers in Marine Science*, Vol 7,

139. Giakoumi, S. *et al.* (2018). Revisiting "Success" and "Failure" of Marine Protected Areas: A Conservation Scientist Perspective. *Frontiers in Marine Science*, Vol 5,
140. Di Franco, A. *et al.* (2020). Improving marine protected area governance through collaboration and co-production. *Journal of Environmental Management*, Vol 269, 110757.
141. Di Cintio, A. *et al.* (2023). Avoiding "Paper Parks": A Global Literature Review on Socioeconomic Factors Underpinning the Effectiveness of Marine Protected Areas. *Sustainability*, Vol 15, 4464. Multidisciplinary Digital Publishing Institute.
142. Cárcamo, P. F. *et al.* (2014). Using stakeholders' perspective of ecosystem services and biodiversity features to plan a marine protected area. *Environmental Science & Policy*, Vol 40, 116–131.
143. Isle of Man Government Manx Marine Environmental Assessment.
144. Gleason, M. *et al.* (2010). Science-based and stakeholder-driven marine protected area network planning: A successful case study from north central California. *Ocean & Coastal Management*, Vol 53, 52–68.
145. Pieraccini, M. (2023). *Improving the social acceptability of Highly Protected Marine Areas (HPMAs)*.
146. Seafish (2020). Future of Our Inshore Fisheries - conference report. *Seafish*.
147. Pieraccini, M. (2016). Stakeholders' participation: a fundamental prerequisite for equitable and functional Marine Protected Areas. University of Bristol.
148. NatureScot (2023). Highly Protected Marine Areas (HPMAs). *NatureScot*.
149. (2023). The Clearances Again [Official Video].
150. Brooks, L. *et al.* (2023). Scottish fishers say marine protection plans will wreck coastal communities. *The Guardian*.
151. Convention on Biological Diversity, B. (2012). TARGET 11 - Technical Rationale extended (provided in document COP/10/INF/12/Rev.1). Secretariat of the Convention on Biological Diversity.
152. Gell, F. *et al.* (2015). Managing Marine Protected Areas in the Isle of Man in partnership with fishermen.
153. Jones, P. J. S. *et al.* (2021). Analysis and discussion of 28 recent marine protected area governance (MPAG) case studies: Challenges of decentralisation in the shadow of hierarchy. *Marine Policy*, Vol 127, 104362.
154. Pieraccini, M. *et al.* (2016). Towards deliberative and pragmatic co-management: a comparison between inshore fisheries authorities in England and Scotland. *Environmental Politics*, Vol 25, 729–748. Routledge.
155. (2022). Environmental Democracy in Marine Protected Areas Management: The Role of Inshore Fisheries Conservation Authorities and Environmental NGOs. in *Regulating the Sea: A Socio-Legal Analysis of English Marine Protected Areas*. (ed. Pieraccini, M.) 110–127. Cambridge University Press.
156. Environment and Climate Change Committee (2023). Written evidence from Marine Conservation Society (MCS) (PAE0017).
157. McGlashan, D. J. (2003). Funding in integrated coastal zone management partnerships. *Marine Pollution Bulletin*, Vol 46, 393–396.
158. Solandt, J.-L. *et al.* (2020). Revisiting UK Marine Protected Areas governance: A case study of a collaborative approach to management of an English MPA. Wiley.
159. Jones, P. J. S. *et al.* (2005). Building partnership capacity for

the collaborative management of marine protected areas in the UK: A preliminary analysis. *Journal of Environmental Management*, Vol 77, 227–243.
160. Defra (2022). Consultation on the Principles of Marine Net Gain.
161. Clemente, S. *et al.* (2011). Context-dependent effects of marine protected areas on predatory interactions. *Marine Ecology Progress Series*, Vol 437, 119–133.
162. Edgar, G. J. *et al.* (2014). Global conservation outcomes depend on marine protected areas with five key features. *Nature*, Vol 506, 216–220.
163. Huvenne, V. A. I. *et al.* (2016). Effectiveness of a deep-sea cold-water coral Marine Protected Area, following eight years of fisheries closure. *Biological Conservation*, Vol 200, 60–69.
164. Hall-Spencer, J. M. *et al.* (2000). Scallop dredging has profound, long-term impacts on maerl habitats. *ICES Journal of Marine Science*, Vol 57, 1407–1415.
165. Defining Irreplaceable Marine Habitats - NECR474. *Natural England - Access to Evidence*.
166. Seafish Scallop Dredge. *Seafish*.
167. Stewart, B. D. *et al.* (2016). Chapter 14 - Quantifying and Managing the Ecosystem Effects of Scallop Dredge Fisheries. in *Developments in Aquaculture and Fisheries Science*. (eds. Shumway, S. E. et al.) Vol 40, 585–609. Elsevier.
168. Gell, F. R. *et al.* (2003). Benefits beyond boundaries: the fishery effects of marine reserves. *Trends in Ecology & Evolution*, Vol 18, 448–455.
169. Harrison, H. B. *et al.* (2012). Larval Export from Marine Reserves and the Recruitment Benefit for Fish and Fisheries. *Current Biology*, Vol 22, 1023–1028.
170. Marshall, D. J. *et al.* (2019). Underestimating the benefits of marine protected areas for the replenishment of fished populations. *Frontiers in Ecology and the Environment*, Vol 17, 407–413.
171. Di Lorenzo, M. *et al.* (2016). Spillover from marine protected areas to adjacent fisheries has an ecological and a fishery component. *Journal for Nature Conservation*, Vol 32, 62–66.
172. Côté, I. M. *et al.* (2001). Effects of marine reserve characteristics on the protection of fish populations: a meta-analysis. *Journal of Fish Biology*, Vol 59, 178–189.
173. Di Lorenzo, M. *et al.* (2020). Assessing spillover from marine protected areas and its drivers: A meta-analytical approach. *Fish and Fisheries*, Vol 21, 906–915.
174. Ovando, D. *et al.* (2021). Models of marine protected areas must explicitly address spatial dynamics. *Proceedings of the National Academy of Sciences*, Vol 118, e2025958118. Proceedings of the National Academy of Sciences.
175. Hilborn, R. (2021). Increasing fisheries harvest with MPAs: Leaving South and Southeast Asia behind. *Proceedings of the National Academy of Sciences*, Vol 118, e2026410118. Proceedings of the National Academy of Sciences.
176. Hilborn, R. *et al.* (2022). A path forward for analysing the impacts of marine protected areas. *Nature*, Vol 607, E1–E2. Nature Publishing Group.
177. Sustainable Fisheries (2023). Do large MPAs benefit tuna and fishermen via spillover?
178. Hampton, J. *et al.* (2023). Limited conservation efficacy of large-scale marine protected areas for Pacific skipjack and bigeye tunas. *Frontiers in Marine Science*, Vol 9,
179. National Federation of Fisherman's Organisations (2023). Personal Communication.

180. Howarth, L. M. *et al.* (2017). Trade-offs in marine protection: multispecies interactions within a community-led temperate marine reserve. *ICES Journal of Marine Science*, Vol 74, 263–276.
181. Rees, S. *et al.* (2016). An evaluation framework to determine the impact of the Lyme Bay Fisheries and Conservation Reserve and the activities of the Lyme Bay Consultative Committee on ecosystem services and human wellbeing.
182. Rees, S. E. *et al.* (2021). An evaluation of the social and economic impact of a Marine Protected Area on commercial fisheries. *Fisheries Research*, Vol 235, 105819.
183. Pita, C. *et al.* (2011). An overview of commercial fishers' attitudes towards marine protected areas. *Hydrobiologia*, Vol 670, 289–306.
184. Hilborn, R. *et al.* (2019). *Ocean Recovery: A sustainable future for global fisheries?* Oxford University Press.
185. Jackson, E. L. *et al.* (2014). Future-proofing marine protected area networks for cold water coral reefs. *ICES Journal of Marine Science*, Vol 71, 2621–2629.
186. Burrows, M. T. *et al.* (2020). Global-scale species distributions predict temperature-related changes in species composition of rocky shore communities in Britain. *Global Change Biology*, Vol 26, 2093–2105.
187. Wilson, K. L. *et al.* (2020). Incorporating climate change adaptation into marine protected area planning. *Glob Change Biol*, Vol 26, 3251–3267.
188. Carr, M. H. *et al.* (2017). The central importance of ecological spatial connectivity to effective coastal marine protected areas and to meeting the challenges of climate change in the marine environment. *Aquatic Conservation: Marine and Freshwater Ecosystems*, Vol 27, 6–29.
189. Olds, A. D. *et al.* (2016). Quantifying the conservation value of seascape connectivity: a global synthesis. *Global Ecology and Biogeography*, Vol 25, 3–15.
190. Gurney, G. G. *et al.* (2013). Modelling Coral Reef Futures to Inform Management: Can Reducing Local-Scale Stressors Conserve Reefs under Climate Change? *PLOS ONE*, Vol 8, e80137. Public Library of Science.
191. D'Aloia, C. C. *et al.* (2019). Coupled Networks of Permanent Protected Areas and Dynamic Conservation Areas for Biodiversity Conservation Under Climate Change. *Frontiers in Ecology and Evolution*, Vol 7,
192. Cashion, T. *et al.* (2020). Shifting seas, shifting boundaries: Dynamic marine protected area designs for a changing climate. *PLOS ONE*, Vol 15, e0241771. Public Library of Science.
193. Schmidt, D. N. *et al.* (2022). Marine protected areas in the context of climate change: key challenges for coastal social-ecological systems. *Philosophical Transactions of the Royal Society B: Biological Sciences*, Vol 377, 20210131. Royal Society.
194. Zentner, Y. *et al.* (2023). Marine protected areas in a changing ocean: Adaptive management can mitigate the synergistic effects of local and climate change impacts. *Biological Conservation*, Vol 282, 110048.
195. Highly Protected Marine Areas (HPMAs) - site selection: draft guidelines.
196. Hopkins, C. R. *et al.* (2016). Perceptions of practitioners: Managing marine protected areas for climate change resilience. *Coastal Management*, 11.
197. Bates, A. E. *et al.* (2019). Climate resilience in marine protected areas and the 'Protection Paradox'.

Biological Conservation, Vol 236, 305–314.

Contributors

POST is grateful to Hazel Cooley for researching this briefing and to all contributors and reviewers. For further information on this subject, please contact the co-author, Dr Jonathan Wentworth.

Members of the POST board*

Dr Jen Ashworth, Department for Environment, Food and Rural Affairs

Robert Clark, Association of Inshore Fisheries and Conservation Authorities

Daniele Clifford, The Wildlife Trusts*

Mike Cohen, National Federation of Fisherman's Organisations*

Dr Sarah Coulthard, Newcastle University

Barrie Deas, National Federation of Fisherman's Organisations

Dr Mark Duffy, Natural England

Dr Bob Earll, Environmental Consultant

Nicholas Greenwood, Marine Management Organisation*

Professor Jason Hall-Spencer, University of Plymouth

Richard Hill, Marine Conservation Society*

Dr Keith Hiscock, Marine Biological Association*

Dr Charlotte Hopkins, University of Hull*

Professor Kerry Howell, University of Plymouth

David Jarrad, Shellfish Association of Great Britain

Professor Peter Jones, University College London*

John Lang, Offshore Renewable Energy Catapult

Paul Leonard, Environmental Consultant*

Dr Abigail McQuatters-Gollop, University of Plymouth*

Professor Susan Owens, University of Cambridge

Jerry Percy, New Under Ten Fisherman's Association

Professor Margherita Pieraccini, University of Bristol*

Dr Eunice Pinn, Seafish*

Jo Pollet, Marine Stewardship Council

Dr Ana Queirós, Plymouth Marine Laboratory

Dr Sian Rees, University of Plymouth*

Hannah Rudd, The Angling Trust

Professor Daniela Schmidt, University of Bristol*

Dr Michaela Schratzberger, Centre for Environment, Fisheries and Aquaculture Science*

Dr Emma Sheehan, University of Plymouth

Dr Jean-Luc Solandt, Marine Conservation Society*

Dr Bryce Stewart, University of York

Jacques Villemot, RSPB*

Dr Caroline Whalley, Offshore Renewable Energy Catapult*

*denotes people and organisations who acted as external reviewers of the briefing.

The Parliamentary Office of Science and Technology (POST) is an office of both Houses of Parliament. It produces impartial briefings designed to make research evidence accessible to the UK Parliament. Stakeholders contribute to and review POSTnotes. POST is grateful to these contributors.

If you have any comments on our briefings please email post@parliament.uk. Please note that we are not always able to engage in discussions with members of the public who express opinions about the content of our research, although we will carefully consider and correct any factual errors.

If you have general questions about the work of the House of Commons email hcenquiries@parliament.uk or the House of Lords email hlinfo@parliament.uk.

DOI: https://doi.org/10.58248/PN698

POST's published material is available to everyone at post.parliament.uk.
Get our latest research delivered straight to your inbox.
Subscribe at post.parliament.uk/subscribe.

post@parliament.uk

parliament.uk/post

@POST_UK