Natural England Commissioned Report NECR241

Displacement of fishing effort from Marine Protected Areas

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

The number of management measures in Marine Protected Areas (MPAs) in England that affect the fishing sector is expected to increase in the coming years and unless managed, the resulting displacement of fishing effort could have knock-on impacts on the marine environment, on fishers and on other marine sectors.

Natural England commissioned this report to help better understand the nature and impacts of any potential displacement.

The findings will be used by Natural England and other partners to support the design, implementation and monitoring of management measures in MPAs.

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Displacement of Fishing Effort from Marine Protected Areas

Final Report

Natural England

May 2017

Creating sustainable solutions for the marine environment





Executive Summary

The number of management measures in MPAs in England that affect the fishing sector is expected to increase rapidly in the coming years. The resulting displacement of fishing effort, unless managed, can have knock-on impacts on the marine environment, on fishers and on other marine sectors. The nature of potential displacement, and its impacts, therefore need to be better understood to support the design, implementation and monitoring of management measures in MPAs.

This report was prepared by ABPmer, the National Federation of Fishermen's Organisations (NFFO) and ICF for Natural England on behalf of the Fishing Displacement Steering Group, comprising Defra, Natural England, the Joint Nature Conservation Committee (JNCC), the Marine Management Organisation (MMO), the Association of Inshore Fisheries and Conservation Authorities (AIFCA), and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

The objectives were to:

- review the literature on displacement of fishing effort from closed areas;
- conduct five case studies of displacement of fishing from MPAs;
- compile information on existing management measures in MPAs in England;
- develop a methodology for assessing displacement of fishing effort from MPAs;
- provide recommendations for monitoring and research to further our understanding of fisheries displacement and its potential management.

The literature on displacement of fishing effort from MPAs highlights that displacement can be both spatial and to other gear types, both within and outside MPAs. Numerous complex factors interact to determine displacement behaviour, many of which are unknown or unquantified. However, there are some key factors that affect displacement behaviour that can help to understand and predict the effects on fishing effort. In relation to spatial displacement, they are the availability, knowledge of and access to alternative fishing grounds (including quota availability, access rights, distance from port), expectation or occurrence of localised 'spillover' effects, and individual strategies and preferences. The scale at which potential displacement effects need to be considered varies from fishery to fishery. Displacement to alternative gear types (not directly affected by the management measure) has two dimensions: (i) displaced fishers switching to alternative gears; and (ii) fishers already using an alternative gear type increasing their fishing effort within the area from which others have been displaced.

Unless managed displaced fishing effort can impact on the marine environment, within and outside MPAs, including on the seabed and benthic communities, mobile species and commercial fish and shellfish stocks. The net effect will depend on the balance between improvements within MPAs, and increased levels of effort in the remaining areas. Displacement can result in fishing disturbance being more widely distributed, including to otherwise previously unfished areas, and can cause localised increases in intensity and impact. The effect of displacement on habitats and benthic communities depends on the sensitivity of the habitat where effort is displaced to, the gear type displaced, the level of fishing in the area prior to displacement and the relative change in fishing pressure compared to the baseline and to prevailing levels of natural disturbance. The net environmental outcome of protection of MPA features and impacts from displaced effort is thus dependent on factors that vary on a case-by-case basis. Whilst some studies have suggested that an overall reduction of fishing effort may be required to avoid negative net environmental impacts as a result of displacement from area closures, this conclusion is based on modelling studies that make a number of assumptions

about fisher behaviour, fishing activity and its impacts, which may not fit the characteristics of MPA displacement situations.

Unless addressed, displacement can also cause social and economic impacts on the affected fishers in terms of decreased revenues from reduced fishing time and lower catch rates, higher costs from increased steaming times, and/or increased conflicts and competition between vessels and different gear types. Other fishers, already operating in the areas to which effort is displaced, can also be affected.

To date, approaches adopted to assess displacement of MPAs and their management measures have not been consistent. There is an explicit requirement to consider potential displacement for proposed management measures in MPAs beyond 12nm. Potential impacts of displacement are generally considered within the MPA itself; whereas outside the MPA it may be acknowledged, but not fully considered. This has been due to the regulatory scope of MPA protection which puts the emphasis on condition of the designated features within the site. Impact assessments are conducted for proposed regulations to understand and quantify the potential environmental, economic and social impacts, and their distribution, for a proposed measure. They are usually focussed on the anticipated direct impacts. Because of the challenges inherent in predicting displacement effects, the approaches adopted to assess the environmental, economic and social impacts of displacement are not consistent across organisations.

This study has developed a methodology for assessing displacement from MPAs, together with an associated template for recording the assessment outputs. The guidance and template were tested and commented on by three Inshore Fisheries and Conservation Authorities, the MMO, Natural England, JNCC and Defra, and subsequently revised. The assessment of displacement could take place as part of an overall impact assessment for a management measure (or other intervention), and the purpose of the methodology is to clearly set out the issues and considerations in relation to displacement to ensure more consistent and systematic consideration of all potential effects and impacts (as far as the available information allows). The method can also be used to inform a rapid assessment of different options as part of the process of developing management measures.
Options for monitoring of displacement are set out in this report. Within MPAs, monitoring of displacement could form part of the monitoring plan for the site. This could address the level of effort by different gear types within the MPA, and how this is distributed across habitats and/or features, to ensure that displacement of fishing effort does not threaten site integrity. This might involve monitoring the level of effort of different gear types, and taking action to limit effort if it increases above a certain level. Monitoring could also consider displacement of effort outside the MPA and its potential impacts on habitats and species elsewhere. Monitoring of the actual nature of displacement (comparing post-implementation fishing patterns with a baseline prior to implementation of the management measure) could be used to improve our understanding of potential displacement behaviour for future assessments.

There are many knowledge gaps in relation to our understanding of displacement and its impacts. Recommendations for addressing these are identified and prioritised. The priority recommendations are:

- The use of iVMS or a similar system for under-12m vessels to improve information on distribution (and therefore displacement) of fishing effort, linked to information about gear type in operation (e.g. from sensors linked to the gear).
- Displacement risk mapping to identify existing and alternative fishing grounds for different fishing sectors, potential areas where fishing effort may be displaced to, and the risk of impacts on benthic habitats at biogeographic regional scales.

- Development and testing of rules-of-thumb for assessing the significance of displacement.
- An MPA-specific study, tracking the behaviour of individual vessels affected by the implementation of management measures, comparing behaviour before and after implementation.
- Development of more comprehensive means of assessing the significance of displacement impacts taking into account cumulative and synergistic effects.
- Development of a look-up table to support regulators in their assessments e.g. for different fishing sectors, to estimate the proportion of landings affected based on the distance of displacement.

Key recommendations of the study are:

- The potential for displacement of fishing effort should be considered during the designation of MPAs and the development of management measures for MPAs (and other spatial interventions that may affect fishing). Where fishing effort is to be displaced (if it is not removed) then efforts should be made to minimise potential displacement, whilst still achieving site Conservation Objectives, network objectives and wider marine environment objectives.
- Assessments of the displacement of fishing effort should be consistent in their approach and involve systematic consideration of the factors that influence displacement effects and impacts. The guidance developed in this study sets out the key considerations for assessing displacement and could support more systematic assessment, and improve transparency in the way assessments are conducted and presented.
- Regulators should continue working together and seek better ways of working to assess and address displacement issues and impacts — the scale for monitoring and assessment of displacement should be appropriate to the fishery and may extend beyond an individual regulator's area, particularly in the inshore area where vessels may move their activity between different IFCA districts.
- The factors determining displacement behaviour and its impacts on the environment are difficult to predict and to model. Therefore, where displacement of fishing effort is unavoidable in order to protect designated features, and is expected to be significant, the displacement effect should be monitored so that any issues arising (e.g. where a redistribution of effort by particular gear types risks an adverse effect on site integrity, or significant impacts outside of MPAs) can be identified and action taken to address them. Monitoring of fishing activity should focus on the level and distribution of fishing effort of different gear types within the MPA, and could also consider displacement of effort outside the MPA.
- There are many knowledge gaps in relation to our understanding of displacement, its impacts, and how best to address it. Recommendations for future research include risk mapping, development of simple tools to support the assessment of the significance of displacement (both in relation to potential direct and net environmental impacts and impacts on fishers), and development of more complex models and means of predicting displacement behaviour and assessing the significance of displacement impacts taking into account cumulative and synergistic effects.
- In addition to improving our understanding of the potential nature and impacts of displacement, management options could be considered to avoid, reduce or mitigate the environmental impacts of displacement. A range of management options exist, the applicability of which will depend on the particular circumstances. A detailed review of such management options was outside the scope of this study, but may be considered by FDSG in the future. Further work is required to consider how such measures can be better integrated into the fishery management framework, and how fisheries issues can be better integrated into the marine planning framework. At wider management scales than MPAs, there is ultimately a need to consider the trade-offs between fishery production and marine ecosystem status and the optimisation of both.

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1 Introduction

When new management measures are applied to fishing (e.g. in a marine protected area, MPA), the fishing effort that affected by the measure that previously occurred in the area may either cease completely (resulting in reduction of landings and social and economic impacts on the fishing fleet and fishermen), or the effort may be displaced (i.e. redistributed) to other areas. The removal of some gear types from an area may in turn open up the possibility for other gear types to operate within the area, which had previously not operated there due to incompatibility (e.g. static and mobile gears).

Displacement of fishing effort is difficult to predict, but unless addressed it can have knock-on impacts on the marine environment (in the areas to which it is displaced, and within the area from which it is displaced when effort from other gear types increases). This includes impacts on species and habitats of conservation importance within the MPA, within other MPAs, and outside the MPA network in the wider marine environment. In order to understand the overall success of management for nature conservation, the environmental benefits that may occur within the MPA need to be balanced against the environmental costs that can result from compensatory increases in fishing activity in other areas (Hiddink *et al.,* 2006a), or of other gear types within the MPA. Displacement can also increase costs to the fishing industry (e.g. increased steaming time to fishing grounds, lower catch-per-unit-effort (CPUE), increased conflicts between fishing sectors and with other maritime sectors), with associated impacts on the economy and society (Slijkerman & Tamis, 2015).

The number of management measures in MPAs in England that affect the fishing sector is expected to increase rapidly in the coming years, as the Revised Approach[1] is applied to commercial fishing to bring its management into line with MPA objectives, as other marine industries have been doing. It is increasingly important that the nature of potential displacement, and its potential impacts on the marine environment (and the economy and society), are better understood in order to adequately support the design and implementation process of those management measures, and address residual impacts where required.

Consideration of the impact of displacement of fishing effort was identified as one of eleven information topics that European Union Member States should provide information on to the European Commission when requesting management measures for fisheries in Natura 2000 sites (i.e. Special Areas of Conservation, SACs, and Special Protection Areas, SPAs, established under the Habitats and Birds Directives). This was set out in a document published by the European Commission in 2008 (EC, 2008) when the previous Common Fisheries Policy (Regulation (EU) No 2371/2002) was in force, and a paper presented at the Marine Natura 2000 Expert Group (anon, 2016) considered that this was still relevant under the revised CFP (Regulation (EC) No 1380/2013).

This project was commissioned by Natural England to review the literature on displacement of fishing effort from closed areas, compile information on existing management measures in MPAs in England, and develop templates and guidance to support consideration and assessment of displacement of fishing effort. This will enable better understanding of the potential impacts of displacement and thus contribute to more effective management of the marine environment including of species and habitats of conservation concern. This will support identification of appropriate mitigation measures and delivery of impact assessments for management measures in MPAs.

[1] Government policy to ensure that all existing and potential commercial fishing operations are managed in line with Article 6 of the Habitats Directive. See www.gov.uk/government/publications/revised-approach-to-the-management-of-commercial-fisheries-in-european-marine-sites-overarching-policy-and-delivery

The objectives of the study are to directly support the Fishing Displacement Steering Group[2] (FDSG) in achieving its objectives:

1) To gain a more detailed understanding of fishing effort displacement when management measures are introduced within MPAs.
2) To develop tools/methods to help fisheries/MPA managers to "account for" displacement, and articulate what the likely displacement might be.
3) To set out the various options that are available for regulators to use that can mitigate impacts arising from fisheries displacement.

This report was prepared by ABPmer, the National Federation of Fishermen's Organisations (NFFO) and ICF and reports on all phases of the work, encompassing the literature review (output 1), compilation of management measures (output 2), preparation of case studies on displacement (output 3), development, testing and revision of a template and method for assessing displacement (outputs 4–7), monitoring requirements (output 8) and research priorities (output 9).

[2] Comprising: Natural England, the Department for Environment, Food and Rural Affairs (Defra), the Centre for Environment, Fisheries and Aquaculture Science (Cefas), the Joint Nature Conservation Committee (JNCC), the Marine Management Organisation (MMO,) and the Association of Inshore Fisheries and Conservation Authorities (AIFCA).

2 Methodology

The overall approach to the study is shown in Figure 1. The first phase of the study involved a review of literature on displacement, the compilation of information on management measures in MPAs in English waters, and production of five case studies of displacement. Later phases involved the development of a template and methodology/guidance for assessing displacement of fishing effort, testing and revision of this, and the development of monitoring requirements and research priorities.

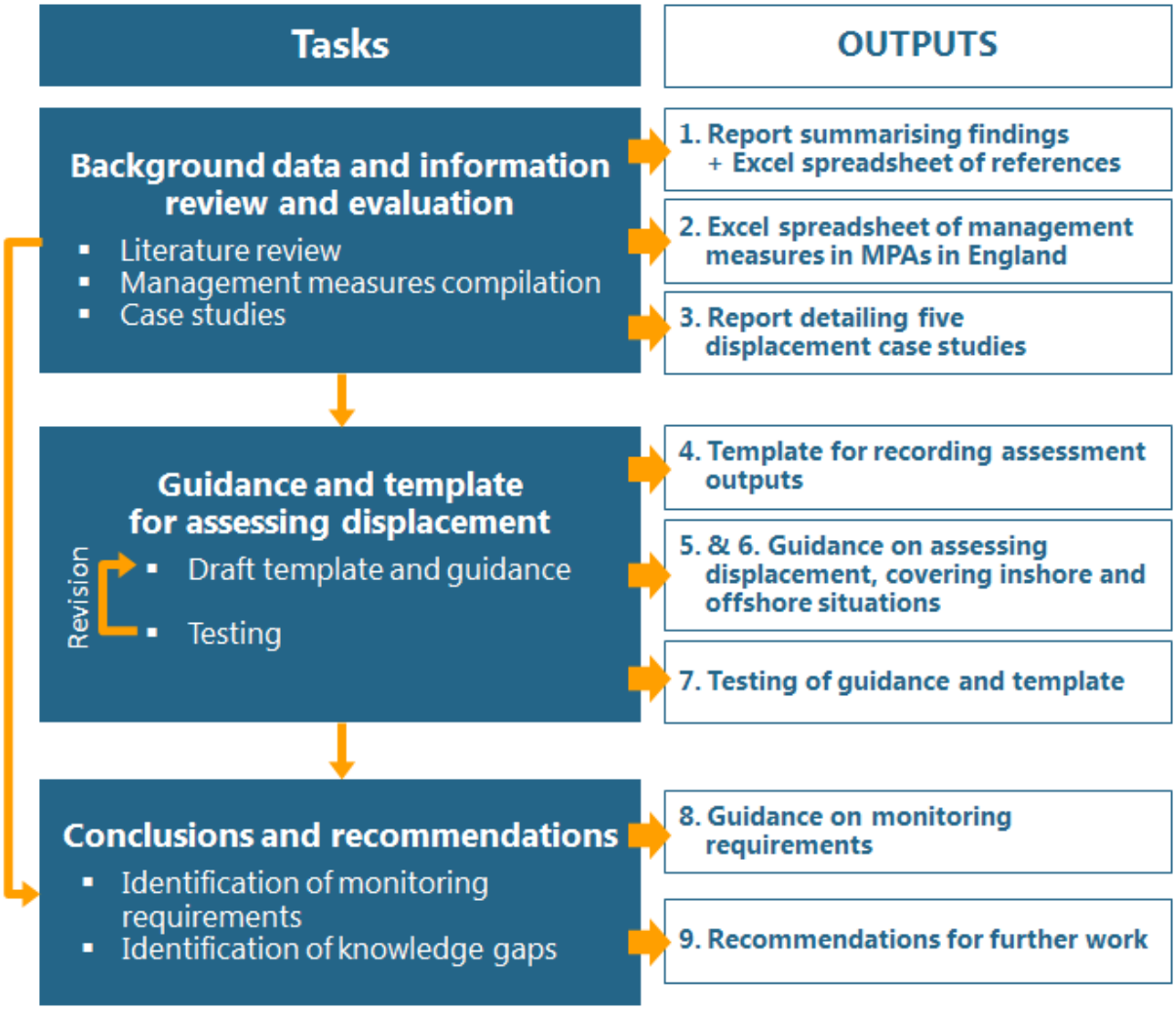

Figure 1. Approach to the project

Definitions of displacement vary. In this study, displacement is defined as the changes in fishing pattern and/or fishing behaviour that occur in response to a new spatially-explicit intervention (e.g. MPA management measure or other spatial restriction of fishing activity). Changes in fishing pattern represent the temporal and spatial changes in fishing activity (e.g. relocation of fishing effort to other fishing grounds). This could cause intensification of fishing effort at certain locations, result in greater fuel consumption, and increase conflict, or competition with other fishers/sectors. Changes in fishing behaviour represent other strategic fishing choices made by fishers, e.g. changes in vessels, adoption of a new fishing method, or target species. This may cause stock depletion, or increase impact on the environment if the change in method was to a more damaging gear type.

Stopping fishing is also a potential consequence of the removal of fishing effort from specific areas, and will have economic impacts. Marine Scotland (2014a) included stopping fishing in their definition of displacement. This may be an appropriate definition when considering the potential social and economic impact of closures. However, for the purposes of the literature review, we consider displacement in terms of fishing that continues, although the potential for fishing to cease is also recognised and discussed. The tightening of environmental regulations in English and UK (and European) waters may also result in 'displacement' or leakage at the regional or global level, through increasing imports of seafood from other parts of the world and export of the environmental consequences to other places. This was explored in the United States of America (USA) by Helvery *et al.* (2017), who found that unilateral marine conservation actions shift fishing activities and subsequent ecosystem impacts beyond national borders. This type of displacement is not considered for the purposes of this report.

Where this report refers to 'closed areas', this relates to a defined area that is closed to a specific gear type.

2.1 Literature review

A search of peer-reviewed and grey literature was conducted using internet search tools (Google and Google Scholar) using the following search terms: MPA, closed area, marine reserve, fishing effort, displacement, fishing patterns. Additional literature was identified from a list provided by Natural England, the project team's own literature database, contacting key researchers, following up relevant references cited in papers that were reviewed, and additional suggestions from discussions with Inshore Fisheries and Conservation Authorities (IFCAs) and Marine Scotland.

A total of 94 articles or reports were identified, of which 46 were included in the review, using the following prioritisation:

- UK or European studies prioritised;
- Permanent closures prioritised over seasonal or rotating closures, although a number of seasonal closures for fisheries management were included as they were among the most well-studied examples;
- Whether the study addresses the displacement of effort (where to, how much, what affects it);
- Whether the study addresses the ecological or environmental consequences of the displacement of fishing effort.

The intention was to focus on MPAs implemented for conservation benefits, rather than for fishery management objectives, but due to the longer history of MPAs for fishery management in the North Sea and other places, and the large amount of research into their impacts, fishery management closures were included. Similarly, some seasonal or rotating closures (e.g. the Cod Box) were included where they yielded useful insights to displacement.

Each literature source was summarised in a spreadsheet including information on the study, the displacement effect predicted or observed, details of fleet segment (gear type, vessel size, target species etc.) that was affected by displacement, and an identification of factors that affected the displacement. The spreadsheet is provided separately. A list of literature sources reviewed is provided in Appendix A. The literature sources that were identified but not included in the detailed review are listed in the spreadsheet. Some of these may provide additional information relevant to displacement from MPAs, but inclusion of further papers in the spreadsheet was beyond the scope of the project in terms of time and resources available for the literature review.

2.2 Compilation of management measures

A spreadsheet was developed to compile information on management measures in MPAs. SACs, SPAs and Tranche 1 and 2 Marine Conservation Zones (MCZs) were included. Information was compiled from AIFCA quarterly reports on the development of byelaws under the Revised Approach, IFCA websites and meeting documents, information from JNCC on the status of measures in offshore sites, and direct contact and discussion with IFCAs.

Byelaws that relate to removing or restricting fishing activity within a defined area that lies within an SAC, SPA or MCZ were included. Byelaws that relate to more general conservation measures or fishery management measures (such as permitting, requirements to use inshore Vessel Monitoring Systems[3] (iVMS), or licensing and reporting requirements) were not included.

The compilation of management measures in the spreadsheet includes:

- Existing IFCA byelaws correct to 01/03/2017;
- Planned IFCA byelaws identified in the AIFCA Quarterly Report dated January 2017;
- Relevant IFCA legacy byelaws[4], included where they restrict or limit the level of fishing effort in a certain area (e.g. through restriction of allowed gear types, vessel size etc.), but not general measures related to data and information or stock management such as catch returns, lobster v-notching;
- MMO planned byelaws for MPAs;
- Planned offshore measures identified by JNCC.

Consultation with the MMO and AIFCA was carried out to determine the most appropriate structure for the spreadsheet, based on its potential uses. The MMO has its own tools for tracking the development of byelaws, however it was agreed that the spreadsheet could be useful in identifying information relating to a specific MPA, which might be needed to respond to Parliamentary questions.

The spreadsheet is provided as a separate output, and a summary of the compilation is provided in section 3.

2.3 Case studies

Case studies were identified from the project team's knowledge and from the literature review. Information on the case studies was compiled from published literature, supplemented with information from discussions with IFCAs where relevant.

2.4 A method and template for assessing displacement

A scoping note setting out the intended audience, scope and format of the template and methodology was developed and discussed at the project Interim Meeting with the FDSG on 7th February 2017.

[3] A monitoring system which at regular intervals provides data to fisheries authorities on the location, course and speed of vessels. All EU vessels over 12m in length must have a satellite-based VMS system installed, and mobile-phone based technology is increasingly being introduced on vessels under 12m length, known as 'inshore VMS' (iVMS).

[4] These will have been created by the previous Sea Fisheries Committees, and were mostly related to fishery management purposes rather than for conservation objectives.

Based on this, a methodology and a template were developed, setting out a series of questions on displacement, and providing guidance on issues to consider in answering each question, possible information sources, and proportionality (level of detail required, depending on whether the assessment is a rapid appraisal of various management options, or a more in-depth assessment of the preferred management option as part of an impact assessment.

The draft version of the method and template was circulated for commenting and testing. Comments were received from JNCC, MMO and Natural England.

Testing of the method and template and provision of feedback on the process was carried out by:

- Cornwall IFCA;
- Devon & Severn IFCA;
- Northumberland IFCA;
- ABPmer; and
- NFFO.

Feedback from the testing process was considered and incorporated into revised versions of the template and methodology.

The original project specification identified the development of a template and methodolgy for assessment of displacement in inshore areas, and a separate guidance document for assessment of displacement in offshore areas. A single draft version of the methodology for assessing displacement was developed, together with a template for recording the outputs of the assessment. This allowed testing and subsequent revisions to focus on a single version of the method, which could subsequently be split into inshore and offshore versions. However, discussions with regulators and advisers for the offshore area (JNCC and Defra) concluded that a single methodology document that addresses both inshore and offshore situations would be appropriate, avoiding future divergence between different versions, and thus ensuring more a consistent approach to assessments between the two areas.

2.5 Monitoring requirements and future research

Monitoring requirements for displacement were identified, based on the expected effects and potential impacts of displacement of fishing effort. The monitoring requirements were considered in the context of Adaptive Risk Management (ARM) and benefited from the involvement of the project team in a workshop run by Natural England on ARM in MPAs on 31 January to 1 February 2017.

3 Literature on Displacement

The literature on displacement of fishing effort from MPAs highlights that displacement can take place both spatially to other areas, or to other gear types. The latter can be displaced fishers switching to an alternative gear, or more commonly, the displacement of one gear type from an area can open up the opportunity for fishers using an alternative gear type to operate in the area. The displacement of fishing effort has impacts on the marine environment and on the affected fishers, but also on other fishers and other marine sectors and activities.

3.1 Type of literature

Of the 46 literature sources reviewed, 14 related to ex-ante studies or predictive modelling, and 23 were ex-post studies of displacement. A further 9 related to general theory of displacement or were reviews of other studies.

The geographical spread of the literature reviewed is shown in Table 1, with the majority of effort directed towards reviewing studies from the UK or Europe, which will have greatest applicability to the situation in English waters. The majority of studies consider demersal mobile gears (e.g. beam trawls, otter trawls, dredges), as these are the gear types with the greatest benthic impact and therefore the ones most likely to be excluded from MPAs. This is reflected in the number of red, amber and green risk-ratings for gear-habitat interactions for mobile demersal and static gears in the Revised Approach matrix, which gives a risk-rating to each gear-feature interaction (Figure 2).

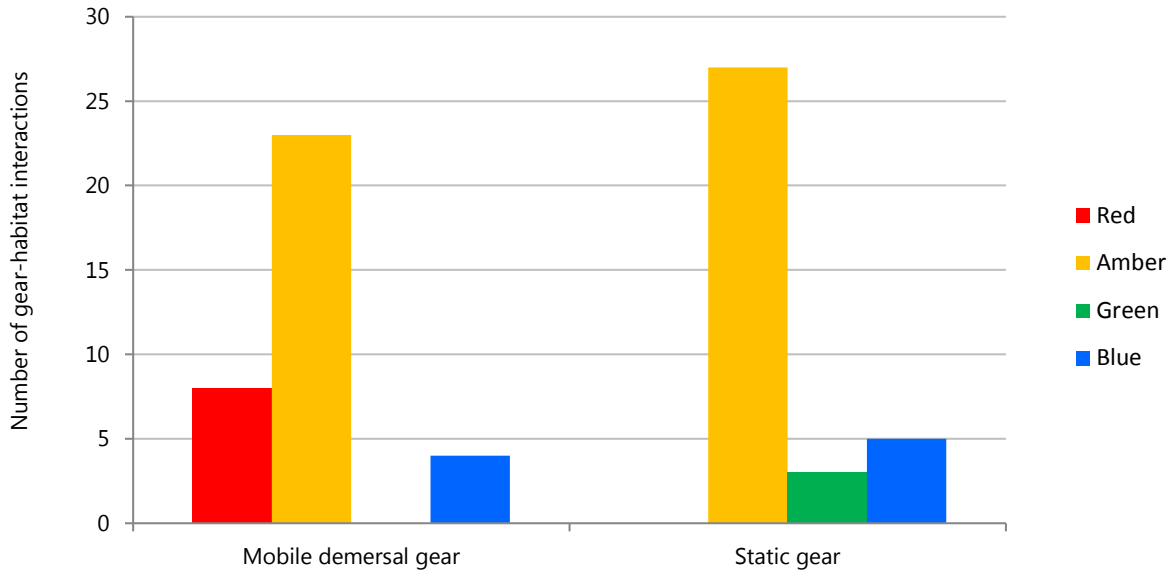

Figure 2. Number of each risk rating for gear-habitat interactions in the Revised Approach matrix for mobile demersal and static gears

Notes:. Mobile demersal gear reflects beam trawl (whitefish and pulse/wing), heavy otter trawl, multirig, pair trawl, anchor seine and towed dredges (scallop). Static gear reflects pots/traps and static (fixed) nets). Red, amber and green risk ratings reflect the potential or actual impact of the gear type on a designated habitat feature, blue indicates no feasible interaction between the gear type and feature. Full definitions available at www.gov.uk/government/publications/revised-approach-to-the-management-of-commercial-fisheries-in-european-marine-sites-overarching-policy-and-delivery.

Of the reviewed studies, 25 considered the displacement of mobile demersal gears. Ten studies were relevant to various or all gear types, such as some inshore MPAs with no-take zones that exclude all fishing activity (e.g. Horta e Costa *et al.,* 2013). A further 11 studies were not specific to a particular gear type (e.g. they considered general theory of displacement).

Table 1. Geographical location of the studies reviewed

Location	Number of studies
UK	16
Europe (excl. UK)	14
Americas	6
Indian Ocean	3
Worldwide or not specific to a geographic region	7

3.2 Displacement to other areas

3.2.1 Factors determining displacement to other areas

The literature highlights a number of key factors that affect where fishing effort may be displaced to following the closure of fishing grounds. These flow from the underlying factors that govern fishers' choice of fishing location, based on the target species and underlying ecosystem dynamics and habitat types (determining possible fishing grounds for different target species), fishing gear, knowledge and experience of different fishing grounds (and catch rates on them), and economic factors such as market prices for different species, distance to port determining steaming time and fuel use, etc. Further detail on the economic factors and models can be found in the economic literature, such as Pascoe and Mardle (2005) and van Putten *et al.* (2012).

The factors explored are:

- Expectation or occurrence of localised 'spillover' effects;
- Availability of alternative fishing grounds (taking into account technical characteristics of the vessels, gears etc.);
- Knowledge of alternative fishing grounds;
- Distance from port (fishing range and steaming time);
- Individual fishers strategies and preferences;
- Availability of fishing rights and quota.

Each of these is considered in more detail below.

The potential for displacement of fishing effort and its impacts should be considered in the context of the wider regulatory and historical factors that have given rise to current patterns of fishing effort allocation. The spatial distribution of fishing activity is dependent on: the abundance (location) of targeted species; the area in which it is accessible based on technical characteristics; and the area in which fishing is authorised (Figure 3) (FAO, 2005). In many cases, current patterns of fishing effort are the result of historical displacement (e.g. increase in the scallop fleet as a result of decreasing whitefish quotas (Linkie, 2014)) and fishing for quota stocks can only take place in those areas for which quota is held.

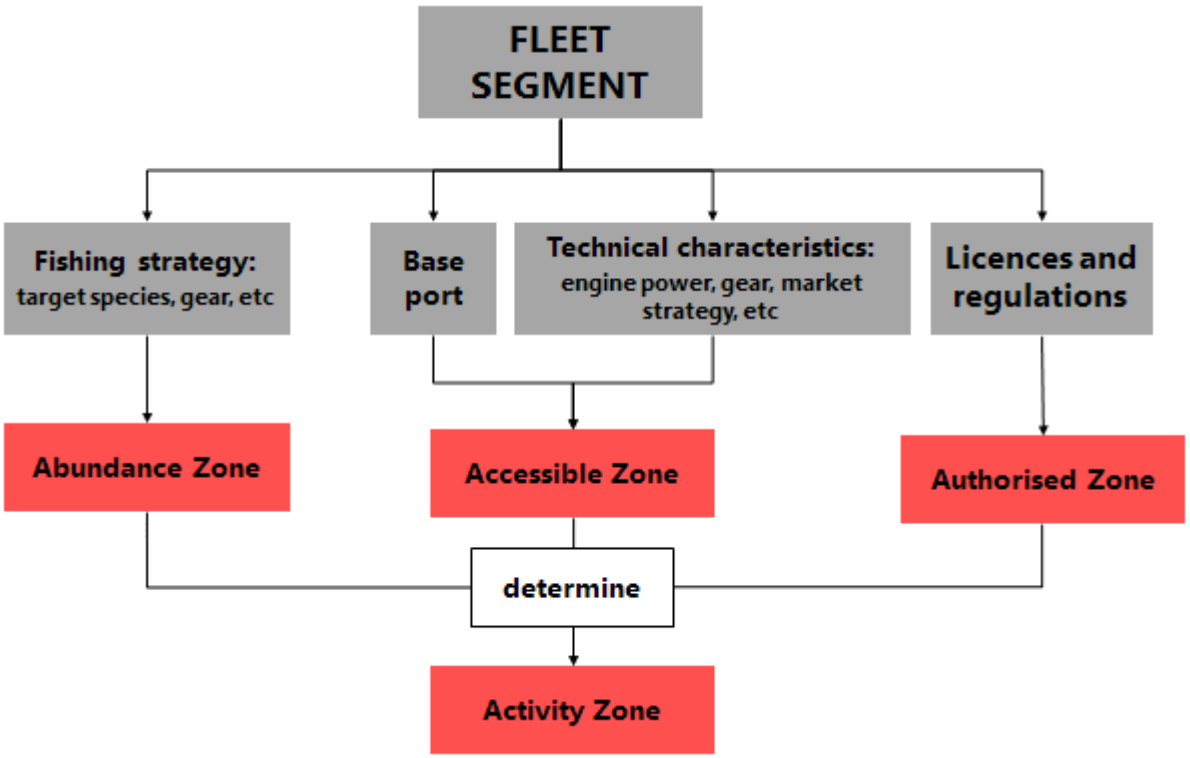

Figure 3. Relationships between a fleet segment and the spatial distribution of its fishing activity

Source: FAO, 2005.

Expectation or occurrence of localised spillover effects

There are many examples of MPAs that have resulted in a concentration of fishing effort around the boundaries of the closed area, known as 'fishing the line'. This may be a response to, or anticipation of, the 'spillover effect', where the build-up of biomass within the reserve results in movement of adult fish out of the reserve and higher catch rates close to the reserve boundaries (Kellner *et al.,* 2007). However, it may also reflect the availability of suitable habitat for the target species assemblage and gear type, coupled with other factors affecting fishing location choice such as steaming distance (Hynes *et al.,* 2016) (see sections below on 'Availability of alternative fishing grounds' and 'Knowledge of alternative fishing grounds'). Kellner *et al.* (2007) showed that 'fishing the line' is part of the optimal effort distribution near no-take marine reserves with mobile species regardless of the cooperation level among harvesters, and this can have a significant impact on the spatial patterns of CPUE and fish density within and outside the reserve. Examples of where 'fishing the line' has been observed linked to the spillover effect are:

- Large closed areas for groundfish protection off the north-east coast of the USA (George's Bank and southern New England) clearly demonstrated concentration of fishing effort for larger trawl vessels close to the boundaries of three of the five closures. Subsequent to the closures, about 10% of effort targeting groundfish was deployed within 1km of MPA boundaries, and about 25% within 5km. Fish density gradients were consistent with spillover for some species but not others (Murawski *et al.*, 2005).
- Seasonal closure of Browns Bank on the Scotian Shelf to protect the spawning stock of haddock concentrated effort near the boundaries of the closure consistent with a 'fishing the line' strategy targeting spillover, although specific catch rates varied depending on the target species and vessel distributions (van der Lee *et al.*, 2013).

- Fishing patterns of some artisanal fishing sectors (particularly sparid trammel net and longline) around the 1400ha coastal Tabarca Marine Reserve in the Mediterranean off south-east Spain, showed concentration of effort around the MPA, although other fishing sectors did not (Forcada *et al.,* 2010).
- A study of the impact of inshore MPAs on artisanal fishers in Kenya and the Seychelles found that fishers may fish close to the boundaries of the closures with the perception of enhanced catches, although the majority of fishers did not perceive an overall impact of closures on their catches (Daw *et al.,* 2011).

The spillover effect is more likely for more sedentary species than others. Highly mobile species are more likely to disperse over a wider area, and gradients in density linked with the closed area are unlikely. Closed areas may however support production in the wider area if they protect spawning aggregations, through enhanced recruitment, or other functionally-important areas (e.g. key feeding locations, spawning, nesting or nursery areas).

Availability of alternative fishing grounds

Different species and species assemblages associate with different habitat types, which in turn are affected by water depth, substrate and disturbance regime (the 'abundance zone' in Figure 3). Water depth is a key indicator of species distributions, and has been identified in several studies as an important factor explaining fishing distribution after MPA implementation:

- Preferred habitats of target species drove much of the artisanal fishers' choices of fishing location around the coastal Arrábida Marine Park in Portugal (Horta e Costa *et al.*, 2013);
- Water depth (indicating habitat preference, which may correlate with preferred species assemblage) was identified as a key factor in fishing effort distribution around MPAs in the Mediterranean (Stelzenműller *et al.*, 2008);
- Habitat heterogeneity was identified as a factor affecting distribution of artisanal fishing effort around the Tabarca Marine Reserve in the western Mediterranean (Forcada *et al.,* 2010).

Where an MPA boundary cuts across a fishing ground, the importance of the existing fishing ground, and fishers' knowledge of it, are likely to result in the concentration of fishing effort around the boundaries of MPAs (due to the availability and knowledge of appropriate fishing grounds, rather than in response to the 'spillover effect'), for example:

- The closure of the 'Cod Box' in the North Sea in 2001, with the aim of protecting cod spawning areas to support stock recovery, caused the fleet of large vessels to displace its activity to fishing grounds in the North Sea outside the closed areas, with beam trawling concentrating along the borders of the closed areas and the already closed Plaice Box (Rijnsdorp *et al.,* 2001).
- The western Baltic cod closure MPAs resulted in the displacement of effort, which was concentrated around the boundaries of the Bornholm MPA in particular, in line with the distribution of the target stock in fishable areas. The decreasing biomass of the target stock was concentrated into the most favourable grounds, further reducing the available fishable area and increasing the concentration of fishing effort in the remaining grounds (Suuronen *et al.,* 2010).
- Implementation of large spatial closures in a North Pacific trawl fishery for protection of red king crab led to redistribution of effort to grounds outside the closures. Effort was concentrated in three zones, one of which was along the southern border of one of the closures (Abbott & Haynie, 2012).

Other modelling studies have also predicted a similar displacement of effort, for example, modelling of the redistribution of effort after a simulated closure suggested that the fishing grounds in closest proximity to the closed site were the ones that would see the highest percentage change in probability of being fished by the fleet (Hynes *et al.,* 2016).

Habitat types representing suitable fishing grounds will be more important in those fisheries that are closely linked to habitat type, for example *Nephrops* (Norwegian lobster) fisheries on muddy habitats, and scallop fisheries on sandy gravelly habitats (although there are other environmental and physical factors that determine what makes a good fishing ground). Potential areas where effort could be displaced to could be identified based on knowledge of the habitat types and existing or historic fishing grounds. Larger vessels may have a considerable operating range, and be semi-nomadic in their operation, meaning that displacement effects can occur over considerable distances. For example, scallop fishing effort displaced from Lyme Bay on the south coast of England as a result of the Statutory Instrument, subsequently moved to waters in the north-east of England and Cardigan Bay (see case studies in section 5). Smaller sized vessels may also move significant distances, by relocating to a different home port in order to fish alternative grounds. This has been observed in the displacement of the North Devon trawl fleet which has moved to South Devon as a result of skate and ray quota restrictions[5], and whelk potters which moved from Lyme Bay in Dorset to the Kent and Essex region following a 'boom and bust' of the whelk fishery in Lyme Bay (Tim Robbins, *pers. comm.*).

Knowledge of alternative fishing grounds

The experience and area specialisation of the skipper will affect displacement behaviour (Slijkerman & Tamis, 2015). Traditional fishing grounds may influence effort allocation (Abesamis *et al.,* 2008), and skippers with experience of a range of fishing grounds are likely to be more adaptable and able to explore alternative grounds. Skippers that only fish in specific areas and have limited knowledge of other fishing grounds are likely to suffer lower catch rates as they explore new areas.

A study of the English and Welsh beam trawl fleets found that the three main drivers of fishing location were past annual effort, past monthly effort in the year of fishing, and fuel price, largely reflecting the fact that previous practices where success was gained are learned (i.e. experience) and become habitual (Tidd *et al.,* 2012).

Following the closure of the Cod Boxes in 2001, skippers of vessels with little experience in the areas that remained open had a lower level of fishing effort or even stopped fishing during the closure, and had a lower catch rate than the skippers of vessels that had experience fishing in the areas that remained open (Poos & Rijnsdorp, 2007). Adjusting to new grounds may also require adjustments to gear and fishing strategy (Slijkerman & Tamis, 2015).

Individual fishers' previous catch rates on different grounds is incorporated into the DISPLACE model as part of the decision-making process (combined with stock availability, fuel prices etc.) to determine where effort is displaced to in the model (Bastardie *et al*., 2015).

Distance from port (operating range and steaming time)

Distance of fishing grounds from the home or landing port is an important factor determining fishing effort distribution. This is based on two main factors:

- Operating range of the vessels: distance from port is particularly important for smaller vessels with a smaller operating range, which limits access to potential alternative fishing grounds.

[5] www.nffo.org.uk/news/the-collapse-of-the-bristol-channel-fisheries-an-early-victim-of-the-rush-to-msy.html.

- Steaming time and associated fuel costs: distance of fishing grounds from port affects the steaming time and associated fuel use, which may be mediated by changes in the oil price. This is a trade-off for all vessel size classes, including for larger vessels with fishing trips of 5–6 days.

Studies that have identified distance from port as an important factor include:

- Stelzenmüller *et al.* (2010) found distance to port to be a significant factor determining fishing location choice in artisanal fisheries around MPAs in the Mediterranean.
- Distance to port was identified as potentially an important factor in Hiddink *et al.* (2006a), but was not included in their model.
- De Vries *et al.* (2015) found that smaller vessels from ports further away from the Voordelta closure reduced their fishing distance from the port, fishing in grounds closer to the port rather than those in the vicinity of the closed area.
- Forcada *et al.* (2010) found that distance to port was a factor in distribution of artisanal fishing effort, as fishers compromise between costs (distance from harbour) and benefits (expectations of improved yields). They highlighted that small boat size limits travel distances to areas surrounding the home ports, especially in winter when bad weather may put boats at risk.
- Tidd *et al.* (2012) found that shorter-term factors affecting fishing location choice can vary in their relative importance over time. Many factors influence a fisher's decision where and when to fish, including fish distribution, fuel price, regulations, their habits and experience, previous catch rates, market prices, and the proximity to landing ports, with the three main drivers being past annual effort, past monthly effort in the year of fishing, and fuel price. Seasonal variations also dominate behaviour in terms of the strong monthly trends and variable costs.

Individual strategies and preferences

Different skippers may have different strategies for fishing, with some being more risk-taking, and others being more risk-averse. In a study of artisanal fishing patterns around an MPA in Portugal, individual fishers showed distinct strategies after MPA implementation, with some operating in a broader area whereas others kept to preferred territories (Horta e Costa *et al.*, 2013). Individual fishing strategies affects vulnerability to displacement (ability to adapt, see section 3.3), with fishermen that fish on specific, traditional grounds potentially being less able to adapt, as they have limited knowledge of alternative fishing grounds.

Marine Scotland (2014a) also noted a strong cultural attachment to fishing methods. It found that in all locations changing from trawling to creeling would not be contemplated by many fishermen, and vice versa — both sectors have strongly-held views on the impact that the other has on the environment and stocks. Accordingly the often-suggested solution of changing vessels from mobile gear to static gear is not as simple as some may envisage it to be. There are also investment costs related to changing gear type (see section 3.3.1).

Availability of fishing rights and quota

For skippers to be able to move effort to alternative areas, they must have sufficient quota for an appropriate mix of species for the new areas. With the implementation of the Landings Obligation[6]

[6] Introduced in the Common Fisheries Policy (Regulation (EU) 1380/2013), the Landings Obligation is the progressive elimination of discarding fish in EU fisheries, and will apply to all stocks subject to Total Allowable Catches (TACs), as well as Mediterranean stocks subject to Minimum Landing Sizes (MLS). It is being introduced to stocks of interest to the UK fleet in a phased manner between 2015 and 2019.

under the CFP (2013/1380/EU), this is even more important. When the Cod Boxes were temporarily closed in 2001, the number of vessels that reallocated their activities to fishing grounds outside the North Sea was relatively small compared with the total size of the fleet (Poos & Rijnsdorp, 2007); a lack of quota for areas outside the North Sea may have contributed to this.

The particular quota regime in which a fishery operates may impact on choices made by fishers in fishing location choice, as they work to catch their quota for the different species they are targeting (Hynes *et al.,* 2016). Quota availability and quota-filling behaviour have not been incorporated in any of the models reviewed for displacement, yet this may have a significant influence on the redistribution of fishing effort following implementation of closures. The way in which this will interact with the implementation of the Landings Obligation brings additional uncertainty.

The unknowns and the unknowables

Whilst a range of factors that influence fishing behaviour and choice of fishing location can be identified (see above) to help understand and predict where fishing effort may be displaced to, there are still numerous complex factors that interact, many of which are unknown or unquantified. Fulton *et al.* (2010) highlight that a consistent outcome of fishery management instruments is that resource users behave in a manner that is often unintended (and unpredicted) by the designers of the management system. The uncertainty generated by unexpected resource user behaviour has unplanned consequences and leads to unintended management outcomes. De Vries *et al.* (2015) found that most of the variation in their data was unexplained by the model, as not all explaining variables can be included or quantified in behavioural studies.

Closing a valuable fishing ground can also lead fishers to dramatically change their decisions (e.g. including stopping fishing), which complicates the prediction of fisher displacement response (Bastardie *et al.,* 2015).

It is important to consider other exogenous factors that may influence fleet dynamics and behaviour. Wider factors, unrelated to the MPA closure, also affect the fleet and decisions about fishing. For example, the Dutch flatfish fleet started to decrease due to the flatfish management plan, poor economic conditions for the fishers, combined with a buy-out regulation (de Vries *et al.,* 2015), confounding the analysis of the effect of MPA closures on fishing patterns.

3.3 Displacement to other gear types

3.3.1 Switching gear types to redirect effort

Few examples of fishers switching gear types were found in the literature. This may be partly due to the difficulty in tracking effort between different gear types for individual vessels. However, it is likely that – particularly for larger and more specialised vessels – there are barriers to changing gears (e.g. investment, potential for safe adaptations to the vessel, knowledge and experience of operating different gears, and availability of resource access rights (e.g. licence restrictions)). Pascoe and Mardle (2005) highlight that there is a surprising lack of models of input substitution i.e. gear switching.

No displacement to other gear types was observed a year after the closure of Lyme Bay to towed gears. Instead, the increase in static gear effort that occurred within the MPA was a result of increasing effort by the existing static gear fishermen (Mangi *et al.,* 2011). This may be because of certain barriers to switching gear type, such as the size (especially when small) or design of vessel may mean it cannot safely or readily change methods of fishing without a large capital outlay, or it may not be possible to use a vessel for alternative methods of fishing due to the specialised equipment used. The opportunity for mobile fishing gear vessels to change over to potting for crustaceans is very

difficult (DSFC 2008, cited in Mangi *et al.*, 2011), and may also be limited by licence conditions (e.g. whether they have a shellfish permit).

For small-scale fisheries where fishers already use a range of different gear types to target different fisheries at different times of year, switching effort to a different gear may be easier. In a study of fishing patterns of small-scale vessels before and after MPA implementation in Portugal, traps were the least-restricted gear type in the MPA, and Horta e Costa *et al.* (2013) found that there was an increasing trend in the number of vessels fishing with traps in the MPA, indicating that some fishers were switching effort to traps in response to the restrictions on other gear types.

The ability of small-scale fishers to switch gear types relies on the availability of fishing opportunities on other species at suitable times of the year, since their strategies often target different target species with different gears at different times of the year, and the financial viability depends on the suite of fisheries exploited. Therefore despite their knowledge of operation of a range of gear types, there may not be any viable opportunities to target alternative fisheries if one of their gear/target species fisheries is removed.

Switching to alternative gears may require financial support to purchase gear and retrain in a new fishing technique. The assessment of the Scottish Nature Conservation MPAs highlighted a single fisher, whose activity (demersal trawling) was restricted to one loch, and as a result 100% of his annual catch would have been affected by an MPA. Subsequently he has been supported through the European Maritime and Fisheries Fund to switch to creeling, a gear type that is not affected by the management measures due to its lower impact, so that he can continue fishing within the loch (M. McLeod, *pers. comm.*).

3.3.2 Other gear types can take advantage of the removal of fishing effort

The 'vacuum' left by the removal of mobile demersal gear can in some instances be rapidly filled by an increase in static gear (or other gear types still permitted in the MPA). This effect has been observed in a number of cases:

- As a result of the implementation of MPAs in the Baltic Sea to protect valuable habitats, the number of vessels, total fishing effort and average landed catch per trip in the active Swedish cod fishing fleet were halved in 2005 compared to 1996 (prior to seasonal and permanent closures). The MPA border was close to a steep slope, making it difficult for Swedish trawlers to operate in the area outside the MPA. As a result, Swedish vessels stopped operating there and Polish gill netters took over the profitable fishing areas that had been vacated by the Swedish fleet (Suuronen *et al,*. 2010). Whilst they have fewer benthic impacts, gill netters have impacts on other ecosystem components such as birds and marine mammals.
- A similar effect was observed after the closure of Lyme Bay to towed gears, as static gear fishermen increased their fishing effort within the closed area due to the removal of mobile gear effort (Mangi *et al.,* 2011), but it is as yet uncertain whether there is any effect of increasing potting intensity on the condition of the benthic communities (Rees, *pers. comm.*).
- The exclusion of large beam trawlers from the Plaice Box in the North Sea led to an increase in effort by the smaller-sized (exempt) shrimp beam trawlers, and Danish gillnetters and trammel netters. Exempt plaice trawlers initially increased their effort inside the Plaice Box (Beare *et al.*, 2013).

3.4 Impacts of displaced effort on the marine environment

3.4.1 Effect on benthic environment

The effect of displacement on the benthic environment depends on the sensitivity of the habitat where effort is displaced to (which in turn is influenced by levels of natural disturbance), the level of fishing in the area prior to displacement, and the gear type displaced. Impacts are expected to be greater for mobile gears that interact with the seabed (e.g. demersal trawls and dredges), and for more sensitive species and habitats with longer recovery times (e.g. maerl beds, seagrass beds, biogenic reefs). This is reflected in the Revised Approach matrix[7], which classifies such gear-feature interactions as 'red risk' (where it is clear that the conservation objectives[8] for a feature (or sub-feature) will not be achieved because of its sensitivity to a type of fishing, irrespective of feature condition, level of pressure, or background environmental conditions in all European Marine Sites where that feature occurs).

Displacing fishing effort to an already heavily-fished area (by the same gear type) causes relatively little additional mortality of benthic invertebrates. However, displacing fishing effort to lightly-fished or unfished areas may cause substantial additional mortality of benthic invertebrates, because the initial effects of fishing on benthic community biomass, productivity and diversity are the greatest (Hiddink *et al.,* 2006b). Based on a modelling study, the overall effect of closures (at the scale of ICES rectangles[9]) on benthic communities was assessed as being either positive or negative, depending on the scenario. Hiddink *et al.* (2006a) found that closure of lightly-fished areas had the strongest positive effect, while closures of more intensively-fished areas had a negative effect (through displacement of effort) on overall biomass, production and species richness of benthic communities.

Modelling of the effect of closed areas on fishing effort distribution and its impacts in the North Sea found that the closure of fishing grounds moves fishers away from traditional fishing areas, resulting in increased effort and seabed disturbance in areas that were previously relatively lightly fished (Cefas, 2005). The Cod Box was also found to result in effort being more widely distributed, effort was redistributed to otherwise unfished areas, and an area to the west of the closure was more intensively trawled during the year of the closure (Dinmore *et al.,* 2003). This redistribution of effort was predicted to have had slightly greater cumulative impacts on total benthic invertebrate production and led to localised reductions in benthic biomass for several years.

Several studies have indicated that area closures may result in negative environmental impacts as a result of displacement, unless there is also an overall reduction of fishing effort (e.g. Dinmore *et al.,* 2003; Hiddink *et al.,* 2006; Greenstreet *et al.*, 2009). However, this conclusion is based on modelling studies that make assumptions about benthic mortality rates, post-displacement effort levels (often assuming that effort increases to compensate for fishing on less productive grounds), and the areas where effort is redistributed to. The assumptions reflect the limitations of the models that do not fully account for fisher decisions and behaviour and other restrictions on fishing activity such as quota mix, area restrictions, days at sea and input costs.

7 www.gov.uk/government/publications/fisheries-in-european-marine-sites-matrix.

8 Conservation objectives can generally be described as being 'the specification of the overall target for the species and/or habitat types for which a site is designated, in order for it to contribute to maintaining or reaching favourable conservation status of the habitats and species concerned at the national, the bio-geographical or the European level' (Natural England, 2014).

9 Each ICES statistical rectangle is 30 min latitude by 1 degree longitude in size, which is approximately 30 by 30 nm. Because the Earth is a spheroid shape, the area of an ICES rectangle varies by latitude. For the North Sea, the area is approximately 800 nautical square miles.

For example, the Greenstreet *et al.* (2009) modelling study found that in the MPA scenario which closed the areas most important to demersal fish species biodiversity, fishing effort would have to increase to maintain landings (as the closed areas represented some of the most productive fishing grounds with the highest levels of CPUE), resulting in an overall negative impact on benthic community condition. In their scenario which closed areas of highest benthic invertebrate mortality (representing areas of higher benthic biodiversity and including some heavily fished areas), effort was assumed to be displaced to areas where CPUE for each target species–main gear combination was higher, therefore overall fishing effort was lower for the same level of landings. This resulted in some overall benefit to benthic invertebrate communities at the North Sea scale. However, the authors acknowledge that it is questionable whether the areas to which effort was displaced would be able to maintain those levels of productivity in the longer term. They therefore recognise that the model probably underestimates the amount of effort required to take the previous level of landings, and thus overestimates the benthic community benefits.

An ex-post analysis of the redistribution of effort as a result of the Cod Box closure in 2001 found that there was no significant expansion in fishing area by the beam fleet in the North Sea at the level of ICES rectangles (indicating that an expansion of benthic impacts due to displacement did not occur), although micro-distribution of effort at a finer spatial scale was not assessed. However, increased interference competition between beam trawlers from increased intensity in the remaining fishing areas, resulting in reduced catch rates and revenue per horsepower day, led to an increase in the number of trips outside the North Sea (Rijnsdorp *et al.,* 2001), which may have expanded the spatial extent of benthic impacts of the fleet, although this was not assessed in the study.

3.4.2 Effect on species

The displacement of fishing effort to other gears or other areas may lead to an increase in incidental by-catch of non-target species, such as marine mammals, seabirds, turtles and other vulnerable species. Dunne *et al.* (2014) concluded that the implementation of the Chagos MPA in the Indian Ocean forced fishing effort into less well-managed areas, where the incidence of by-catch of vulnerable shark species may increase due to the lack of measures to minimise by-catch (within the British Indian Ocean Territory area, which became the Chagos MPA, longliners had to use a wire trace to minimise by-catch of sharks).

No other studies were identified that considered by-catch of non-commercially exploited species.

3.4.3 Effect on fish stocks

Stock biomass

Increased fishing effort in open areas may increase fishing pressure on portions of the stocks (Slijkerman & Tamis, 2015) and shifting effort from sink areas to source areas could impact on future recruitment in the wider area, including within the MPA boundaries itself (Agardy *et al.,* 2011). However, there is limited empirical evidence for the effect of displacement of effort on fishing mortality and stock biomass.

Studies of the effects of closed areas on fishing mortality have focussed on MPAs implemented for fishery management purposes, to protect juveniles or spawning aggregations (rather than for conservation or biodiversity objectives):

- In modelling three closed area scenarios in the North Sea, Cefas (2005) found that the effects of closures on fishing mortality were negated by effort displacement to other areas which in some cases actually resulted in increased mortality on the stock. . This indicates that effort

levels and fishing patterns should be monitored before and after closed area implementation to identify any concerns as they arise.

- Scientific advice indicated that the implementation of closures aimed at protecting the cod stock in the western Baltic Sea were not effective at reducing total effort of the cod fleet nor conserving the Baltic cod stock (Suuronen *et al.,* 2010). This indicates that fishery management objectives need to take into consideration overall levels of fishing effort or fishing mortality, as well as protecting important areas or parts of the stock.
- Bastardie *et al.* (2015) in a linked displacement and bio-economic model, found that for the western Baltic cod closures, effort displacement redirected some fishing pressure to other localities, but this did not impair the whole dynamics and abundance of the main stocks.

These studies indicate that closed areas with fisheries management objectives need to be carefully designed, take into account potential displacement of fishing effort, and control overall levels of fishing mortality. Where the objective is to reduce fishing mortality, effort levels need to be reduced and closed areas are not necessarily the best way to achieve that, due to the potential for displacement of fishing effort. In relation to MPAs for conservation purposes, there should be consideration of what factors exist to limit fishing effort (e.g. quotas, effort restrictions, fleet capacity, weather) and how these will apply in the context of the MPA implementation. If there are concerns that effort might be redirected to areas that could negatively affect stocks, further interventions may be required for fishery management purposes.

If displacement of fishing effort contributes to driving investment into larger vessels (see section 3.5.3), this may lead to an increase in latent fishing capacity, or an increase in fishing pressure, as the need to finance such new vessels demands that they are used, and they have the potential to be operated in a wider range of weather conditions. Therefore overall levels of fishing effort need to be monitored and, where necessary, controlled.

Discards

Displacement of fishing effort can result in increased bycatch of vulnerable species, which may be either landed or discarded[10]. The large spatial closures in the North Pacific groundfish fishery, to protect red king crab were successful in reducing bycatch of red king crab, but also resulted in dramatic increases in Pacific halibut bycatch as a result of both direct (reallocation of fishing effort to areas outside the closures where halibut bycatch was higher) and indirect (increased targeting of cod, due to the loss of prime rock sole fishing grounds from the closures, which are more closely associated with halibut) impacts of fishing displacement (Abbott & Haynie, 2012).

Size structure

Displacement can also affect the size structure of fish populations if effort is displaced to areas that are dominated by smaller individuals. Displacement of cod fishing effort from the western Baltic MPAs caused fishers to fish in areas dominated by smaller sized fish, and may have markedly increased the discarding of juvenile cod (Suuronen *et al.,* 2010). With the introduction of the Landings Obligation, this could have a significant impact on fishing operations if effort is displaced into areas where fish under the Minimum Conservation Reference Size (MCRS) or where choke species[11] are more prevalent.

[10] Discarding is the practice of returning unwanted catches to the sea, either dead or alive.

[11] A species with a low quota that, under the Landings Obligation, could cause a vessel to have to stop fishing even if it still has quota for other species.

3.4.4 Key factors affecting the impact of displacement on the environment

Both positive and negative effects of MPAs on overall condition of benthic invertebrate communities and fish stocks have been demonstrated in fishing displacement modelling studies. However, empirical studies on the actual observed impacts are lacking. The following summarises the key factors that have been identified as affecting the impact of displacement on the environment.

Amount of effort displaced

The increase in fishing effort outside an MPA is a function of the proportion of effort that is displaced from inside the MPA. The proportionate increase in fishing effort is 1/(1–R) where R is the fraction of total habitat area (for the fishery) set aside in MPAs (Halpern *et al.,* 2004). An MPA closure of 20% of a fishing ground for a particular gear type thus leads to a 25% increase in fishing pressure of that gear (effort per unit area) in the remaining fishing grounds outside the MPA.

Habitat type

The sensitivity, productivity, level of natural disturbance and recovery time of the habitat to be protected, and of the habitat to where fishing effort is displaced to, affects whether the overall effect of the management will be positive or negative. Hiddink *et al.* (2006a) found that if areas closed to fishing have low levels of production because of high natural disturbance, and/or recover quickly after disturbance, then closure tends to have a negative effect overall, because trawling effort may redistribute to more productive habitats with longer recovery times. If the closed areas have high production in the absence of disturbance, and effort is displaced to areas where production is low, then closure is more beneficial to overall levels of benthic production and biomass. Studies have not considered the overall effect on biodiversity.

Fish community assemblage

The species composition and size structure of the fish or shellfish population in the area to which effort is displaced will affect the impact of displacement on the wider environment. If fishing effort is displaced to an area where levels of bycatch are higher and/or the size structure of the population includes more juveniles, ecosystem impacts may increase (Abbott & Haynie, 2012) (and vice versa).

Level of fishing intensity in the area to which effort is displaced to

The first pass of a fishing gear has a proportionately greater impact on the benthic community than subsequent passes (Hiddink *et al*. 2006b), therefore if fishing effort is displaced from a core fishing ground into new areas of similar habitat[12] that have not been previously fished or have been only fished lightly, the overall impact on the benthic community will increase. If the area to which effort is displaced is already heavily fished the marginal increase in effort will have a relatively lower impact that if, *ceteris paribus,* the effort is displaced to an area that had previously only been lightly fished (Hiddink *et al.* 2006a).

Amount of fishing effort exerted to compensate for lost catches from the MPA

If important (and productive) fishing grounds are closed, a comparably greater amount of fishing effort may be required in other areas to compensate for the lost catches from the MPA:

[12] Recognising that different habitat types have different sensitivities to fishing pressures and are subject to different levels of natural disturbance.

- Greenstreet *et al.* (2009) modelled benthic invertebrate community condition based on benthic species' mortality rates from different gear types, combined with the level of fishing effort for those gear types. Benthic condition was therefore determined by the post-MPA fishing effort required to maintain landings. If a higher level of effort were to be exerted in areas outside the MPA in order to maintain catch levels, the overall impact on benthic habitats would increase.
- In Lyme Bay, there was an increase in effort required from the mobile fleet to achieve landings and value of catch comparable to when access was permitted within the MPA (Rees *et al.,* 2016). There was a 12% increase overall in number of trips per month (35 trips per month inside and 41 outside the reserve in 2005/2006 prior to the SI closure, compared to 85 trips per month after the SI closure in 2013/2014), although this peaked at 101 trips per month in 2012/2013 (33% increase). The data on effort levels are confounded by the possible presence of visiting mobile gear vessels from outside the region prior to the SI closure, and the possible displacement of effort to other areas outside of the ICES rectangles studied.

3.5 Impacts of displacement on fishers and the fishing fleet

3.5.1 Types of impact

A range of impacts of displacement on fishers has been observed, and is summarised below.

Increased competition between vessels
An ex-post analysis of effort allocation in the Dutch beam trawl fishery in response to the Cod Box closure in 2001 found that the number of trips in the open area increased by 40% immediately following closure (due to displacement of effort from the closed area). Around Browns Bank closed area in Nova Scotia, fishing the line was found to be most intensive for the first few weeks, following which effort then spread out further, possibly as a result of high levels of competition between vessels (van der Lee *et al.,* 2013).

Decreased CPUE
Fishers that are displaced to other fishing grounds may experience reduced catch rates due to the alternative fishing grounds being less favourable (Suuronen *et al.,* 2010). Reduced catch rates may also occur due to increased competition in remaining fishing grounds (Suuronen *et al.,* 2010). Conversely, de Vries *et al.* (2015) found that for some fleet segments (small flatfish trawlers), closure of the Voordelta resulted in increased CPUE, which could be explained by shorter trip distances.

Decreased revenues
As a result of increased interference competition and decreased CPUE, revenues can decline. The displacement from the Cod Box closures, and the interference competition that resulted, led to an initial decrease in revenue per horsepower day of 40%, which decreased further in the following weeks (Rijnsdorp *et al.,* 2001).

Cost of searching for new fishing areas, longer steaming times and higher fuel costs
In the Lyme Bay example (see case study 1, section 5.1), fishermen using towed gear have been displaced to grounds outside the closed area, some of which are not as productive as those in the closed area. Over 80% of towed gear fishermen reported an increase in steaming time, leading to extended working hours (Mangi *et al.,* 2011). Other costs may also increase, such as gear costs from increased wear and tear of fishing gears due to less favourable ground conditions (Suuronen *et al.,* 2010).

Stopping fishing/exiting the fishery

The loss of specific fishing grounds may contribute to fishers' decisions to stop fishing or to exit the fishery. Few studies have investigated this aspect, due to the difficultly of identifying effort that has been lost from the fishery, and attributing cause and effect. Wider trends in the fishing fleet, and the impact of fishery management measures and restrictions also need to be considered, as reductions in effort may be part of a general trend. The implementation of the Western Baltic MPAs preceded a 50% reduction in the Swedish active cod fleet, however this was not exclusively due to the implementation of the MPAs. Declining stock size and reducing TACs meant that many vessel owners were considering exiting the fishery before the closures were implemented (Suuronen *et al.,* 2010). However, the cumulative impact of closures on top of other management restrictions, that make the fishery unviable, should be considered.

Conflicts between gear types

Displacement to other fishing grounds will directly affect the fishers that are displaced, and the vessels' economic performance, but it will also affect the fishers already in those areas (Pascoe & Mardle, 2005). This can result in increased conflict between fishers and between gear types. Static gear fishermen who fished outside the Lyme Bay closed area reported increased conflicts with towed gear fishermen who were displaced from the MPA to their traditional grounds (Mangi *et al.,* 2011), but were also able to increase their effort within the closed area due to the removal of mobile gears. Increased competition and gear conflict (gear collisions) between Swedish gill netters and cod trawlers as a result of the Western Baltic MPAs, may have increased the number of lost nets ghost fishing (Suuronen *et al*., 2010).

3.5.2 Assessing the impact of displacement in impact assessments

The actual social and economic impacts of displacement on fishers are complex and difficult to predict and assess. Impact assessments are conducted for proposed MPA designations as well as for proposed management regulations to understand and quantify the potential environmental, economic and social impacts, and their distribution. They are usually focussed on the anticipated direct impacts, and have not generally taken into consideration environmental impacts beyond the intended environmental outcomes of the proposed measure. Impact assessments may value the economic impacts in relation to the value of past landings from the area to be closed (i.e. a worst-case scenario of 100% landings lost, and effort is not displaced), with additional caveats surrounding the nature, scale and impact of potential displacement that may occur but which are uncertain.

The MCZ Impact Assessment[13] adopted assumptions regarding the level of displacement of fishing effort from MCZs, based on an analysis of the overlap of MCZs with fishing grounds. The assumptions were based on analysis carried out by Cefas on the extent of overlaps between modelled spatial data of under-15m vessels' and 15 metre and over vessels' fishing activity, which provided a proxy for identifying fishing grounds, and the MCZ locations. The displacement assumptions were applied to the value of landings of the effort being displaced from the MCZs to establish the value that would be lost to the sector and the value that would be retained through increased fishing effort outside of the MCZs. A blanket assumption was adopted for all MCZs, rather than being estimated at a site-specific level, reflecting the uncertainty in the actual likely nature of displacement, and applied differently to each of the management scenarios being considered for each MCZ. A displacement assumption of 75% was applied (i.e. 25% of the value is lost, and 75% retained through increased effort elsewhere) to the lowest cost management scenario (i.e. implementing the weakest management solution) and no

[13] Defra (2012). Impact Assessment Designation of Marine Conservation Zones in English Inshore waters and English and Welsh Offshore waters. Defra 1475. (Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82721/mcz-designate-ia-20121213.pdf). The impact assessment was focussed on the social and economic impacts, rather than environmental impacts. .

displacement was assumed (i.e. 100% of the value assumed lost) in the high cost management scenario (i.e. that implementing the strongest management solution). Where the likelihood between the lowest and highest cost scenario was not known or considered equal, the best estimate of the impact of the MCZ was halfway between the low and high cost estimates produced (Defra, 2012).

The 'Fisheries Measures in Protected Areas' (FIM-PAS) project considered options for management measures in Natura 2000 sites in the Dutch Exclusive Economic Zone (EEZ). It highlighted that assessment of the economic impact of displacement requires input from the fishing industry, but did not assess potential economic impact. Displacement scenarios (increasing effort in other areas, re-rigging to alternative gears) were considered qualitatively and briefly, discussing that there was 'no information that suggests where effort displacement may take place but it is likely that close neighbouring areas will be more heavily impacted. It is unlikely that there would be a switch to another gear' (ICES, 2011).

The evidence base informing the impact assessment for Scottish Nature Conservation MPAs assumed a worst-case scenario of the value of all landings from affected gear types would be lost (ABPmer, 2013). Subsequent work on displacement taken forward by Marine Scotland involved consultations with the industry (Marine Scotland, 2014a) and further analysis to contextualise the amount of effort (or landings) affected. Potential environmental impacts were considered in relation to the amount of effort affected by the closure as a % of effort in the MPA area, in the ICES rectangle, and in the wider region. Most management measures affected demersal trawls (especially *Nephrops*) and dredges. Alternative fishing grounds for these gears were mostly already exploited (there were no potential fishing grounds for the target species that were not already exploited), therefore effort would be displaced to already-fished grounds, rather than to unfished areas. As a result, environmental impacts would result from a marginal increase in the level of fishing effort in already-fished areas, rather than the more severe environmental impact expected from the first pass of a fishing gear in a previously unfished area (Hiddink *et al.,* 2006b). Rules-of-thumb were used to identify displacement of a magnitude that existing grounds might have difficulty in absorbing (in relation to the potential for an increase in level of environmental impact and of conflicts between fishing vessels or gears) — 10% for within the MPA or ICES rectangle; 1% for the wider region, i.e. if the effort displaced from within an ICES rectangle was less than 10% of the total effort in the ICES rectangle (for a particular gear type), then it was assumed that the displaced effort could be absorbed by the remaining fishing grounds within the ICES rectangle (Marine Scotland, 2014b). The economic impact of the value of landings lost was also considered in relation to Gross Value Added (GVA) at different scales, and also the potential impact on the profitability of individual vessels was assessed (Marine Scotland, 2015).

3.5.3 Vulnerability to displacement

The impact that closure of an area has on a vessel will vary between individual vessels and between fleet segments. For example, closure of a particular area may affect 90% of the fishing grounds of one vessel, but only 5% of the fishing grounds of a different vessel. For vessels that are more significantly affected by a closure, the associated economic and social impacts will be proportionally greater, and loss of fishing grounds may contribute to decisions to leave the fishery. The vulnerability to displacement (i.e. potential significance of the loss of an area of fishing ground) depends on:

- Proportion of catch/effort from the MPA;
- Level of specialisation;
- Availability/accessibility of alternative grounds and fishing access (i.e. existing restrictions on fishing gears and vessels, do they have or can they purchase shellfish permits/lease alternative species quota etc.?);
- Size of the vessel, affecting its potential operating range.

Proportion of catch/effort from the MPA

MPAs that will displace fishing effort that represents a high proportion of those fishers' total effort will have more significant impacts on the fishers than those that displace a low proportion of their total effort. Chollett *et al.* (2016) provides a framework to assess this, based on the proportion of the fishing grounds (or fishing effort, or CPUE) that will be closed. Sen (2010) proposes a framework to select appropriate compensation or assistance options for displaced fisheries based on (i) the proportion of the fishers' catch that is from the MPA; and (ii) the exploitation status of the fishery. If a fishery is under-fished, displaced effort may be readily accommodated within the fishery (although it is unlikely that there are many fisheries in English waters that fit into this category). Indeed migration of the whitefish fleet into the shellfish fleet has seen concerns raised regarding the stock status of shellfish (crabs and lobsters) and effort levels that are able to access those stocks[14].

Level of specialisation

A high vulnerability due to the level of specialisation in particular grounds is likely to be reflected as a high proportion of catch or effort coming from the (proposed) MPA. Discussions with fisher representatives on MPA scenarios in the Frisian Front and Central Oyster Grounds fishing areas in Dutch waters highlighted that vulnerability was higher for skippers that specialise in fishing in those grounds (as a result of tradition, historic (not formalised) rights), having built up an in-depth knowledge of the grounds, and the personality of the skipper (risk averse)). They were more likely to be negatively affected as they did not have knowledge of other areas and have a low radius of activity (vessels of limited size/power). These fishers may decide to stop fishing altogether, or if they explore new grounds, this is likely to be initially homogenised/random, until other suitable grounds are identified (Slijkerman & Tamis, 2015).

Availability, accessibility and knowledge of alternative grounds

Some types of vessels or fishing communities are more impacted than others by MPAs. The availability and accessibility of alternative fishing grounds (combined with the proportion of effort or catch that will be affected by the MPA) determines this. Chollett *et al.* (2016) develop the concept of *inherent* mobility (the extent of fishing grounds regularly used, but not to full capacity), and *imposed* mobility (the availability of new unfished grounds). Alternative grounds may be limited naturally, or by constraints imposed by other activities (other marine sectors or conservation priorities). If fishing grounds outside the MPA are already being intensively exploited, or the alternative grounds are too far away, impacts on the fleet will be greater. The most impacted fishers are the ones with few alternative fishing grounds, that cannot easily cope with the additional steaming time to reach other grounds and return (e.g. within a day trip), which greatly affects their overall efficiency by lowering the total fishing time. These vessels will have to extend their time at sea to maintain their revenue and fish closer to the shore to save fuel compared to larger vessels that can travel further, but at the cost of less rewarding catches (Bastardie *et al.,* 2009). Cinner *et al.* (2014) found in Kenya that poorer fishermen may not have the ability or resources to change fishing location or tactics or have knowledge about alternative fishing grounds, increasing their vulnerability to negative impacts from displacement.

[14] www.gov.uk/government/consultations/reducing-unused-licences-latent-capacity-in-the-english-10-metre-and-under-fishing-fleet.

Size of the vessel

The size of the vessel directly influences the availability and accessibility of alternative fishing grounds, based on the potential operating range of the vessel in question. Small inshore day boats have a limited operating range and therefore fewer alternative fishing grounds available to them, than larger vessels with a much greater operating range and the ability to stay at sea for a number of days or weeks. In assessing the loss of grounds due to inshore MPA closures in Scotland, Marine Scotland (2015) considered the proportion of fishing grounds that were affected by closures within 15 nm of each port, reflecting the operating range of the smaller vessels. Displacement of fishing effort further offshore may contribute to driving investment into larger vessels that have an increased operating range and greater fishing capacity (e.g. in terms of number of pots, length of nets etc. that can be deployed, as well as the range of weather conditions in which they can operate).

Cumulative impact of closures and other restrictions

The above factors combine with the impact of other MPA closures, restrictions due to other sectors (e.g. offshore renewable energy installations), fisheries management restrictions, quota restrictions, and other exogenous factors (such as weather conditions, stock dynamics and availability), to determine the overall effect on different fleet segments, and the remaining area that is available for them to fish in. Different fleet segments can be affected differently. For example, in the western Baltic MPAs, Swedish cod trawlers were displaced from the MPA areas and also prevented from fishing in some open areas due to difficult conditions (the MPA boundary was close to a steep slope), which resulted in them stopping fishing in the area. Polish gill netters were not so constrained by the seabed profile and as a result took over the fishing grounds (Suuronen *et al.,* 2010).

3.6 Tools available for assessing displacement

A number of studies have modelled displacement, either to consider the impacts of the displaced effort on the environment (e.g. Greenstreet *et al.*, 2009; Hiddink *et al.,* 2006a), or on fish stocks and fleet economics (e.g. Kjærsgaard & Frost, 2008). Other studies have explored the factors that affect fishers' decisions in where to allocate their effort, independent of MPA-related analyses, but which may nevertheless be usefully applied to an MPA displacement scenario to consider where effort may be reallocated to (e.g. Pascoe & Mardle, 2005; Girardin *et al.,* 2015). There is always a trade-off between the degree to which a model reflects reality and the increasing complexity of incorporating the various factors involved.

There are various tools and approaches available that can be used to assess different aspects of displacement, which have varying levels of complexity in terms of data requirements and expertise in order to apply them, linked to the robustness of their predictive power. A process looking at co-existence between the fishing sector and development of offshore renewable energy indicated that consultation regarding effort displacement should be framed in terms of (de Groot *et al.,* 2014):

- identification of locations where the displaced fishers go;
- assessment of new activity in the displacement area; and
- assessment of changes in the pressure on fish stocks.

Key tools and approaches for assessing displacement and its effects are summarised below.

Assessing the amount of effort that might be affected by a closure

Seafish & UKFEN (2012) provides best practice guidelines for assessing the economic and financial implications of closures on the fishing industry. This was applied in:

- The assessment of the impact of Irish Sea MCZs (Cappell *et al.,* 2012);
- The initial assessment of the impact of Scottish Nature Conservation MPAs (ABPmer, 2013).

Assessing how significant the closure is to the fleet segments affected

The amount of effort (or catch value) affected by the closure (see above) can be compared to the total amount of effort (or catch value) of the fleet segment. It can also be compared to the total amount of effort (or catch value) from the fleet segment from the ICES rectangle, and/or from the wider region. Examples include:

- Chollett *et al.* (2016) provide a framework for assessing the potential for displaced fishing effort to be absorbed, based on the proportion of existing fishing grounds that are affected by the closure, the ability of the remaining grounds to absorb additional fishing effort, and the availability of alternative (new) grounds. This is a relatively simple framework to apply, which does not require huge amounts of data or complex analysis (but the more comprehensive the data available, the better), and can be used in a qualitative manner based on expert judgement to assess the potential severity of displacement on a fleet segment.
- Marine Scotland (2015) carried out a comprehensive analysis of the potential impact of landings value from closed areas compared to: the value from the MPA area as a whole; the value from the ICES rectangle; and the value from the region. Additionally, the impact on profitability of individual vessels was assessed. A non-monetary analysis assessed the proportion of fishing grounds that would be affected, within MPAs, in an ICES rectangle and in a region. Additionally, the proportion of fishing grounds affected within 15 nm of each port (reflecting approximately the range of inshore vessels) was assessed.

Assessing where fishing effort might be displaced to:

- Initially, consideration of the location of alternative fishing grounds, particularly for habitat-restricted fisheries such as *Nephrops* trawling or scallop dredging, can provide an indication of where effort may be displaced to.
- Various behavioural models exist that combine information on past catch rates, revenue, etc., to predict where effort may be displaced to. However, the complexity of behavioural studies mean that there will always be variables that cannot be quantified or modelled, which will lead to uncertainty in the predictions. Examples of such studies include:
    - Greenstreet *et al.* (2009) modelled the effects of fishing displacement in the North Sea by reallocating displaced effort across open ICES rectangles in the same ratios as before MPA introduction. This is a relatively coarse method of reallocating effort, at a large spatial scale;
    - CEFAS (2005) study modelled the displacement of fishing effort;
    - Hiddink *et al.*, (2006), which applied a Random Utility Model (RUM) to beam trawl displacement, assuming that individual fishers selected fishing grounds on the basis of their knowledge of previous catch rates;
    - Hynes *et al.* (2016) used more nuanced habitat information to define fishing grounds, which improved the predictability of behavioural models.

Assessing potential impacts of displaced effort on the environment and fish stocks

Some studies have combined models to predict the redistribution of fishing effort with models of the impact of that effort on the environment:

- CEFAS (2005) and Hiddink *et al.* (2006) applied benthic mortality and production models to a model of displaced fishing effort to assess the impact on the benthic communities.
- Marine Scotland (2014b) considered the potential increase in effort in areas outside closed areas, and used rules of thumb for the ability of the remaining areas to absorb the increased effort.
- Pastoors *et al.* (2000), CEFAS (2005) and Kjærsgaard and Frost (2008) considered the impact of displaced effort on fish stock dynamics.

Assessing the potential impacts of displacing effort on the fleet

Economic models can assess the potential economic impacts of the landings affected, and of displacement of effort, however models usually do not consider increased costs from additional steaming time, changes in CPUE etc.:

- Pascoe and Mardle (2006) assessed the economic impacts of the displacement modelled by CEFAS (2005).
- The DISPLACE model (Bastardie *et al.,* 2015) uses a static approach to evaluate the parts of the fisheries affected by the spatial restrictions through VMS, individual vessel-based bio-economic assessment to predict redistribution of fishing effort (based on catch rates, stock availability, quotas, spatial constraints), assesses the future possible states of the vessels' economic efficiency and robustness to increases in fuel price and the harvested stocks' status, and changes in productivity. The outcome of this in terms of vessel and fleet economic performance (energy efficiency, profitability) and fishing mortality and spawning stock biomass is assessed. In terms of the impacts of displacement on the marine ecosystem, only the type of habitat affected is assessed, and not the impact of the additional fishing effort on benthic communities.

4 Management Measures in MPAs

4.1 Compilation

We compiled information on the latest state-of-play of management measures relating to fisheries in MPAs. There was no centralised data source of MPA-related fisheries management measures in England and this compilation of measures aims to fill this void, providing a useful data source to support Defra and others' future work in the field of MPA management, in particular in order to identify relevant conservation measures that apply to particular MPAs. The full compilation of measures is provided in a separate Excel spreadsheet that can be easily updated as byelaws come into force and new management measures are developed. A summary of the measures is provided in Appendix B.

Measures included in the compilation were byelaws, statutory instruments and voluntary measures which restrict the level of fishing effort on conservation features in MPAs. Legacy byelaws were included in the compilation where they involved closure of areas to types of fishing or limiting the level of fishing effort (e.g. restrictions on vessel size in inshore areas, restrictions on certain gear types in inshore areas).

The spreadsheet is structured by MPA, with a single measure entered multiple times for each MPA that it applies to. This means that the data can be filtered by MPA to identify which management measures apply within that MPA. The spreadsheet includes a field that indicates the date at which the information is correct to (for each entry). As proposed measures progress and are implemented, they can be updated in the spreadsheet.

4.2 Overview

Table 2 provides a summary of the management measures included in the spreadsheet, that have the effect of restricting fishing effort for certain gears or vessel sizes within MPAs or parts of MPAs (SACs, SPAs and T1 and T2 MCZs).

The majority of management measures in MPAs are currently in the inshore area, and within the 6 nm zone (97 measures), most commonly through IFCA Byelaws. At the present time management measures in the 6–12 nm are being developed and to date (April 2017), four byelaws have been introduced. In the offshore area, the introduction of measures is slower due to the need to develop, with other Member States affected, a joint recommendation to the Commission for management measures to be introduced under the CFP. Measures in offshore sites will have a greater impact on fishers with larger vessels that fish for quota stocks and will probably lead to both spatial and species displacement. In addition to impacts on the UK fleet, they will also have potential impacts on other countries' fleets, in particular the Netherlands, Belgium, France and Ireland.

The oldest measures that restrict fishing in MPAs derive from Sea Fisheries Committees (SFC) measures. These were predominantly established for fishery management purposes in the 0–6 nm area, but some have the effect of limiting or prohibiting fishing by certain gear types in areas that overlap with MPAs. The SFC byelaws have been transferred to the IFCAs as 'legacy' byelaws, and all are undergoing review, revocation, revision or replacement as part of a general byelaw review by IFCAs. 39 legacy byelaws were identified that have the effect of restricting effort within MPAs within 6 nm.

With the introduction of the revised approach to managing fisheries in MPAs, a new suite of measures have been, and are being, introduced, which specifically relate to restrictions on fishing in order to meet site conservation objectives for specific features. The 'red-risk' interactions have been addressed (mobile bottom gear on sensitive features such as reefs and seagrass) in the inshore area, and IFCAs are starting to address the 'amber' interactions. There are 69 management measures either in force or being developed, under the Revised Approach. The majority (45) apply to the area within 6 nm (of which 24 are in force and 21 are in preparation) and 17 are being prepared for the area beyond 12 nm. There are seven measures that relate to the 6–12 nm area, of which four are in force. Some of the measures in preparation within 6 nm will result in the repeal of existing measures that are in force.

'Other' measures include IFCA Byelaws that have been developed in order to manage fishery exploitation — not under the Revised Approach — but they have the effect of limiting the level of effort or permitted gear types within MPAs. 13 such byelaws were identified, of which 11 are in force. For the purposes of compiling the spreadsheet of management measures in MPAs, wider fishery-related restrictions beyond IFCA byelaws (e.g. CFP regulations) were not reviewed, therefore this summary does not reflect 'other' measures of this sort, particularly beyond 6 nm.

Table 2. Summary of MPA management measures

Measure type, area	In force	In preparation	Total
Revised approach			
<6nm	24	21	45
>12nm	-	17	17
6-12nm	4	3	7
Subtotal	*28*	*41*	*69*
Legacy			
<6nm	39	-	39
Subtotal	*39*	-	*39*
Other			
<6nm	11	2	13
Subtotal	*11*	*2*	*13*
Grand Total	**78**	**43**	**121**

5 Case Studies on Displacement

Five case studies were selected for a more in-depth analysis of displacement, based on information from the literature review and the compilation of information on management measures. The case studies are (see Figure 4):

1. Lyme Bay;
2. Berwickshire and Northumberland Coast SAC;
3. Cardigan Bay SAC;
4. The Plaice Box;
5. Western Baltic MPAs.

Figure 4. Map of case studies' locations

5.1 Case Study 1: Lyme Bay

5.1.1 Background

Lyme Bay is located in south-west England, UK and comprises a mosaic of substrates from sand, mud and gravel to rock and mixed ground. Traditionally within Lyme Bay, fishers towing mobile demersal gear (otter trawls, beam trawls, scallop dredges) avoided the rocky areas and fished on the mixed sediment areas (sands, gravels, cobbles) between the rocky reefs, while static gear fishers placed pots in the rocky areas to catch crabs and lobsters (Rees *et al.* 2016). The Lyme Bay Statutory Instrument[15] (SI) was made in 2008, implementing a mobile demersal gear closure in Lyme Bay to protect the temperate reef communities (Defra, 2008). This expanded the previous voluntary exclusion areas around specific reefs at Saw Tooth Ledges and Lanes Ground which had been agreed by local stakeholders. The voluntary closures encompassed an area approximately 10.3 km^2, whereas the SI closed an area over an order of magnitude larger at 206 km^2. Further areas that relate to the SAC were closed through the 2013 Southern IFCA Bottom Towed Fishing Gear Byelaw[16] and the 2013 Devon and Severn IFCA Mobile Fishing Permit Byelaw[17] (Figure 5).

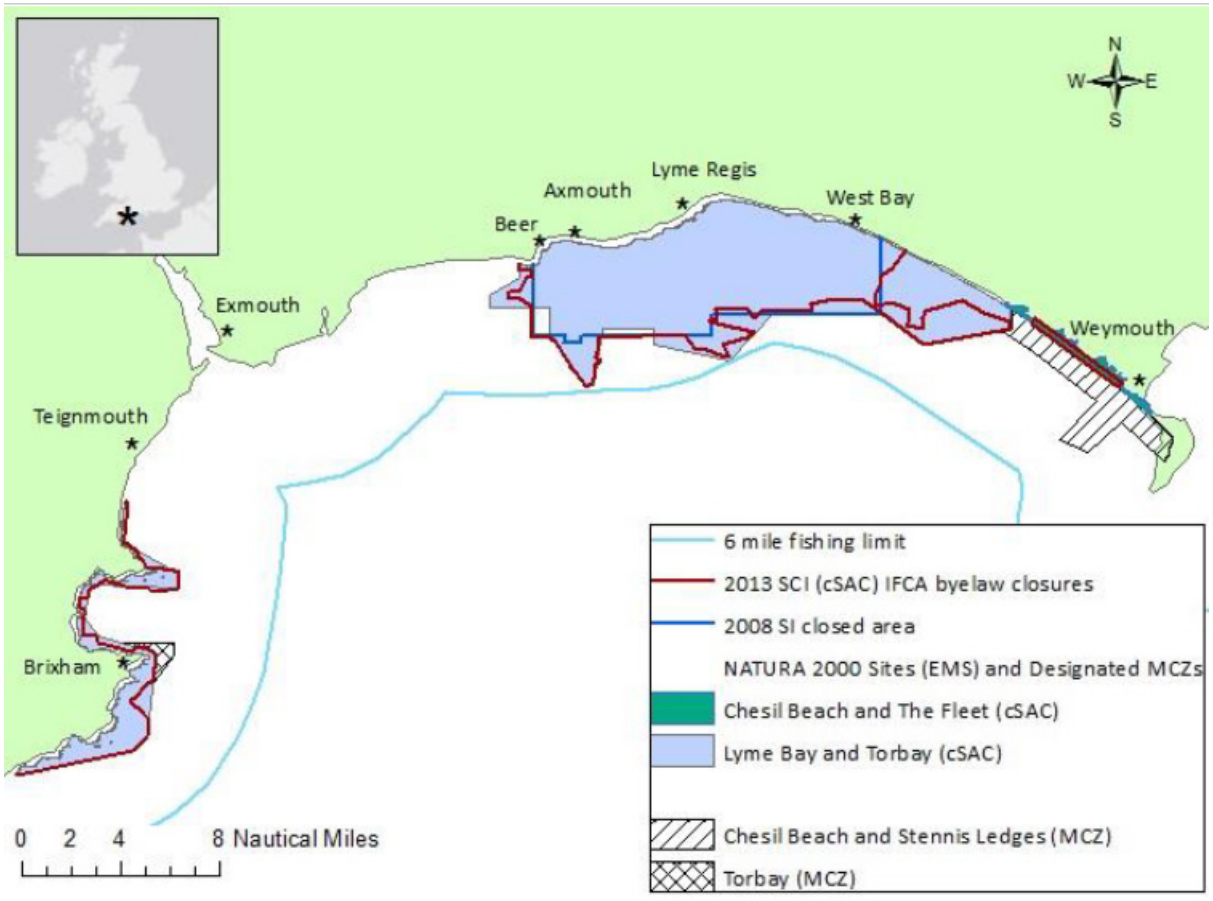

Figure 5. Lyme Bay MPAs, excluding transitional waters (candidate SACs, designated MCZs, IFCA Byelaws and the 2008 SI closure.

Source: Rees *et al.*, 2016.

15 www.legislation.gov.uk/uksi/2008/1584/pdfs/uksi_20081584_en.pdf.
16 www.southern-ifca.gov.uk/byelaws.
17 www.devonandsevernifca.gov.uk/byelaw_review_.

5.1.2 Fishing sectors affected

Dredging for shellfish and demersal trawling were excluded from across the inshore reefs, but the use of static fishing gear (pots, nets), hand-diving for scallops and recreational activity remained permitted.

5.1.3 Observed displacement effects

Before the SI closure, the number of mobile gear fishing trips per month was slightly higher inside the closed area than those made to outside the closed area, highlighting the importance of this fishing ground to the mobile gear fleet. Between 2005 and 2014, the number of mobile gear vessels actively fishing outside the MPA increased from 10 to 16 vessels per month, likely due to displacement of mobile trawl and dredge effort from the MPA to grounds outside it. Additionally, there was an increase in effort required from the mobile fleet to achieve landings and value of catch comparable to when access was permitted within the MPA (Rees *et al.,* 2016). In 2005/2006 (prior to the SI closure), there was an average of 35 and 41 trips per month inside and outside the reserve respectively, compared to 85 trips per month (outside the reserve) after the SI closure in 2013/2014). This peaked at 101 trips per month in 2012/2013 (a 33% increase on pre-SI effort levels within the ICES rectangles considered). The data on effort levels are confounded by the possible presence of visiting mobile gear vessels from outside the region prior to the SI closure, and the possible displacement of effort to other areas outside of the ICES rectangles studied.

A significant increase in potting effort occurred in the Lyme Bay area after the mobile gear closure was implemented[18]. There has been minimal change in the number of static gear vessels operating within the MPA when compared before and after the SI closure came into force (Rees *et al.,* 2016); the increase in static gear effort that occurred within the MPA was a result of increasing effort by the existing static gear fishermen, rather than displacement of trawl/dredge effort to other gear types (Mangi *et al.,* 2011). There are likely to be various barriers to switching gear type, such as the size (especially when small) or design of vessel which may mean it cannot safely or readily change methods of fishing without a large capital outlay, or it may not be possible to use a vessel for alternative methods of fishing due to the specialised equipment used. The opportunity for mobile fishing gear vessels to change over to potting for crustaceans is limited (DSFC 2008, cited in Mangi *et al.*, 2011).

In addition to the increase in crab and lobster pots, there was also an increase in whelk potting in the MPA, which led to a 'boom and bust' cycle of the fishery. The whelk potters subsequently moved from Lyme Bay to the Kent and Essex region (Tim Robbins, *pers. comm.*), with an increase in effort in that region prompting the introduction of an emergency whelk byelaw there in 2011[19]. An emergency whelk byelaw was subsequently introduced in the Eastern IFCA area (adjacent to Kent and Essex IFCA district) as well in 2015[20]. Recreation participants and providers have also increased their use of the MPA (Rees *et al.*, 2016).

The initial increase in mobile demersal effort outside the MPA after its implementation decreased over time (Vanstaen & Breen, 2010), perhaps reflecting the nomadic nature of the scallop fleet which exploits scallop grounds around the whole of the UK — some scallop fishing effort that was displaced subsequently moved to waters in the north-east of England (Tim Robbins, *pers. comm.*), and Cardigan Bay (see Case Study 3, section 5.3). This highlights that consideration of displacement of effort should not be restricted to the area immediately surrounding the MPA, but should also consider potential impacts at a wider spatial scale.

[18] Based on anecdotal reports from local fishermen, IFCA sightings data and MMO VMS data, cited in www.lymebayreserve.co.uk/conservation-and-science/research.php.

[19] www.kentandessex-ifca.gov.uk/wp-content/uploads/2014/05/B41.pdf.

[20] www.eastern-ifca.gov.uk/emergency-whelk-byelaw-2/

There was also a marked increase in vessels using static gear outside the MPA from 29 vessels in 2005/06 (before the SI closure) to 61 vessels in 2013/2014 (after the closure) (Vanstaen & Breen, 2010; Rees *et al.* 2016). Rees *et al.* (2016) speculated that the increase in static gear effort both inside and outside the reserve indicate that there were other factors supporting static gear fisheries in the Lyme Bay region, such as availability of species or markets, as well as the influence of selective gear spatial management measures, and the spatial measures that comprise the reserve may have been influencing where static gear fishermen choose to fish and may have attracted fishermen from other areas. They also noted that as there is no statutory requirement for fishermen to declare their catches for 10 metre and under vessels, and the level of voluntary declarations may have increased or decreased over the years, the data may not reflect actual landings and spatial effort.

Value of landings, pooled for fishing locations both inside and outside the reserve, for mobile (towed) gear fishermen decreased significantly from the two ICES rectangles, from a peak of approximately £24,561 in 2005/2006 to approximately £6,056 (mean per vessel per month) in 2013/2014. Meanwhile, landings for static gear vessels increased significantly from £5,411 in 2005/2006 to £7,267 (mean per vessel per month) in 2013/2014 (Rees *et al.,* 2016).

5.1.4 Impacts of displacement

The implementation of the closure to mobile demersal gears has protected the reef feature from potential damage from scallop dredging. Surveys have shown that within three years, positive responses were observed for species richness, total abundance, assemblage composition and seven of 13 indicator taxa studied (Sheehan *et al.*, 2013).

However, the displacement of fishing effort had impacts both outside and within the MPA.

Impacts of displaced effort outside the MPA

Static gear fishermen who fished outside the Lyme Bay closed area reported increased conflicts with towed gear fishermen who were displaced from the MPA to their traditional grounds (Mangi *et al.,* 2011). However, Rees *et al.* (2016) suggested there has also been a significant increase in effort from vessels using static gear outside the MPA. Fishermen using towed gear have been forced to look for other grounds outside the closed area, some of which are not as productive as those in the closed area. Over 80% of towed gear fishermen reported an increase in steaming time, leading to longer hours (Mangi *et al.*, 2011).

Impacts of increased static gear within the MPA

The implications of the increase in static gear pressure on the seabed inside the MPA are uncertain. A Potting Intensity Study has been undertaken to understand the potential seabed impacts of the increase in potting intensity, but it is as yet uncertain whether there is any effect of increasing potting intensity on the condition of the benthic communities (Adam Rees, *pers. comm.*). A further study into the impacts of potting within the MPA concluded that whilst potting does have some negative impact on some individual taxa, overall it should not negatively impact assemblage composition (Gall, 2016).

5.1.5 Conclusions

This case study highlights the importance of considering the potential impact of displacement of fishing effort, on those fishers affected (increased steaming time, reduced catch rates), and the fishers in the grounds to which they are displaced (increased gear conflict). The displacement of effort from the MPA may result in an increase in the effort of permitted gears within the MPA, resulting in potential impacts on the environment as well as increased conflict. Fishing effort may move considerable distances, especially in the case of more nomadic fleets (e.g. scallopers), but also for smaller-scale vessels such as whelk potters, which may change home port. Therefore it is important to consider such impacts at a wider spatial scale than just the immediate surroundings of the MPA.

5.2 Case Study 2: Berwickshire and North Northumberland Coast SAC

5.2.1 Background

The Berwickshire and North Northumberland Coast (BNNC) SAC (Figure 6) was proposed as a Site of Community Importance (SCI) and designated as a SAC in 2005. The BNNC was selected for the presence of reefs, intertidal sand and mudflats and sea caves; sea inlets and bays and seals were added later. Under the Marine and Coastal Access Act of 2009, management of MPAs within 6 nm passed to the new IFCAs, in this case the Northumberland IFCA.

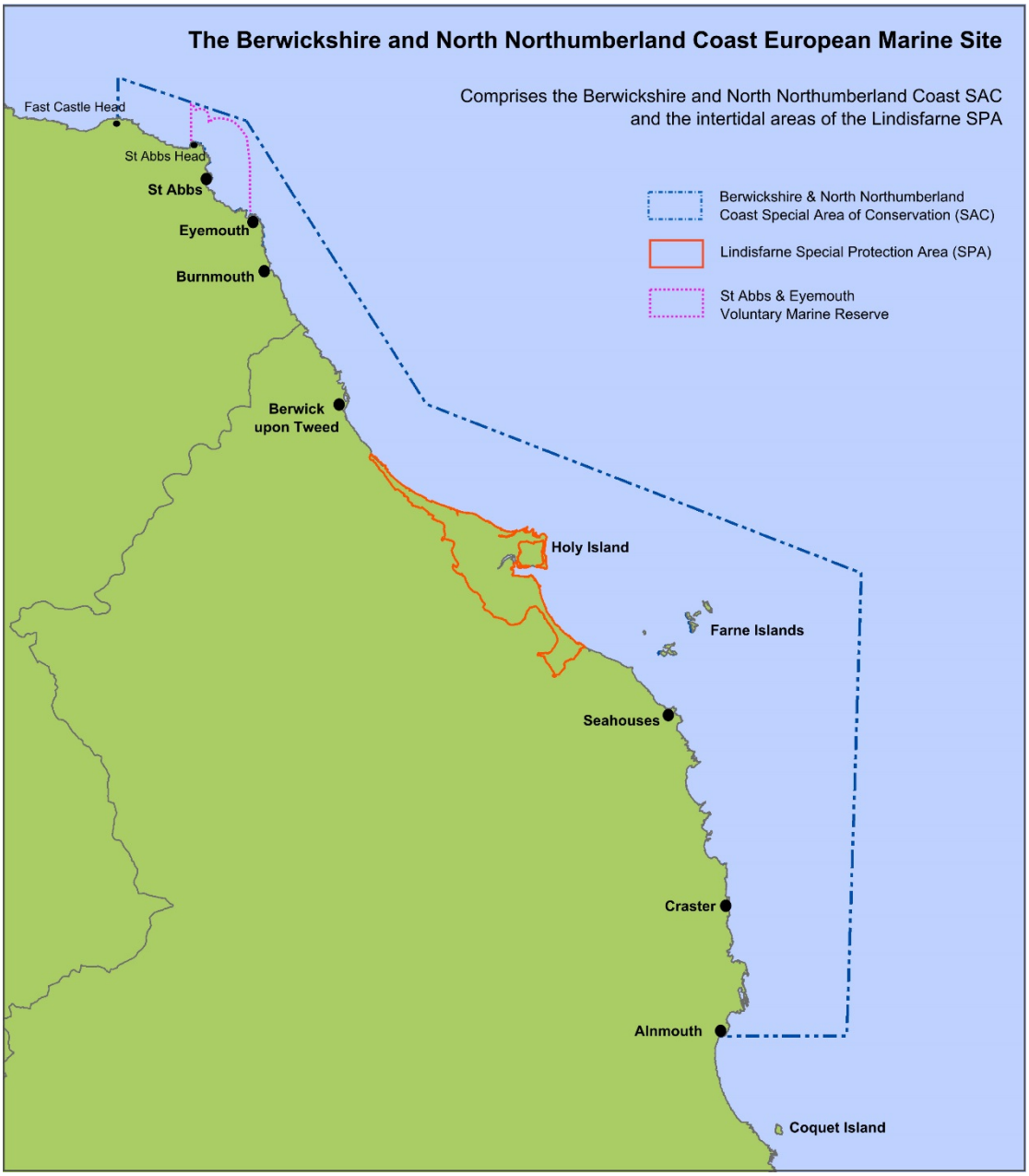

Figure 6, Berwickshire and North Northumberland Coast SAC

The reefs for which the BNNC were designated were identified as 'red risk' features under the Revised Approach, requiring protection; this led to the introduction of management measures in 2014 through the Northumberland IFCA Byelaw 7[21], 'Prohibition of the use of Mobile Fishing gear within the English section of the Berwickshire and North Northumberland Coast Special Area of Conservation (SAC)'. The Byelaw applies, to 'any dredge, trawl or similar device that is designed to be towed or pushed to take any Sea Fisheries Resources on the seabed' (Article 1(d)).

The addition of seagrass to the list of protected features led to a further Byelaw 8, 'Seagrass Protection Byelaw within the English section of the Berwickshire and North Northumberland Coast Special Area of Conservation (SAC)'[22], being introduced, also in 2014. This Byelaw specified that 'no person shall dig for, fish for or take any sea fisheries resources in, or from, the Specified Area where Seagrass is situated'. There is, however, an exemption for fishing with nets, rod and line, hook and line and fishing that does not involve contact with the seabed.

5.2.2 Fishing sectors affected

All mobile demersal gears (trawls and dredges) are affected by Byelaw 7. There were, however, already restrictions on trawling in place which limited trawling within the Northumberland IFCA area to vessels under 12 metres in length.

It should be noted that according to anecdotal evidence, there was little trawling for whitefish taking place within the area when the SAC was first mooted – apparently it was ground that was occasionally used on a rotational basis. The decline in the cod fishery, which was particularly noticeable from 1998 onwards, and the resulting restrictions, were already leading to changes in fishing patterns as fishermen increasingly targeted *Nephrops*. Commercial fishing vessel decommissioning schemes in 2001, 2003 and 2007–2009 have also encouraged the reduction in demersal trawling for whitefish. Whilst drift netting and lining were not affected by the seagrass restrictions, potting is not permitted.

5.2.3 Observed displacement effects

Due to the restriction on vessel size in the Northumberland IFCA area, only vessels under 12m length would have been affected by the establishment of management measures in the BNNC SAC. The fact that relatively little whitefish trawling previously took place in the SAC will have limited any direct displacement effects of the SAC itself. However, the case study highlights two displacement effects which may have been compounded by the BNNC SAC:

- Firstly, there has been a displacement of effort to different species (cod to *Nephrops*) in the North Sea fisheries in general, which is partially linked to the decline of the cod fishery, but will also have contributed to displacement of activity outside the SAC to areas more conducive to *Nephrops* fishing;
- Secondly, Northumberland IFCA officers have noted displacement of scalloping activity into the Northumberland IFCA area from the North Eastern IFCA area in response to the introduction of closed areas there, and vessels have been observed fishing intensively along the boundary of the SAC.

[21] www.nifca.gov.uk/wp-content/uploads/2013/02/Byelaws-Jan-2017.pdf.
[22] www.nifca.gov.uk/wp-content/uploads/2013/02/Byelaws-Jan-2017.pdf.

5.2.4 Impacts of displacement

Evidence of the impact of displacement of activities tends at the present time to be limited to anecdotal evidence since most vessels in the area have not been subject to VMS requirements. Information is drawn from communication with Northumberland IFCA officers, based on sightings.

It would appear that nomadic scallopers from outside the area are fishing intensively along the line of the SAC and are exerting pressure on stocks. The level of activity is such that there is gear conflict leading to increased pressure on any alternative areas for local fishermen with potential implications for stock levels there as well (Northumberland IFCA, *pers. comm.*).

The increasing fishing effort on the Farne Deeps *Nephrops* grounds (potentially due to displacement of effort from cod to *Nephrops*, and additional displacement from the BNNC SAC area) may have contributed to the recent advice to reduce *Nephrops* catches in the Farne Deeps, Functional Unit 6[23].

5.2.5 Conclusions

The BNNC SAC highlights a number of issues in relation to the management of MPAs and displacement of fishing effort:

- Implementation of management measures within an MPA can result in the displacement of fishing effort to other areas. The potential for displacement of fishing effort and its implications therefore needs to be considered in the development of management measures. Displacement may occur beyond the immediate vicinity of the MPA and may cross management or regulatory jurisdictional boundaries. Communication and coordination between regulatory authorities is therefore desirable.
- Due to there being no requirement for VMS on vessels under 12m length, and no statutory requirement to declare catches for vessels 10m and under, data on the activity of these vessels are typically less robust than for larger vessels. In order to gain a better appreciation of the level of displacement – particularly at a time when quota stocks are recovering in a number of areas – more needs to be known about the activities of the 10 metre and under fleet. The introduction of a requirement for iVMS or a similar system, coupled with sensors to identify fishing activity (e.g. gear in/gear out), would facilitate this.
- The natural variability and inter-related nature of mixed fisheries means that it is difficult to construct a counterfactual scenario as to what would have happened if the measures had not been taken. In addition, fishers' displacement response to management measures in MPAs could be affected by quota availability (including the potential for increasing quotas as MSY is approached), prices and market demand.
- The distinction between quota and non-quota stocks means that the potential risk of displaced activity is greater for non-quota stocks where there are fewer barriers to entry into the fishery and no restrictions on overall catches, compared to stocks which have quotas that are being reduced in order to facilitate recovery.
- Northumberland IFCA is currently preparing a possible amendment to Byelaw 7, opening up certain areas within a previously closed area as more evidence becomes available. This is important for evidence-based management and displacement should be considered within an adaptive management context.

[23] www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/nep-6_reopen.pdf.

5.3 Case Study 3: Cardigan Bay SAC

5.3.1 Background

Cardigan Bay was first considered as a SAC in 1995 on account of the presence of bottlenose dolphins. In 2004 it was officially designated as a SAC[24] for sandbanks, reefs and sea caves as well as bottlenose dolphins. Management measures were introduced in 2010 through the Welsh Statutory Instrument 2010 No. 269 (W.33) – The Scallop Fishing (Wales) (No.2) Order 2010[25].

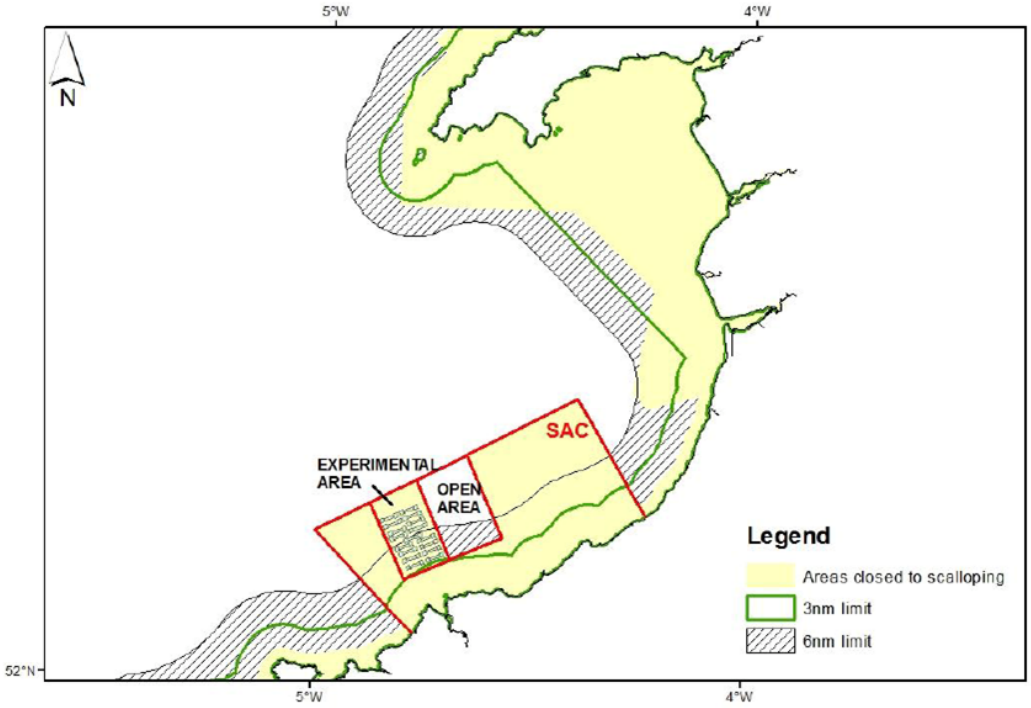

Figure 7. Cardigan Bay SAC

5.3.2 Fishing métiers affected

The measure applied to all commercial vessels fishing for king scallop regardless of vessel length or engine power. In particular the local day vessels which predominated in the area were affected. The Welsh Statutory Instrument applied to Welsh waters (out to 12 nm) and restricted commercial vessels fishing for king scallop to a power output not exceeding 221 kW. There was a further closure from 1 May to 31 October which applied to all fishing for king scallop, including diving. There was a graduated series of exclusion measures applicable to vessels fishing for scallops:

- A total exclusion zone of 1 nm from the baseline was introduced to apply to all British fishing vessels targeting scallops;
- Between 1 and 3 nm, vessels were limited to under 10 metres towing no more than a total of 6 dredges;
- Between 3 and 6 nm, vessels were restricted to no more than a total of 8 dredges;
- Between 6 and 12 nm, vessels were restricted to a total of 12 dredges;
- There were also restrictions on tow bar lengths within the different zones.

[24] www.cardiganbaysac.org.uk/?p=554.
[25] www.legislation.gov.uk/wsi/2010/269/contents/made.

Notwithstanding all these restrictions, Article 12 of the SI set an outright prohibition on dredging for king scallop in those areas identified in the Schedule, which specifically mentions Cardigan Bay SAC. There is, however, an exemption which allows a specific area of the SAC, known as 'the Kaiser Box', to open from 1 November to 30 April, chiefly for scientific purposes.

Following the Scallop Dredging Operations (Tracking Devices) (Wales) Order 2012[26], there is also a requirement for all scallop fishing vessels to carry a tracking device, iVMS, to enable vessel monitoring to take place.

5.3.3 Observed displacement effects

Displacement has taken two forms. Firstly, there was concentration of scalloping into the small areas that were not closed. This contributed to the stock being over-fished. Conversely, within the SAC the lack of fishing pressure has meant that there has been an over-abundance of king scallop, impacting negatively on the stock through over-crowding (Welsh Government, 2015). Secondly, in the period from 2012 to 2015 there was an influx of nomadic scallop-fishing vessels into Welsh waters. Over this period 32% of vessels were English. Anecdotal evidence suggests that these vessels were displaced following the closure of Lyme Bay. As a result, the Welsh Authorities recognised that the number of vessels had increased and that economic returns were declining (Natural Resources Wales, 2016).

5.3.4 Impacts of displacement

Within Welsh Waters, as a partial response to displacement, revised management measures for the scallop fishery were announced on 31 October 2016 as more scientific evidence on natural disturbance within certain areas of the SAC was established and monitoring of activity was possible (Welsh Government, 2015; Welsh Government, 2016). It is noticeable that there has been a clear reduction in the number of vessels from other countries that were active in the area in 2015, particularly England, Northern Ireland and Scotland, as the stocks outside the SAC came under increased pressure and economic returns declined. In the public consultation relating to the new management measures some respondents claimed that enforcement against nomadic scallop vessels was less than effective (Welsh Government, 2015).

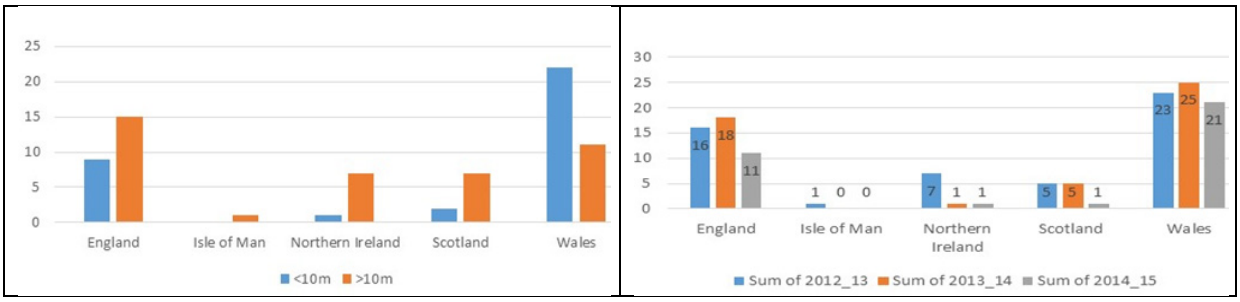

Figure 8. Number of vessels by country fishing for scallops in Wales, 2012-2015, by over-10m and 10m and under (left); by year (right).

Source: Natural Resources Wales, 2016.

[26] C.f. Explanatory Memorandum to the Scallop Dredging Operations (Tracking Devices) (Wales) Order 2012.

5.3.5 Conclusions

The evolution of management measures within the Cardigan Bay SAC provides a useful commentary on the effects of displacement. Total closure threatened the fisheries that existed by placing additional fishing pressure on those areas that remained at least partially open. Displacement of non-quota fisheries from within Welsh Waters and elsewhere as a result of other closures and management measures threatened the viability of local fishery communities.

The Welsh Government has been able to mitigate this situation due to two developments:

- The availability of new scientific information has enabled some areas of the SAC to be opened to fishing whilst ensuring the conservation objective of the designated features is maintained;
- The evolution of technology has improved the ability of the authorities to monitor activities and thus manage activities at a more precise scale through iVMS systems with frequent data transmissions.

5.4 Case Study 4: The Plaice Box

5.4.1 Background

The Plaice Box was a fisheries management closure implemented in 1989 (EU Council Resolution 4193/88), encompassing an area of c. 42,000 km^2, of which 24,000 km^2 is within the 12 nm zone (Figure 9) (Beare *et al.,* 2013). Initially it was a seasonal closure but from the 4th quarter of 1994 it was closed permanently (Regulation (EC) No 850/98). The purpose of the Plaice Box was to protect spawning grounds and thus ensure sustainable stock levels of plaice (Kjærsgaard & Frost, 2008).

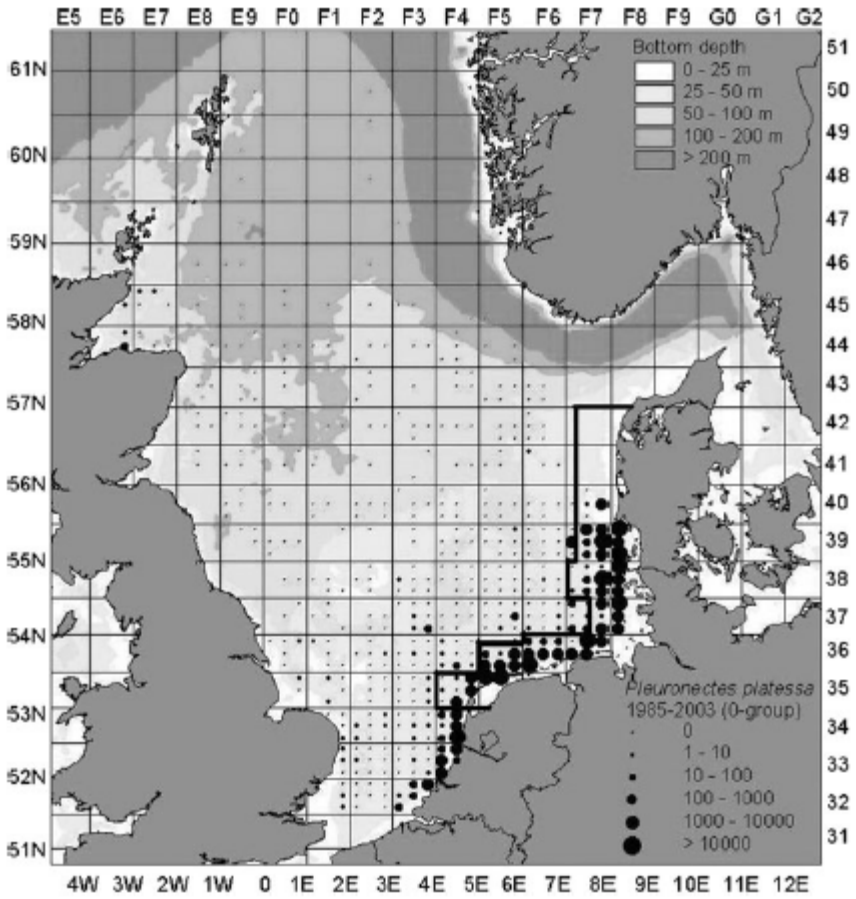

Figure 9. **The plaice box (solid black line) and spatial distribution of juvenile plaice in the North Sea**

Source: Kjærsgaard & Frost, 2008.

5.4.2 Fishing métiers affected

The North Sea flatfish fishery, targeting sole and plaice, is conducted primarily by Dutch, British and Danish vessels, with small catches by vessels from Germany, Belgium and others.

Demersal trawlers exceeding 221 kW engine power were excluded from the Plaice Box. Smaller whitefish trawlers such as beam trawlers and shrimp trawlers of under 221 kW power were permitted to continue fishing within the area, as they were considered to have no alternative to fish further away from their ports. The Plaice Box effectively extended their exclusive fishing area in the 12 nm zone by 75% (Beare *et al.,* 2013).

5.4.3 Observed displacement effects

An evaluation of fishing effort before and after the implementation of the plaice box was conducted by Beare *et al.* (2013). They found that after the closure of the Plaice Box:

- Fishing activity within the Plaice Box by some fleet segments intensified;
- Total fishing effort by Dutch beam trawlers inside the Plaice Box fell in 1989-1994 (during seasonal closures) to 15% of the pre-box level, and to 3% in 1995-2008 (after permanent closure), and showed higher levels of activity along the borders of the Plaice Box (Rijnsdorp *et al.,* 1998);
- Danish gill netters and trammel netters expanded their fishing effort rapidly inside the Plaice Box after closure to the large vessels;
- Shrimp trawlers also increased their fishing effort within the Plaice Box;
- Small vessels (otter and beam trawl) targeting sole and plaice partly fished in the same areas as the large vessels *outside* the Plaice Box, despite the fact that they had the right to continue fishing *inside* it. The Plaice Box became less important to these fleets from 2000. This was explained by the general movement of plaice to deeper waters outside the Plaice Box, as a result of warming temperatures in the North Sea, thereby undermining the usefulness of the closure for its intended purpose.

5.4.4 Impacts of displacement

Inside the Plaice Box, there was an increase in epibenthic predators due to reduction in fishing mortality from beam trawling (Beare *et al.,* 2013). The impact of the displaced fishing effort on the environment outside the Plaice Box has not been assessed. NSRAC (2005) indicate that there was evidence that discard rates had increased in the waters adjacent to the Plaice Box, although this may be due to the offshore movement of juvenile plaice rather than a result of displaced effort.

Despite the implementation of the Plaice Box, yield and spawning stock biomass continued to decrease (Pastoors *et al.,* 2000), which some parts of the fishing industry attributed to reduced productivity of the area due to the removal of trawling. However, the decrease in importance of the Plaice Box to the fleets that were permitted to fish within it from 2000 coincides with a decrease in food availability both inside and outside the Plaice Box. The offshore shift in distribution of juvenile plaice, and decrease in the growth rate of juveniles was not due to the implementation of the Plaice Box but due to wider environmental changes in the North Sea (increasing temperature, reduced nutrient inputs) (Beare *et al.,* 2013). Although Pastoors *et al.* (2000) did not rule out a possible feed-back mechanism between the distribution of beam trawling and stock effects. The subsequent increase in the plaice stock more recently is attributed to general North Sea-wide reduction in fishing mortality, due to substantial decreases in fishing effort (Beare *et al.,* 2013).

5.4.5 Conclusions

The Plaice Box resulted in a displacement of effort by large beam trawlers to areas outside the closed area, some of which was concentrated close to the boundary of the area. The removal of large beam trawlers from the area led to an increase in effort from small shrimp trawlers, and the Danish gill netters and trammel netters. Smaller flatfish trawlers, although they were permitted to fish inside the area, over time began to direct more effort outside of the Plaice Box due to the movement of the plaice stock. The impact of displacement on the plaice stock is inconclusive, and the impact on other fish stocks and of the wider marine environment has not been assessed.

5.5 Case Study 5: Western Baltic MPAs

5.5.1 Background

High abundance of the eastern Baltic cod in the 1980s led to substantial investments and over-capitalisation of the fleets, and when catches decreased dramatically, a seasonal fishing ban was introduced during the summer spawning months (early June to late August) (Suuronen *et al.*, 2010). In spring 1997 the summer ban was completed with an area closure ('box closure') enforced for all fishing activities from mid-May to the end of August in the Bornholm Deep ('Bornholm MPA') through a resolution of the International Baltic Sea Fishery Commission (IBSFC). In 2004 the Bornholm MPA was extended further to the east and south-east and in January 2005 it was expanded northwards and enforced year-round under CFP Regulations. Additional year-round MPAs were introduced in 2005 in the Gdansk Deep and in the southern Gotland Deep (Figure 10).

5.5.2 Fishing métiers affected

All commercial fishing activities were banned in the MPAs, but those most affected were the cod trawl fisheries for which these were important fishing grounds.

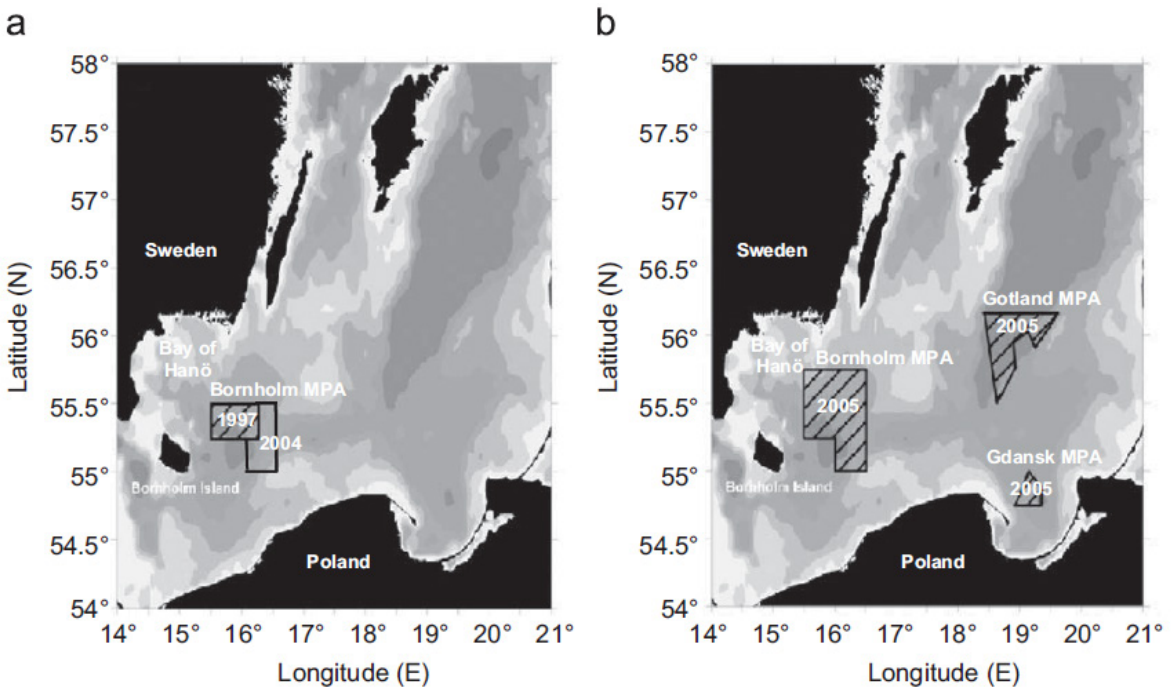

Figure 10. **MPAs and their introduction years in the Baltic Sea Main Basin: (a) the Bornholm MPA 1997–2004 (b) the Bornholm MPA, Gdansk Deep and in the southern Gotland Deep in 2005.**

Source: Suuronen *et al.*, 2010.

5.5.3 Observed displacement effects

Demersal and pelagic trawl activity was gradually displaced by the Bornholm MPA that enlarged eastwards and northwards in the Bornholm Deep. The Swedish cod fishery gradually concentrated towards the Bay of Hanö and the northern and eastern boundaries of the Bornholm Deep MPA (Figure 11).

The south-westward concentration of effort was mainly due to the concentration of the shrinking cod stock into the most favourable grounds. Over the same period, the number of active vessels in the fleet decreased more than 50%, and the average landed catch per trip decreased by 50% (in all gear types). The total fishing effort declined to 48% of that in 1996, but the average number of trips per year by demersal trawlers increased by almost 100%.

The pelagic cod fleet was displaced to the western side of the Bornholm Deep MPA, and some effort displacement of pelagic herring/sprat vessels also took place to the same area, increasing harvest overlaps between the two fleets.

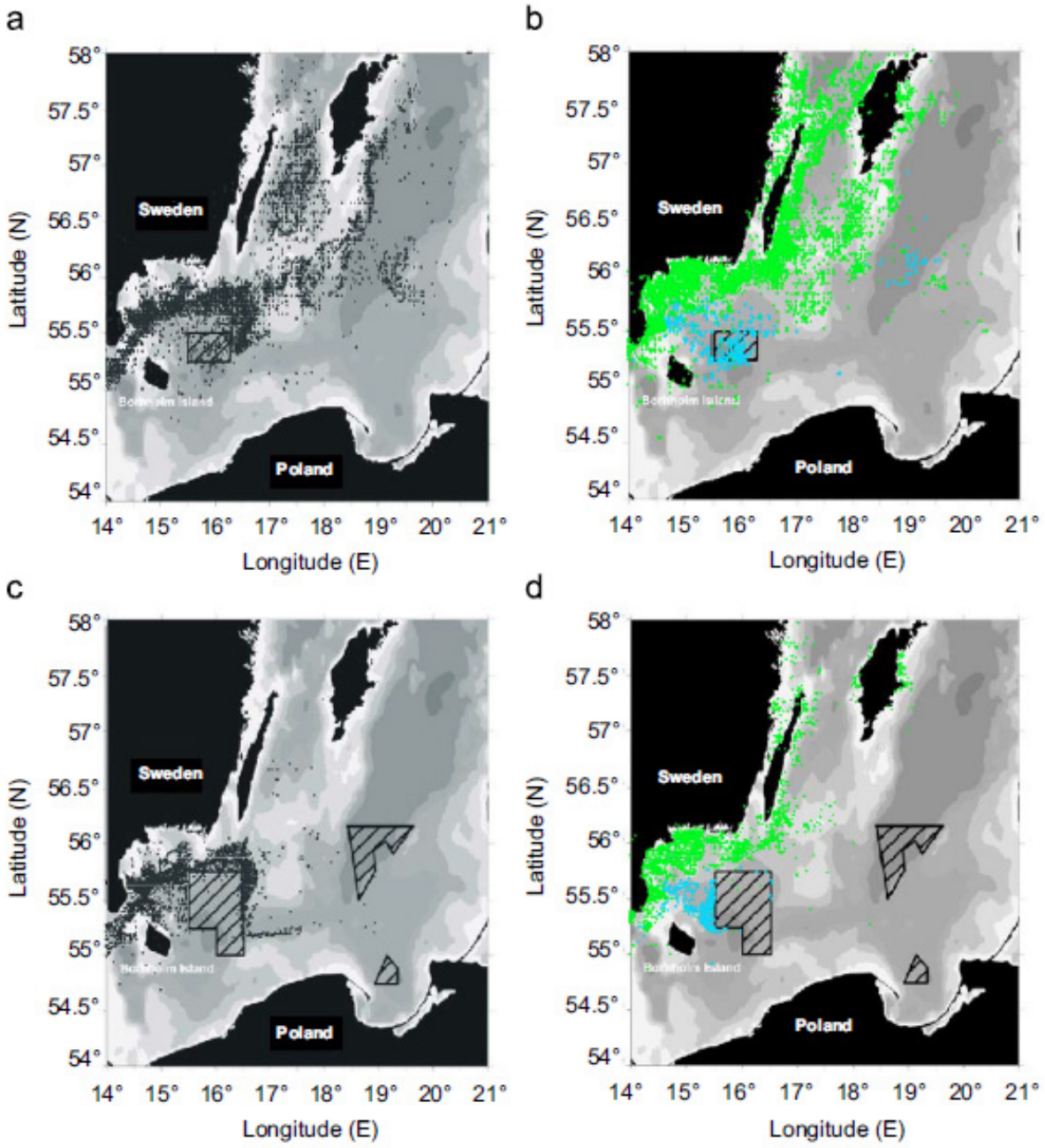

Figure 11. **Swedish cod fishermen's location choice in 1996 (a, b) and in 2005 (c, d). Black dots = demersal trawl, blue dots = pelagic trawl, and green dots = gill net.**

5.5.4 Impacts of displacement

The displacement of the pelagic vessels targeting cod to the western side of the Bornholm MPA has, according to fishermen, resulted in higher capture and discarding of undersized cod. ICES reported that total discards in weight in 2006 were approximately three times higher than in the previous two years. Although this was partly caused by the relatively strong 2003 year class in cod, it is likely that the enlarged Bornholm MPA caused additional discarding (Suuronen *et al.,* 2010).

Additionally cod trawlers and pelagic herring/sprat trawlers were forced to operate in less favourable fishing grounds, and the overlapping harvest areas reduced the catch rates of both fleets, reducing the profitability of harvests and increasing the by-catch of juvenile cod (Suuronen *et al.,* 2010). Also the less favourable ground conditions resulted in increased wear and tear on the demersal fishing gear.

The eastern boundary of the Bornholm Deep MPA was positioned only a few miles from a steep slope, which significantly narrowed the traditional fishing area of the Swedish trawlers. Due to the limited area available for fishing and the steep slope, the trawlers had difficulty operating their gears there, and Polish gill netters took over the profitable fishing grounds in that area (Suuronen *et al.,* 2010).

5.5.5 Conclusions

The MPAs displaced fishing effort, resulting in intensified competition between different fleet segments, causing gear conflicts and additional fleet displacement. The MPAs affected different fleet segments (and in this case, different countries' fleets) differently, with the trawl segment being particularly affected, and trawl effort was replaced by gill netting effort on some fishing grounds.

Fishing effort was displaced to areas of higher juvenile abundance, likely resulting in increased catches and contributing to increased levels of discarding of juvenile cod that were observed in 2006 compared to the previous two years.

6 A method for Assessing Displacement

The method for Assessing Displacement, with an accompanying template for recording the outputs of an assessment, is provided in Appendix C. The findings of the testing and feedback process, and resulting changes to the method and template are summarised in Table 3.

Table 3, Outcomes of testing and feedback on the guidance and template

Issue	Outcome
The method allowed the main displacement impacts to be identified.	No change required.
The flow of the questions was clear and logical.	No change required.
The method is very long, with lots of detail, and the detailed data requirements are too much (not always achievable).	Clarified the basic information needs, and more in-depth / advanced possibilities, which may not be possible to fulfil at the present time, or for all assessments. Also clarified that 'not known' or 'not possible to assess' is a valid response where appropriate.
Structure of assessment – proposal for two-stage process (similar to screening and test for likely significant effect in HRA process).	Split the assessment process to clearly separate the initial assessment of whether displacement is likely to be significant or to cause significant effects, and the subsequent more in-depth assessment of the nature and consequences of displacement.
Displacement is already considered as part of MPA assessments.	Re-framed the guidance in terms of being one part of an overall assessment that would be carried out.
Minor additions and improvements.	Additional considerations (e.g. potential for increased infringements), adjustment of language and examples, addition of other information sources.

7 Monitoring and Research Needs

7.1 Identification of Monitoring Requirements

Monitoring requirements are multifaceted. Principally, monitoring is necessary in order to provide evidence on which to conclude on the success (or otherwise) of the management in delivering the MPA Conservation Objectives. It can also provide evidence to support a wider understanding of the influence of the MPA, and its fisheries displacement effects, on the marine environment as well as on social and economic issues for affected activities such as commercial fisheries.

Where Adaptive Risk Management (ARM) is applied, monitoring of the level of effort in relation to trigger points, and taking action to limit effort if required, should form part of the Monitoring and Control Plan for a site, and be implemented on a regular/ongoing basis. Monitoring against MPA conservation objectives and broader environmental parameters (e.g. MSFD descriptors) may be required on a less frequent basis (i.e. in line with the 6-yearly conservation objective review cycle and/or MSFD review cycle) (Figure 12).

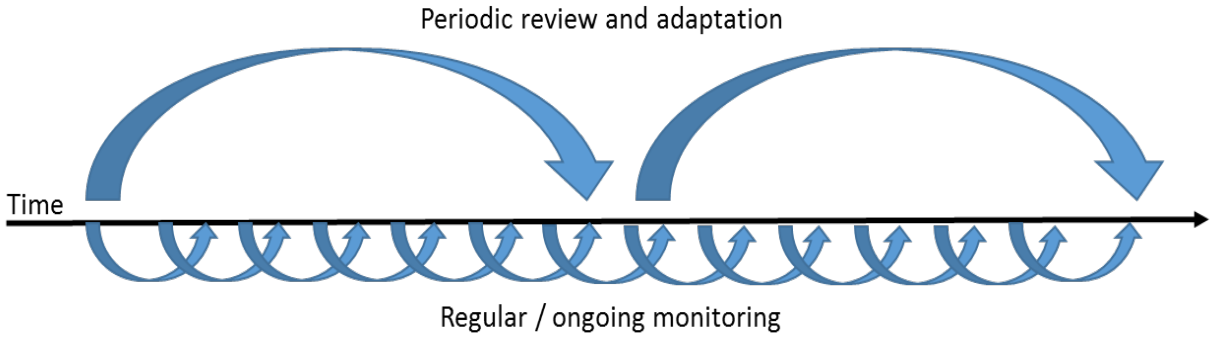

Figure 12. Regular monitoring and periodic review and adaptation of management

Management of the marine environment (and of commercial fishing following CFP reforms) is underpinned by the ecosystem approach, which includes the principle of adaptive management. In operationalising this principle for MPAs in the UK, ARM is currently being considered as a specific approach that could be adopted where there are data deficiencies. This involves implementing management based on assumptions, monitoring changes in the situation, adjusting the management measures as required, and verifying the appropriateness of the assumptions used. However, any management measures implemented, as part of the management cycle, should be reviewed and adapted if required.

Key to the implementation of ARM is the establishment of trigger points. When a monitored parameter (e.g. fishing effort) reaches or exceeds a trigger point, this provides the signal that there may be a need for further action to be taken, such as limiting further increases in fishing effort to avoid impeding the achievement of the site conservation objectives. If it is not possible to set trigger points based on site conservation objectives (due to a lack of evidence on understanding of condition-pressure-activity interactions), they could be set against a level that reflects the pre-existing value of the parameter (e.g. the pre-management level of fishing effort in the MPA).

To support management of MPAs and the wider marine environment in relation to potential implications of displacement, it is anticipated that monitoring would need to provide:

- Evidence of the effects of displacement on the distribution and nature of fishing activity, both within and outside of the MPA;
- Evidence of the environmental implications of displacement on MPA features and the wider environment.

This evidence needs to be both timely (i.e. available on a regular and frequent basis) as well as obtainable at reasonable cost. This has implications for the sources of monitoring data which may be appropriately used.

7.1.1 Monitoring within MPAs

Monitoring within sites should be designed to address the following questions:

- What is the level of fishing activity, and is it within acceptable or expected levels? In the context of ARM, are trigger points being breached that indicate that action needs to be taken?
- Are the site conservation objectives being achieved?
- Does management need to be adapted?

It is important that the monitoring programme is engaged prior to the implementation of the management in order to be able to set a baseline level of activity (although in many instances it may be feasible to recreate historic baselines through the available secondary data sources).

Monitoring fishing activity

Monitoring fishing effort against trigger points can be undertaken through analysis of fishing activity data. This is available at lower cost and at more regular intervals than environmental data, and therefore provides the focus for regular, ongoing monitoring, which can also be used to support ARM. Monitoring should address the following questions:

- What is the level and distribution of fishing effort, by gear type, within the site and how is this changing over time?
- Is this meeting/exceeding levels or trigger points that indicate action should be taken?

Overlaying fishing activity with environmental data on habitat distribution and sensitivity can inform the assessment of feature condition:

- How is the effort distributed across habitats or features?
- What does the interaction of fishing pressures with habitat/feature sensitivity tell us about the likely changes in feature condition?

Potential sources of information on the distribution and intensity of fishing are shown in Table 4.

Table 4. Data sources on fishing effort

Source	Description
Logbooks and catch returns	May provide information on the level of effort and catches from different areas. If they record information at suitable spatial resolution related to specific MPAs, this could be used. Some IFCA permit requirements tailor information requirements to higher spatial resolutions. Only available for UK vessels.
Permit systems	Where there is a permit system in place, this can be monitored through the number of permits issued to fish for different gear types. If possible, there should be a cross-check of whether permits issued have resulted in actual fishing effort within the MPA. Inshore only.
VMS	Effort levels for over-12m vessels (UK and non-UK fleets) can be monitored through VMS data linked to gear type and filtered to identify fishing activity from non-fishing activity. An increase in required ping frequency within the MPA and any surrounding buffer zones, can be used to support enforcement and will help improve the accuracy of effort monitoring. UK vessels: gear information identified from logbooks, but linking method can result in a proportion of pings with unidentified gear type. For non-UK vessels: gear information can be identified from the Community Fleet Register but is not necessarily a true indication of the gear in use.
iVMS	Where there is iVMS in place, effort for under-12m vessels can be monitored through iVMS. Together with VMS, this would provide an indication of the level of effort for different gear types in the site. This could be monitored monthly and annually. The use of gear in-out-technology would improve the accuracy of effort monitoring further, particularly in the case of monitoring effort in static gear fisheries.
AIS data	AIS data can be used to monitor vessel activity. If it is a mandatory requirement for fishing vessels (as some IFCA byelaws propose), this could be used to support monitoring of effort.
MMO and IFCA sightings data	Sightings data may support the monitoring of fishing effort, particularly for under-12m vessels where there is no VMS requirement, but due to its patchy nature it does not provide a comprehensive picture of fishing activity.
Periodic survey of affected fishers	Periodic surveys targeted at affected fishers can support triangulation and enrichment of secondary data. It may be particularly beneficial where the area under management / analysis does not align well with the spatial dimensions of secondary source data. Periodic survey can provide: spatially explicit descriptions of redistributed fishing effort levels (on- and off-site); forward-looking expectations of fishing effort levels and distribution; as well as explanations for fisher reactions to displacement and perceived economic/social impacts.

Monitoring feature condition

Monitoring and assessment of feature condition in a site supports periodic reporting on the performance of the MPA against its conservation objectives and can also inform the period review and revision (if required) of management measures. This is beyond the scope of this report, but there are some considerations that are relevant to displacement.

Periodic monitoring of feature condition against conservation objectives can be used to refine and adjust the parameters and the levels at which trigger points are set for ARM. This might be used, for example, to sense-check the evidence already considered in the ongoing ARM process, provide evidence on how feature condition has changed in light of the known changes in fishing pressure

arising from displacement, and thereby support the reselection or readjustment of trigger point parameters and levels, and confirm or further adapt site management measures. Critical questions for this analysis to respond to are:

- Is the feature condition improving (or being maintained) as expected, given the known changes in fishing effort (and pressures) within the MPA?
- What does this tell us about the appropriateness of the parameters and levels that were set for ARM trigger points, if relevant? Do they need to be amended?
- If feature condition is not improving as expected:
    - Are there other pressures that are impacting on the feature that need to be addressed?
    - Was the fishing effort previously occurring in the area not affecting the feature condition, and can management measures be adapted to allow a level of fishing to occur?
- If feature condition is improving as expected:
    - Can the level of fishing effort permitted within the MPA be increased without affecting the achievement of the conservation objective?

7.1.2 Monitoring outside sites

Marine environment managers require information on the implications of MPA management for the wider environment i.e. outside of the site, as well as within it. A key challenge, particularly for off-site impacts (i.e. impacts outside of MPAs), is interpretation of the available monitoring data i.e. the extent to which observed changes in off-site fishing effort distribution and habitat (and species) conditions are the result of MPA management or other drivers; particularly in light of often poor baseline data and understanding about habitat extent and condition.

Monitoring outside MPAs should be designed to support responses to similar questions to those for inside MPAs, and similar data sources will be relevant (Table 4). However the specific language may differ in order to align with wider marine environment and MSFD monitoring programme approaches:

- Are thresholds being breached that indicate that management may require adaptation?
- Are marine environment objectives (i.e. Good Environmental Status) being achieved?

More specifically, monitoring outside MPAs should focus on answering the following questions:

- What has been the displacement effect?
    - This requires a baseline of average fishing effort levels before implementation of the management measure (inside and outside the site). See section 7.1.1 for options for collecting these data.
    - Monitoring should focus on the level of effort of affected fishing sectors, and seek to identify any significant changes in distribution and level of effort at local (e.g. within an ICES rectangle) and wider scales (e.g. within an ICES Division), although appropriate scales will vary by site, depending on the size of the site and the expected distance of displacement (likely to be greater for larger offshore sites and larger vessels).
    - Other drivers that could have affected the level of and distribution of fishing effort, such as changes in fishery management regime, should also inform the interpretation of the monitoring data. Where possible, the changes resulting from displacement from the MPA should be separated from changes resulting from other drivers.

- Monitoring of the activity of the vessels affected by the management measure could also inform an understanding of displacement behaviour in response to the implementation of the management measure.

- Is it what was expected?
  - The original assessment of potential displacement should be revisited, and predicted displacement should be compared with the observed displacement.
  - This should be used to learn lessons and improve understanding of potential displacement behaviour for future assessments.
- What are the environmental impacts?
  - How have environmental status indicators changed? Do these changes align with what was expected given the changes in fishing pressures?
  - Is the existing management regime enabling both MPA objectives and general marine environment status objectives to be met?

7.2 Identification of Knowledge Gaps

There are a number of knowledge gaps in relation to current understanding of potential displacement behaviour by fishers, and of its environmental, social and economic impacts. These are identified in Table 5, together with recommendations for addressing them, and their relative priority.

Table 5. Knowledge gaps relating to displacement, and recommendations for addressing them

Knowledge gap	Recommendation	Relative priority
Information on smaller vessels' activity	The introduction of a requirement for iVMS or a similar system for under-12m vessels to improve information on distribution and displacement of fishing effort. Ideally this should be linked to information about gear type in operation.	High
Information on gear type for larger vessels	Improve method of linking logbook and VMS databases, based on vessel, date and fishing trip, rather than vessel, date and ICES rectangle, to reduce the number of pings with 'unknown' gear type.	High
Displacement risk mapping	Applying factors and combinations of factors to map the level of risk of adverse environmental impacts from displacement of effort, according to overall effects on benthic habitats and species at biogeographic regional scales, e.g. fishing effort intensity (where existing levels of no or low effort would represent higher risk of impact from displacement) and habitat sensitivity (where more sensitive habitats would represent higher risk of impact).	High
Impact of displacement on affected fishers	Development of a look-up table to support regulators in their assessments e.g. for different fishing sectors, to estimate the proportion of landings affected based on the distance of displacement.	Medium

Knowledge gap	Recommendation	Relative priority
Tipping points determining fishing behaviour – points at which fishers invest, switch gears, displace effort, exit the fishery etc.	Further research into factors affecting decisions.	Low
Areas where fishing effort might be displaced to	Research identifying existing and alternative fishing grounds (e.g. based on habitat type and existing or historic fishing effort) for different fishing sectors (gears, target species, vessel sizes).	High
	Development of a tool to predict where effort might be displaced to if a particular area is closed. This could draw on the DISPLACE model, and build on the Cefas MPA Tool. Taken further, this could be combined with the displacement risk mapping (above).	Medium
	Mapping of choke species catches to inform assessment of potential impacts on the fishing industry of displacement to different areas.	Medium
Significance of potential displacement and its impacts	Development and testing of rules-of-thumb for assessing the significance of displacement (e.g. as a proportion of effort or landings from an MPA, from an ICES rectangle and from a region, as in Marine Scotland, 2014a).	High
Impact of different gears on benthic habitats and species (lack of primary evidence for English gear types and habitats)	Specific gear impact studies (modelling and *in situ*) to improve the evidence base for UK-specific gear types (taking into account size, configuration, weight, tow speed etc.) on the habitats and species of interest in UK/English waters.	Medium
Impact of displacement on the wider marine environment	MPA-specific study, tracking the behaviour of individual vessels affected by the implementation of management measures, comparing behaviour before and after implementation. This could use a Before-After-Control-Impact (BACI) analysis to compare changes in fishing pattern by vessels affected by the management measure compared to others that were unaffected, and/or incorporate interviews with skippers to determine the factors affecting observed changes in fishing behaviour (i.e. to understand the influence of displacement compared to other factors such as weather conditions, quota availability, market prices etc.).	High
	Monitoring of fishing effort displaced from MPAs to quantify changes in level of fishing effort before/after management measures in MPAs are implemented, and linking to wider ecosystem services and/or MSFD Descriptor 6 targets.	Medium
Understanding of cumulative displacement impacts (e.g. additive, synergistic or compensatory effects)	Development of more comprehensive means of assessing the significance of displacement impacts taking into account cumulative and synergistic effects, which may differ by region.	Medium-low

Knowledge gap	Recommendation	Relative priority
Tools for addressing impacts of displacement	Study to identify the potential management tools to address displaced effort and its impacts (where it is determined to be significant), including how they can be integrated into current and future fishery management frameworks, and ultimately how fishery and environmental objectives for the marine environment can both be pursued.	High

7.3 Addressing and mitigating impacts from displacement

If the assessment of displacement identifies that potential environmental impacts are likely to be significant, a number of steps are recommended to determine appropriate interventions:

1. **Where potentially significant environmental impacts from effort expected to be displaced from an MPA or MPAs have been identified through modelling studies, the assumptions of the models should be checked and verified.** It is important to ensure that the underlying assumptions hold true in real-world conditions. Such assumptions may include the management measure (how much fishing effort is likely to be displaced), the resulting actions of fishermen (location to which fishing effort is displaced, increased levels of effort to compensate for lower catch rates in new areas), and the relevance or appropriateness of the 'impact' indicator such as levels of benthic production (and mortality rates from fishing) or biodiversity (and how it is calculated). Additionally, the scale at which such displacement is modelled (e.g. ICES rectangles) may assume displacement across large distances, rather than finer-scale adjustments within an ICES rectangle. It is also important to recognise that fishing is mediated by fishery-specific factors such as quota availability and species mix, market conditions, weather conditions, and vessel and skipper specialisation, which are usually not incorporated in the models.

2. **Ensure that the design of the MPA (where possible) and management measure(s) minimise the potential displacement and the impact of displaced fishing effort, whilst still achieving network and site Conservation Objectives.** To ensure that the optimal MPA and management options are adopted, application of the Guidance for assessing displacement developed by this project (see Appendix C) in an iterative manner during the development of management options can support this. In particular, for both the environment and for the fishing industry, this should ensure that the evidence on which the assessment is based is robust, and appropriate for feature being protected, and the vessel size, gear type and configuration being used in the site — the cost of missing a potential environmental impact is borne by biodiversity, whereas the cost of a false alarm is borne by the fishing industry (Figure 13). These considerations apply to individual MPAs and also to multiple MPAs that affect the same fleet sector or which interact via displacement effects. Such cumulative effects should also be taken into consideration.

3. **Monitor the effect of displacement of fishing effort and its impacts on the environment to determine the overall net effects (including taking into consideration the improvements in condition within the areas from which effort has been displaced) and implications for wider environmental objectives (e.g. Good Environmental Status).** See section 7.1 for recommendations on monitoring requirements.

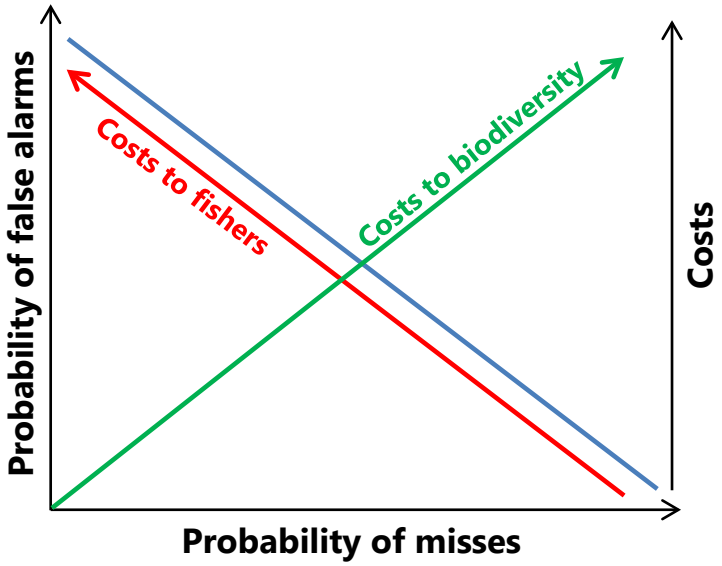

Figure 13. Costs to biodiversity and to fishers with increasing probability of misses and of false alarms (of environmental damage)

Source: Garcia *et al.*, 2015.

4. **Where net impacts are confirmed, consider appropriate options to address these impacts.** Where it is determined that displacement is having a net negative effect on the marine environment (after taking account of the improvements in condition within the protected areas), then the issue of concern should be identified (e.g. is it higher levels of bycatch of sensitive species, or increased benthic habitat damage?) and appropriate means of addressing the issue developed and implemented.

   It is also appropriate to consider such options ex-ante i.e. where it is anticipated that MPA-induced displacement may have an overall net effect, but this has not yet occurred. However due to the uncertainty surrounding the modelling of anticipated displacement and its impacts, there may not be strong enough grounds to implement such management prior to the negative impact being evidenced.

The following options may be considered for addressing or mitigating impacts from displaced effort:

1. Re-design of the MPA and its management;
2. Gear modifications and adaptations to reduce environmental impacts (reduction of benthic impact, increased selectivity), and support for fishers to develop and implement such adaptations;
3. Incentives to encourage the use of less damaging gear and to minimise environmental impacts from fishing;
4. Use of codes of conduct for fishing activities;
5. Real-time management where this can contribute to reducing the potential impacts identified;
6. Consider additional spatial measures to restrict or limit the amount of effort on more sensitive habitats or features of concern;
7. Effort management, for example:
   a. Measures to limit or restrict levels of effort;
   b. Develop approaches to link spatial and effort management measures in fisheries e.g. providing for up to a certain level of effort within a particular management area, in order to restrict the overall level of impact that occurs. However, experience of

combining effort controls (i.e. days at sea) with output controls (i.e. quotas) in European fisheries has not been successful, and may itself generate further displacement of fishing effort. The full roll-out of the Landings Obligation is likely to compound such difficulties further.

c. Remove effort from the system, e.g. through vessel decommissioning or licence buy-outs. Detailed consideration of such approaches is necessary, as decommissioning programmes are effective only in certain circumstances and need to be carefully designed (OECD, 2009). Decommissioning UK vessels will not affect the effort applied by other EU fleets under the current management framework, or the level of effort applied by the remaining UK vessels in the area of concern.

8. Approaches to fisheries management that maximise environmental benefits. Options that could be explored are to manage fisheries to Maximum Economic Yield, so that the same level of production of fish can be achieved with less effort and therefore lower environmental impact; to manage fisheries according to effort, with the effort level set according to both environmental and stock considerations; and to take into account aspects of mixed fisheries and ecosystem considerations.

Ultimately the need for, and challenges of, addressing displacement impacts relate to how to integrate both fishery and environmental objectives in the context of management of the wider marine environment. Fishery management and environmental management have evolved as two separate governance streams in the international and national arena, and are beginning to converge, with fisheries taking greater consideration of environmental and ecosystem aspects, and conservation recognising the importance of sustainable use. Garcia *et al*., (2015) highlight the need for an integrated and holistic approach to addressing specific fishery challenges and marine governance overall. Such integration is a fundamental component of applying an ecosystem based approach to marine management, and marine planning has the potential to play a greater role in the integration of fishery and environmental objectives in the marine environment.

More broadly, this needs to take into account risk management within a context of uncertainty (in the data, evidence base, and future conditions, including climate change).

Adopted management approaches must deal explicitly in both fisheries and biodiversity conservation, within the broader goals of promoting human wellbeing, food security, and equity.

The immediate next steps that could be taken to develop a better understanding of the potential justifications, approaches and measures for dealing with the impacts of MPA-induced displacement are:

- Clarification of legislation and policy drivers that provide the justification for management of MPA-induced displacement.
- Study on the available approaches and tools to manage fishing effort in the context of displacement from MPAs and current and future fishery management frameworks.
- Study on the interplay between fisheries management and biodiversity conservation, and the optimisation of both – for example fishery management approaches that incorporate incentives for promoting ecosystem health, incentives to minimise damage and promote the development of natural capital, approaches to minimise impact per unit of fishing effort, individually and in aggregate e.g. the removal of fishing effort from lightly-fished areas, which would deliver a proportionally greater contribution to promoting recovery per unit of effort affected.
- Involvement of both conservation and fishing stakeholder groups in a conversation about objectives for the marine environment and fisheries, and how to achieve them in a way that takes account of the environmental, economic and social pillars of sustainability as part of an ecosystem-based approach.

8 Conclusions and Recommendations

8.1 Conclusions

The literature on displacement of fishing effort from MPAs highlights that displacement can take place both spatially to other areas, and to other gear types, both within and outside MPAs. The displacement of fishing effort can have impacts on the marine environment and on the affected fishers, and also on other fishers and other marine sectors and activities. The majority of studies on displacement of fishing effort consider demersal mobile gears (e.g. beam trawls, otter trawls, dredges), as these are the gear types with the greatest benthic impact and therefore the ones most commonly excluded from MPAs to-date.

Numerous complex factors interact to determine displacement behaviour, many of which are unknown or unquantified. A consistent outcome of management instruments in fisheries is that fishers behave in a manner that is often unintended (and unpredicted) by the designers of the management system, leading to unplanned consequences and unintended outcomes. There is therefore a need to consider potential displacement behaviour in relation to MPA management measures, consult with affected parties, and monitor the outcomes to determine if any issues arise that need to be addressed.

Some key factors that affect displacement behaviour can be identified to help understand and predict the spatial redistribution of displaced activity; their importance varies from case to case and from fisher to fisher. The factors identified in the literature that affect where activity may be displaced to spatially are: availability, knowledge of and access to alternative fishing grounds (including e.g. quota availability, access rights, distance from port); expectation or occurrence of localised 'spillover' effects; and individual strategies and preferences.

The scale at which potential displacement effects need to be considered varies from fishery to fishery, as the factors that influence displacement behaviour vary between fishing sectors and locations. For example, 10m and under vessels have a limited operating range and potential displacement is likely to be restricted to a certain distance from the management area (notwithstanding the potential for some vessels to move home port). Larger vessels and those with more 'nomadic' operating patterns may displace their activity considerable distances and the spatial scale considered will need to be correspondingly greater.

Displacement to alternative gear types (not directly affected by MPA management) has two dimensions: (i) displaced fishers switching to an alternative gear to enable continued fishing within the MPA or in alternative grounds; (ii) fishers already using an alternative gear type increasing their fishing effort within the area from which others have been displaced. There are few examples of the first in the literature; this may be due to barriers to changing gear types (e.g. investment, potential for safe adaptations to the vessel, knowledge and experience of operating different gears, licence restrictions). It may be more likely in polyvalent sections of the fleet which already use multiple gear types. The second, where alternative gear types increase their effort in the area where effort has been displaced from, is more commonly reported (and robustly evidenced) in the literature. In the case of an MPA, where this results in a meaningful increase in fishing effort within the site, it may have implications for the conservation objectives.

Both gear-related and spatial displacement of fishing effort can impact on the marine environment, within and outside MPAs, including on the seabed and benthic communities, mobile species and commercial fish and shellfish stocks.

The effect of displacement on habitats and benthic communities depends on the sensitivity of the habitat where effort is displaced to, the level of fishing in the area prior to displacement, and the gear type displaced. Impacts are expected to be greater for more sensitive species and habitats with longer recovery times (e.g. maerl beds, seagrass beds, biogenic reefs) and subject to lower levels of natural disturbance, for areas that are previously unfished or only lightly-fished, and for mobile gears that interact with the seabed (e.g. demersal trawls and dredges).

Displacement of fishing effort can result in fishing disturbance being more widely distributed, including to otherwise previously unfished areas, and can cause localised increases in intensity. Modelling studies have shown that displacement of effort from heavily-fished areas to lightly-fished areas can have a negative overall impact on the wider benthic environment, whereas displacing effort from lightly-fished areas can have a positive effect on overall biomass, production and species richness of benthic communities. In both instances, if fishing effort is displaced to less productive fishing grounds, and there is an increase in effort to maintain catch volumes, the overall level of benthic disturbance may also increase. Whilst some studies have suggested that an overall reduction of fishing effort may be required to avoid negative net environmental impacts as a result of displacement from area closures, this conclusion is based on modelling studies that make a number of assumptions about fisher behaviour, fishing activity and its impacts. Such assumptions should be investigated and verified that they hold true in reality before measures are taken to remove effort.

Displacement of fishing effort spatially or to other gear types can have impacts on commercial fish and shellfish stocks and other species, for example if effort is displaced to areas where there is a higher abundance of juveniles, results in localised increases in effort, or is displaced to areas or gears that cause greater incidental by-catch of non-target species.

The net environmental outcome of protection of MPA features and impacts from displaced effort is dependent on a number of factors that vary on a case-by-case basis. These can be summarised as (i) factors influencing the location and scale of effort displacement e.g. the location of alternative fishing grounds, access constraints, economics, knowledge and preferences; and (ii) factors influencing the impact of that displaced effort on the environment e.g. the sensitivity of the features in the areas that effort is displaced from and to, to the change in gear-specific pressures, the marginal change in fishing pressures relative to prevailing natural factors such as productivity, biodiversity and disturbance.

Displacement can cause social and economic impacts on the affected fishers in terms of decreased revenues from reduced fishing time and lower catch rates, higher costs from increased steaming times, lower catch rates, increased conflicts and competition between vessels and different gear types. Other fishers, already operating in the areas to which effort is displaced, can also be impacted.

Approaches to assessing displacement of MPAs and their management measures have, to date, been inconsistent. Beyond 12 nm, there is a requirement to consider potential displacement for proposed management measures in MPAs. Potential impacts of displacement are generally considered within the MPA itself; whereas outside the MPA it may be acknowledged, but not fully considered. This has been due to the regulatory scope of MPA protection which requires the condition objectives of the designated features within a site to be met. Impact assessments are conducted for proposed regulations to understand and quantify the potential environmental, economic and social impacts, and their distribution, for a proposed measure. They are usually focussed on the anticipated direct impacts. Because of the challenges inherent in predicting displacement effects, the approaches adopted to assess the environmental, economic and social impacts of displacement are not always consistent or systematic.

This study has developed guidance on assessing the nature and impacts of potential displacement of fishing effort as a result of actions which restrict fishing activity spatially. It can be used to help ensure more consistent and systematic consideration of all potential displacement effects and impacts (as far as the available information allows), and can also be used to inform a rapid assessment of different options as part of the process of developing management measures.

8.2 Recommendations

Displacement of fishing effort should be considered during the development of management measures for MPAs (and other spatial interventions that may affect fishing). Where fishing effort is to be displaced (if it is not removed), then efforts to minimise the potential impacts of displacement, whilst still achieving site Conservation Objectives should be taken.

Assessments of the displacement of fishing effort should be consistent in their approach and involve systematic consideration of the factors that influence displacement effects and impacts. The guidance developed in this study sets out the key considerations for assessing displacement and could support more systematic assessment and improve transparency in the way assessments are conducted and presented.

Regulators should continue working together and seek better ways of working to assess and address displacement issues and impacts — the scale for monitoring and assessment of displacement should be appropriate to the fishery and may extend beyond an individual regulator's area, particularly in the inshore area where vessels may move their activity between different IFCA districts.

The factors determining displacement behaviour and its impacts on the environment are difficult to predict and to model. Therefore, where displacement of fishing effort is unavoidable in order to protect designated features, the displacement effect should be monitored so that any issues arising (e.g. where a redistribution of effort by particular gear types risks an adverse effect on site integrity, or significant impacts outside of MPAs can be identified and action taken to address them.

Monitoring of fishing activity should focus on the level and distribution of fishing effort of different gear types within the MPA, and how this is distributed across habitats and/or features, to ensure that displacement of fishing effort does not threaten site integrity. Monitoring could also consider displacement of effort outside the MPA and its potential impacts on habitats and species. Monitoring of the actual nature of displacement (comparing post-implementation fishing patterns with a baseline prior to implementation of the management measure) could be used to improve our understanding of displacement behaviour for future assessments, and inform understanding of its environmental, economic and social impacts.

There are many knowledge gaps in relation to our understanding of displacement and its impacts, and recommendations for future research include risk mapping, development of simple tools to support the assessment of the significance of displacement (both in relation to impacts on fishers and potential environmental impacts), and development of more complex models and means of predicting displacement behaviour and assessing the significance of displacement impacts taking into account cumulative and synergistic effects.

In addition to improving our understanding of the potential nature and impacts of displacement, it is necessary to begin to consider how the displacement itself, and its impacts, can be minimised where possible, and addressed where needed. A range of management options exist for addressing the impacts from displacement, the applicability of which will depend on the particular circumstances. Further work is required to consider how such measures can be integrated into the fishery management framework, and how fisheries issues can be better integrated into the marine planning framework. At wider management scales than MPAs, there is ultimately a need to consider the trade-offs between fishery production and marine ecosystem status and the optimisation of both.

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10 Abbreviations

AIFCA	Association of Inshore Fisheries and Conservation Authorities
ARM	Adaptive Risk Management
BNNC	Berwickshire and North Northumberland Coast
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
CPUE	Catch per Unit Effort
CROW	Countryside and Rights of Way Act
DSFC	Devon Sea Fisheries Committee
EEZ	Exclusive Economic Zone
EMFF	European Maritime and Fisheries Fund
EMS	European Marine Sites
EU	European Union
FAO	Food and Agriculture Organization
FDSG	Fishing Displacement Steering Group
FIM-PAS	Fisheries Measures in Protected Areas
GVA	Gross Value Added
IA	Impact Assessment
IBSFC	International Baltic Sea Fishery Commission
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authority
iVMS	Inshore Vessel Monitoring System
JNCC	Joint Nature Conservation Committee
MCAA	Marine and Coastal Access Act
MCRS	Minimum Conservation Reference Size
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSY	Maximum Sustainable Yield
NE	Natural England
NERC	Natural Environment and Rural Communities Act
NFFO	National Federation of Fishermen's Organisations
NSRAC	North Sea Advisory Council
OSPAR	Oslo-Paris Convention
RUM	Random Utility Models
SAC	Special Area of Conservation
SI	Statutory Instrument
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UKFEN	UK Fisheries Economics Network
USA	United States of America
VMS	Vessel Monitoring System

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices

A List of Literature Sources Reviewed

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B Summary of Management Measures in MPAs[27]

B.1 EMS

Name	In force	In preparation	In force, to be repealed
Alde & Ore Estuaries SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing	EIFCA Shrimp Permit Byelaw 2016	
Alde, Ore & Butley Estuaries SAC	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing	EIFCA Shrimp Permit Byelaw 2016	
Bassurelle Sandbank SCI		Bassurelle Sandbank proposed measure	
Benacre to Easton Bavents Lagoons SAC	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing	EIFCA Shrimp Permit Byelaw 2016	
Benfleet and Southend Marshes SPA	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
Berwickshire and North Northumberland Coast SAC	NIFCA Byelaw 7 - Prohibition of mobile gear in BNNC SAC NIFCA Byelaw 8 - Seagrass protection byelaw in BNNC SAC NIFCA Legacy Byelaw - Bait digging Boulmer NIFCA Legacy Byelaw (National Trust)		
Breydon Water SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing	EIFCA Shrimp Permit Byelaw 2016	
Chesil and the Fleet SAC	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016	
Chesil Beach and the Fleet SPA	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016	
Chichester and Langstone	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016	

[27] As of 31 March 2017.

Name	In force	In preparation	In force, to be repealed
Harbours SPA		SoIFCA Solent Dredge Fishing Byelaw	
Chichester Harbour EMS	Sussex IFCA Chichester Harbour (Specified Areas) Prohibition of Fishing Methods Byelaw Sussex IFCA Oyster Permit Byelaw		
Coquet Island SPA	NIFCA Legacy Byelaw - Landing prohibition Coquet Island		
Croker Carbonate Slabs SCI		Croker Carbonate Slabs proposed measure	
Deben Estuary SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing	EIFCA Shrimp Permit Byelaw 2016	
Dee Estuary EMS	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Byelaw 6 Protection for EMS features NWIFCA EA Legacy Byelaw 5 Use of instruments NWIFCA Emergency Byelaw Bivalve Molluscs	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
Dogger Bank SCI		Dogger Bank proposed measure	
Drigg Coast SAC	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA CSFC Legacy Byelaw 13 Multi-rigged trawls NWIFCA CSFC Legacy Byelaw 14 Shrimps or prawns NWIFCA CSFC Legacy Byelaw 26 Permit to fish for lobster, crab and whelk NWIFCA CSFC Legacy Byelaw 3 Vessel size limit NWIFCA CSFC Legacy Byelaw 7 Winkles NWIFCA Emergency Byelaw Bivalve Molluscs	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
Dungeness to Pett Levels EMS	K&EIFCA Legacy Vessel Length and Engine Size Sussex IFCA Legacy Byelaw Trawling Prohibition		
Essex Estuaries SAC	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Thames Estuary Cockle Fishery Order K&EIFCA Legacy Vessel Length and Engine Size	K&EIFCA Bottom Towed Gears (Prohibited Areas) Byelaw 2017 K&EIFCA Byelaw to restrict trawling K&EIFCA Native Oyster Permit Byelaw	K&EIFCA Bottom Towed Fishing Gear (Prohibited Areas) Byelaw
Essex Estuaries SPA		K&EIFCA Byelaw to restrict trawling	
Exe Estuary SPA	D&SIFCA Mobile Gear Permit Byelaw	D&SIFCA Hand Gathering Permit Byelaw	

Name	In force	In preparation	In force, to be repealed
Fal & Helford SAC	CIFCA Closed Areas (European Marine Sites) No. 2 Byelaw CIFCA Fal Fishery Order 2016		
Falmouth Bay to St Austell Bay pSPA	CIFCA Closed Areas (European Marine Sites) No. 2 Byelaw	CIFCA Netting/Bird Bycatch Byelaw	
Farne Islands SPA	NIFCA Byelaw 7 - Prohibition of mobile gear in BNNC SAC NIFCA Byelaw 8 - Seagrass protection byelaw in BNNC SAC NIFCA Legacy Byelaw - Intertidal hand gathering Farne Islands		
Flamborough Head EMS	NEIFCA Byelaw 23 – Dredging NEIFCA Byelaw 26 Flamborough Head fishing (trawling) NEIFCA Legacy Byelaw 18 Fixed Engines NEIFCA Legacy Byelaw 24 Cockles NEIFCA Legacy Byelaw 27 No Take Zone NEIFCA Legacy Byelaw 3 Trawling	NEIFCA 18 - Method and Area of Fishing (Netting) Byelaw, 2016 NEIFCA Byelaw 22 Possible New Measures - Shellfish permit byelaw 2016 NEIFCA Possible New Measures - Potting limitation	
Gibraltar Point SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Wash Fishery Order 1992	EIFCA Shrimp Permit Byelaw 2016	
Haig Fras SAC		Haig Fras proposed measure	
Haisborough, Hammond and Winterton SAC/SCI	EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing Haisborough, Hammond and Winterton MMO Byelaw for bottom towed gear restriction	Haisborough, Hammond and Winterton proposed measure Marine Protected Areas Byelaw 2017	
Hamford Water SPA	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
Humber Estuary EMS	EIFCA Legacy Byelaw 15 - Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing EIFCA Legacy Byelaw III NESFC Trawling Prohibition EIFCA Legacy Byelaw XXIV - NESFC Humber cockle fishery byelaw NEIFCA Byelaw 23 – Dredging NEIFCA Byelaw 29 Humber Estuary Fishing NEIFCA Legacy Byelaw 18 Fixed Engines NEIFCA Legacy Byelaw 24 Cockles NEIFCA Legacy Byelaw 3 Trawling	NEIFCA 18 - Method and Area of Fishing (Netting) Byelaw, 2016 NEIFCA Byelaw 22 Possible New Measures - Shellfish permit byelaw 2016 NEIFCA Byelaw 29 Humber Estuary Fishing Byelaw 2016 NEIFCA Possible New Measures - Potting limitation	

Name	In force	In preparation	In force, to be repealed
Humber Estuary SAC	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions	EIFCA Marine Protected Areas byelaw 2016 EIFCA Shrimp Permit Byelaw 2016 Marine Protected Areas Byelaw 2017	EIFCA Protected Areas Byelaw 2014
Humber Estuary SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions	EIFCA Shrimp Permit Byelaw 2016	
Inner Dowsing, Race Bank and North Ridge SAC/SCI	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing Inner Dowsing, Race Bank and North Ridge MMO Byelaw for bottom towed gear restriction	EIFCA Shrimp Permit Byelaw 2016 Inner Dowsing, Race Bank and North Ridge proposed measure Marine Protected Areas Byelaw 2017	
Isles of Scilly Complex EMS	IoSIFCA Fishing Gear Permit Byelaw IoSIFCA Voluntary Measures		
Lands' End and Cape Bank SCI	CIFCA Closed Areas (European Marine Sites) No. 2 Byelaw Lands End and Cape Bank MMO Byelaw for bottom towed gear restriction		
Lindisfarne SPA	NIFCA Byelaw 7 - Prohibition of mobile gear in BNNC SAC NIFCA Byelaw 8 - Seagrass protection byelaw in BNNC SAC NIFCA Legacy Byelaw - Lindisfarne bait digging		
Liverpool Bay SPA	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Emergency Byelaw Bivalve Molluscs NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 3 Prohibition of Seine Netting NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
Lizard Point SCI	CIFCA Closed Areas (European Marine Sites) No. 2 Byelaw		
Lundy SAC	D&SIFCA Mobile Gear Permit Byelaw	D&SIFCA Mobile Gear Permit Byelaw - changes to permit conditions D&SIFCA Netting Permit Byelaw	
Lundy SAC	D&SIFCA Legacy Lundy No Take Zone Byelaw D&SIFCA Legacy Trawling, Netting & Spearfishing Byelaw		
Lune Deep SAC	NWIFCA Emergency Byelaw Bivalve Molluscs	NWIFCA Byelaw bivalve molluscan shellfish 2016	

Name	In force	In preparation	In force, to be repealed
Lyme Bay and Torbay SAC	D&SIFCA Lyme Bay Voluntary Code D&SIFCA Mobile Gear Permit Byelaw Lyme Bay Designated Area (Fishing Restrictions) Order 2008 No 1584 Lyme Bay Designated Area (Fishing Restrictions) Order 2008 No 1584 SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Lyme Bay Fisheries and Conservation Reserve Vol. Code of Conduct	D&SIFCA Netting Permit Byelaw D&SIFCA Potting Permit Byelaw - changes to permit conditions SoIFCA Bottom Towed Fishing Gear Byelaw 2016	
Margate and Longsands SAC	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Thames Estuary Cockle Fishery Order K&EIFCA Legacy Vessel Length and Engine Size	K&EIFCA Bottom Towed Gears (Prohibited Areas) Byelaw 2017 Margate and Long Sands European Marine Site (Specified Areas) Bottom Towed Fishing Gear Byelaw 2016	
Medway Estuary and Marshes SPA	K&EIFCA Byelaw No Take Zone K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
Mersey Estuary SPA	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Emergency Byelaw Bivalve Molluscs NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 3 Prohibition of Seine Netting NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
Mersey Narrows and North Wirral Foreshore SPA	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Emergency Byelaw Bivalve Molluscs NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 3 Prohibition of Seine Netting NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
Mid-Essex Coast SPA	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		

Name	In force	In preparation	In force, to be repealed
Minsmere to Walberswick Heaths & Marshes SAC	EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing		
Minsmere to Walberswick SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs	EIFCA Shrimp Permit Byelaw 2016	
Morecambe Bay EMS	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Byelaw 6 Protection for EMS features NWIFCA Emergency Byelaw Bivalve Molluscs NWIFCA Heysham Flat Byelaw 13a Closure NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWIFCA Legacy Byelaw 5 Heysham BNA NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 26 Fixed Engines - prohibitions and authorisations NWSFC Legacy Byelaw 27 Mobile nets - prohibitions and authorisations NWSFC Legacy Byelaw 3 Prohibition of Seine Netting NWSFC Legacy Byelaw 30 Fishing for lobster, crawfish, crab, prawn and whelk NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
North Norfolk Coast SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions	EIFCA Shrimp Permit Byelaw 2016	
North-Norfolk Sandbanks and Saturn Reef SCI		North-Norfolk Sandbanks and Saturn Reef proposed measure	
Northumberland Marine pSPA			
Northumbria Coast SPA	NEIFCA Byelaw 23 – Dredging NEIFCA Legacy Byelaw 18 Fixed Engines NEIFCA Legacy Byelaw 24 Cockles NEIFCA Legacy Byelaw 3 Trawling	NEIFCA 18 - Method and Area of Fishing (Netting) Byelaw, 2016 NEIFCA Byelaw 22 Possible New Measures - Shellfish permit byelaw 2016 NEIFCA Possible New Measures - Potting limitation	
Orfordness to Shingle Street SAC	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing	EIFCA Shrimp Permit Byelaw 2016	

Name	In force	In preparation	In force, to be repealed
Outer Thames Estuary SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing K&EIFCA Legacy Vessel Length and Engine Size	EIFCA Shrimp Permit Byelaw 2016 Marine Protected Areas Byelaw 2017	
Outer Thames Estuary SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing K&EIFCA Legacy Vessel Length and Engine Size	EIFCA Shrimp Permit Byelaw 2016 Marine Protected Areas Byelaw 2017	
Pagham Harbour SPA	Sussex IFCA Legacy Byelaw Trawling Prohibition	Sussex IFCA MPA Byelaw 2015	
Pisces Reef Complex SCI		Pisces Reef Complex proposed measure	
Plymouth Sound & Estuaries SAC	CIFCA Closed Areas (European Marine Sites) No. 2 Byelaw D&SIFCA Mobile Gear Permit Byelaw	D&SIFCA Hand Gathering Permit Byelaw D&SIFCA Netting Permit Byelaw D&SIFCA Potting Permit Byelaw - changes to permit conditions	
Poole Harbour SPA	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Memorandum of Agreement Bait Digging SoIFCA Poole Harbour Dredge Permit Byelaw SoIFCA Poole Harbour Shellfish hand Gathering Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016	
Portsmouth Harbour SPA	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016 SoIFCA Solent Dredge Fishing Byelaw	
Ribble & Alt Estuaries SPA	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Emergency Byelaw Bivalve Molluscs NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 26 Fixed Engines - prohibitions and authorisations NWSFC Legacy Byelaw 27 Mobile nets - prohibitions and authorisations NWSFC Legacy Byelaw 3 Prohibition of Seine Netting	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	

Name	In force	In preparation	In force, to be repealed
Ribble & Alt Estuaries SPA Cont…	NWSFC Legacy Byelaw 30 Fishing for lobster, crawfish, crab, prawn and whelk NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns		
Severn Estuary SAC	D&SIFCA Mobile Gear Permit Byelaw	D&SIFCA Hand Gathering Permit Byelaw D&SIFCA Netting Permit Byelaw	
Severn Estuary SPA	D&SIFCA Mobile Gear Permit Byelaw	D&SIFCA Hand Gathering Permit Byelaw D&SIFCA Netting Permit Byelaw	
Shell Flat and Lune Deep SAC	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Byelaw 6 Protection for EMS features NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 3 Prohibition of Seine Netting NWSFC Legacy Byelaw 30 Fishing for lobster, crawfish, crab, prawn and whelk NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns	NWIFCA Byelaw 3 Review	
Solent and Southampton Water SPA	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016 SoIFCA Solent Dredge Fishing Byelaw	
Solent Maritime SAC	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016 SoIFCA Solent Dredge Fishing Byelaw	
Solway Firth EMS	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Byelaw 6 Protection for EMS features NWIFCA CSFC Legacy Byelaw 13 Multi-rigged trawls NWIFCA CSFC Legacy Byelaw 14 Shrimps or prawns NWIFCA CSFC Legacy Byelaw 15 Engine power NWIFCA CSFC Legacy Byelaw 26 Permit to fish for lobster, crab and whelk NWIFCA CSFC Legacy Byelaw 3 Vessel size limit NWIFCA CSFC Legacy Byelaw 7 Winkles NWIFCA Emergency Byelaw Bivalve Molluscs	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
South Wight SAC	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Prohibition gathering in seagrass	SoIFCA Bottom Towed Fishing Gear Byelaw 2016	

Name	In force	In preparation	In force, to be repealed
Start Point to Plymouth Sound and Eddystone SAC	CIFCA Closed Areas (European Marine Sites) No. 2 Byelaw D&SIFCA Legacy IPA Licence Agreement D&SIFCA Mobile Gear Permit Byelaw Start Point to Plymouth Sound and Eddystone Reefs MMO Byelaw for bottom towed gear restriction	D&SIFCA Netting Permit Byelaw D&SIFCA Potting Permit Byelaw - changes to permit conditions	
Stour & Orwell Estuaries SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - ESFC Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing K&EIFCA Legacy Vessel Length and Engine Size	EIFCA Shrimp Permit Byelaw 2016	
Studland to Portland SAC	SoIFCA Bottom Towed Fishing Gear Byelaw SoIFCA Legacy Mussels Byelaw	SoIFCA Bottom Towed Fishing Gear Byelaw 2016	
Tamar Estuaries Complex SPA	CIFCA Closed Areas (European Marine Sites) No. 2 Byelaw D&SIFCA Mobile Gear Permit Byelaw	D&SIFCA Hand Gathering Permit Byelaw D&SIFCA Netting Permit Byelaw	
Taw Torridge SAC		D&SIFCA Hand Gathering Permit Byelaw D&SIFCA Netting Permit Byelaw	
Teesmouth and Cleveland Coast SPA	NEIFCA Byelaw 23 – Dredging NEIFCA Legacy Byelaw 18 Fixed Engines NEIFCA Legacy Byelaw 24 Cockles NEIFCA Legacy Byelaw 3 Trawling	NEIFCA 18 - Method and Area of Fishing (Netting) Byelaw, 2016 NEIFCA Byelaw 22 Possible New Measures - Shellfish permit byelaw 2016 NEIFCA Possible New Measures - Potting limitation	
Thames Estuary and Marshes SPA	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Thames Estuary Cockle Fishery Order K&EIFCA Legacy Vessel Length and Engine Size		
Thanet Coast and Sandwich Bay SPA	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
Thanet Coast SAC	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size	K&EIFCA Bottom Towed Gears (Prohibited Areas) Byelaw 2017	K&EIFCA Bottom Towed Fishing Gear (Prohibited Areas) Byelaw

Name	In force	In preparation	In force, to be repealed
The Swale SPA	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
The Wash & North Norfolk Coast SAC	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Wash Fishery Order 1992	EIFCA Marine Protected Areas byelaw 2016 EIFCA Shrimp Permit Byelaw 2016 Marine Protected Areas Byelaw 2017	EIFCA Protected Areas Byelaw 2014
The Wash SPA	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Wash Fishery Order 1992	EIFCA Shrimp Permit Byelaw 2016	
Tweed Estuary SAC			
Wight-Barfleur Reef SCI		Wight-Barfleur Reef proposed measure	

B.2 MCZs

Name	In force	In preparation	In force, to be repealed
Allonby Bay MCZ	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Byelaw 6 Protection for EMS features NWIFCA CSFC Legacy Byelaw 13 Multi-rigged trawls NWIFCA CSFC Legacy Byelaw 14 Shrimps or prawns NWIFCA CSFC Legacy Byelaw 15 Engine power NWIFCA CSFC Legacy Byelaw 26 Permit to fish for lobster, crab and whelk NWIFCA CSFC Legacy Byelaw 3 Vessel size limit NWIFCA CSFC Legacy Byelaw 7 Winkles NWIFCA Emergency Byelaw Bivalve Molluscs	NWIFCA Byelaw 3 Review NWIFCA byelaw bivalve molluscan shellfish 2016	
Aln Estuary MCZ			
Beachy Head West MCZ	Sussex IFCA Legacy Byelaw Trawling Prohibition Sussex IFCA MPA Byelaw 2015		
Bideford Bay to Foreland Point MCZ		D&SIFCA Netting Permit Byelaw	
Blackwater, Crouch, Roach & Colne MCZ	K&EIFCA Closed Shellfish Bed Byelaw K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size	K&EIFCA Byelaw to restrict trawling K&EIFCA Native Oyster Permit Byelaw	
Coquet – St. Mary's MCZ			
Cromer Shoal Chalk Beds MCZ	EIFCA Legacy Byelaw 12 ESFC Inshore Trawling Restrictions EIFCA Legacy Byelaw 15 - Towed gear restriction for bivalve molluscs EIFCA Legacy Byelaw 3 - ESFC Molluscan shellfish methods of fishing	EIFCA Shrimp Permit Byelaw 2016	
Cumbria Coast MCZ	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA CSFC Legacy Byelaw 13 Multi-rigged trawls NWIFCA CSFC Legacy Byelaw 14 Shrimps or prawns NWIFCA CSFC Legacy Byelaw 26 Permit to fish for lobster, crab and whelk NWIFCA CSFC Legacy Byelaw 3 Vessel size limit NWIFCA CSFC Legacy Byelaw 7 Winkles NWIFCA Emergency Byelaw Bivalve Molluscs	NWIFCA Byelaw 3 Review NWIFCA byelaw bivalve molluscan shellfish 2016	

Name	In force	In preparation	In force, to be repealed
Dover to Deal MCZ	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
Dover to Folkestone MCZ	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
Dungeness SAC	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
East of Haig Fras MCZ		East of Haig Fras proposed measure	
Farnes East MCZ			
Folkestone Pomerania MCZ	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size	K&EIFCA Bottom Towed Gears (Prohibited Areas) Byelaw 2017	K&EIFCA Bottom Towed Fishing Gear (Prohibited Areas) Byelaw
Fulmar MCZ			
Fylde MCZ	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA Emergency Byelaw Bivalve Molluscs NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 3 Prohibition of Seine Netting NWSFC Legacy Byelaw 30 Fishing for lobster, crawfish, crab, prawn and whelk NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns	NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
Greater Haig Fras MCZ		Greater Haig Fras proposed measure	
Hartland Point to Tintagel MCZ		D&SIFCA Netting Permit Byelaw	
Isles of Scilly MCZ	IoSIFCA Voluntary Measures		
Kingmere MCZ	Sussex IFCA MPA Byelaw 2015		
Lundy MCZ	D&SIFCA Diving Permit Byelaw D&SIFCA Legacy Lundy No Take Zone Byelaw D&SIFCA Legacy Trawling, Netting & Spearfishing Byelaw D&SIFCA Potting Permit Byelaw	D&SIFCA Mobile Gear Permit Byelaw - changes to permit conditions D&SIFCA Netting Permit Byelaw	
Manacles MCZ	CIFCA Lobster, Crawfish and Crab Fishing Permit Byelaw 2016	CIFCA Manacles Towed Gear Byelaw	

Name	In force	In preparation	In force, to be repealed
Medway Estuary MCZ	K&EIFCA Byelaw No Take Zone K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		
North-West of Jones Bank MCZ		North-West of Jones Bank proposed measure	
Offshore Brighton MCZ		Offshore Brighton proposed measure	
Offshore Overfalls MCZ		Offshore Overfalls proposed measure (<12nm) Offshore Overfalls proposed measure (>12nm)	
Padstow Bay and Surrounds MCZ	CIFCA Lobster, Crawfish and Crab Fishing Permit Byelaw 2016		
Pagham Harbour MCZ		Sussex IFCA MPA Byelaw 2015	
Poole Rocks MCZ		SoIFCA Bottom Towed Fishing Gear Byelaw 2016	
Skerries Bank and Surrounds MCZ	D&SIFCA Diving Permit Byelaw D&SIFCA Legacy IPA Licence Agreement D&SIFCA Potting Permit Byelaw	D&SIFCA Mobile Gear Permit Byelaw - changes to permit conditions D&SIFCA Netting Permit Byelaw	
South Dorset MCZ		South Dorset proposed measure (<12nm) South Dorset proposed measure (>12nm)	
South-West Deeps (West) MCZ		South-West Deeps (West) proposed measure	
Stennis Ledges and Chesil Beach MCZ	SoIFCA Stennis Ledges Scallop Dredging Agreement	SoIFCA Bottom Towed Fishing Gear Byelaw 2016	
Tamar MCZ		D&SIFCA Hand Gathering Permit Byelaw D&SIFCA Netting Permit Byelaw	
Thanet Coast MCZ	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size	K&EIFCA Bottom Towed Gears (Prohibited Areas) Byelaw 2017	K&EIFCA Bottom Towed Fishing Gear (Prohibited Areas) Byelaw
The Canyons MCZ		The Canyons proposed measure	
The Needles MCZ			
The Swale Estuary MCZ	K&EIFCA Cockle Fishery Flexible Permit Byelaw K&EIFCA Legacy Mussel Byelaw K&EIFCA Legacy Vessel Length and Engine Size		

Name	In force	In preparation	In force, to be repealed
Torbay MCZ	D&SIFCA Mobile Gear Permit Byelaw	D&SIFCA Hand Gathering Permit Byelaw D&SIFCA Mobile Gear Permit Byelaw - changes to permit conditions D&SIFCA Netting Permit Byelaw	
Upper Fowey and Pont Pill MCZ			
Utopia MCZ		Sussex IFCA MPA Byelaw 2015	
West of Walney MCZ	NWIFCA Byelaw 3 Permit for cockles & mussels NWIFCA CSFC Legacy Byelaw 13 Multi-rigged trawls NWIFCA CSFC Legacy Byelaw 14 Shrimps or prawns NWIFCA CSFC Legacy Byelaw 26 Permit to fish for lobster, crab and whelk NWIFCA Emergency Byelaw Bivalve Molluscs NWIFCA Legacy Byelaw 12 Restrictions on Bivalve Molluscs NWSFC Legacy Byelaw 13A Management cockles & mussels NWSFC Legacy Byelaw 3 Prohibition of Seine Netting NWSFC Legacy Byelaw 30 Fishing for lobster, crawfish, crab, prawn and whelk NWSFC Legacy Byelaw 6 Restrictions on shrimp & prawns	NWIFCA Byelaw - West of Walney - to be prepared NWIFCA Byelaw 3 Review NWIFCA Byelaw bivalve molluscan shellfish 2016	
Whitsand and Looe Bay MCZ		CIFCA Whitsand and Looe Bay Towed Gear Byelaw	

C A Method for Assessing Displacement

C.1 Introduction

C.1.1 Purpose

This method for assessing displacement of fishing effort was funded by Natural England on behalf of the Fishing Displacement Steering Group, which comprises Defra, Natural England, the Joint Nature Conservation Committee (JNCC), the Marine Management Organisation (MMO), the Association of Inshore Fisheries and Conservation Authorities (AIFCA), and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

The Fishing Displacement Steering Group was set up in the context of the increasing spatial extent of the UK Marine Protected Area (MPA) network in English waters and a recognition that the effects of displacement (i.e. the redistribution of fishing activity affected by areas such as MPAs, spatial fisheries management restrictions and other maritime developments that may restrict access by fishing vessels to an area) need to be better understood and represented within decision making (e.g. within impact assessments). In particular, the net environmental impacts of displacement (i.e. environmental benefits from establishing protection for features in MPAs, and environmental damage resulting from the redistribution of fishing effort to other areas or other gear types) and options available to minimise any negative consequences, need to be better understood.

The purpose of this method is to support the consistent, effective and proportionate assessment of displacement of fishing effort in the English marine area as part of a range of possible interventions:

- MPA designation decisions;
- MPA management measure decisions;
- Other spatial area management decisions (e.g. for fishing regulations, licensing decisions);
- Review and revision of management measures as part of Adaptive Risk Management (ARM).

The method focusses on the development and assessment of management measures in MPAs, as that is the current focus of regulators in English waters. However it is equally applicable to other intervention types listed above. The assessment of displacement of fishing effort is one aspect of the overall process of assessment of a proposed intervention and should not be considered in isolation. It is likely to draw on the same information sources as the overall assessment, and it will also contribute information to the assessment of social and economic impacts in the Impact Assessment. A template for recording the outputs of the assessment of displacement is provided in Annex I.

C.1.2 Aim

The method provides a series of questions with supporting information on relevant factors and information sources to guide users in the consideration of relevant issues when assessing the potential for displacement of fishing effort and its impacts. The assessment of displacement should be integrated into the overall assessment process for the proposed management measure, not considered in isolation.

The method does not provide answers or look-up tables of what displacement might occur, as it will vary according to each situation and needs to be considered on a case-by-case basis by people with knowledge and understanding of the fisheries involved.

C.1.3 Scope

Type of intervention

The method is specifically developed for the assessment of displacement in the context of the development of management measures in MPAs. However, it may also be useful for the review of management measures and their adjustment under Adaptive Risk Management (ARM), and may also be applicable to other situations in which displacement of fishing effort is expected, such as other spatial area restrictions on activity from fisheries management measures, licensing decisions or other interventions that may affect access by fishing vessels. It may also be relevant to consider in the context of MPA designation decisions, although the potential for its use in this context in English waters is limited, as many sites have already been designated.

Fishing activities

This method is intended for the assessment of the following type of fishing activities:

- Boat-based fishing activity (not shore-based);
- All gear types.

Types of impact

The method is focussed on the assessment of potential environmental impacts (on habitats, species, and commercial fish stocks) of displacement. It also includes consideration of potential economic and social impacts on fishers and other marine users, so that a full consideration of the potential impacts of displacement can be undertaken. As economic and social impacts would form part of a full impact assessment, the method does not provide full detail on how to assess these aspects, but provides pointers to the types of issue that should be considered in those assessments in relation to the displacement of fishing effort.

Potential displacement effects and their impacts are many and complex, and there may be cumulative or synergistic effects (i.e. impacts may not be additive). The guidance provides information on the individual issues that may need to be considered, but does not provide a judgement on the significance of these issues which will be influenced by site-specific factors and a judgement of their significance will need to be taken by regulators.

Geographical relevance

The method has been developed in the context of English waters, although the principles may hold true for other UK and non-UK locations.

It is relevant to both inshore (within 12 nm) and offshore (beyond 12 nm) waters. The principles for assessing displacement apply to both, although the level of information available and potential and requirement for a detailed assessment may differ between different areas.

In the offshore area, there is a requirement to follow the CFP process to developing and submit a joint recommendation for a management measure to the Commission, together with other Member States.

Definitions

The following terminology is used in the context of this method:

Displacement of fishing effort is defined as the changes in fishing patterns and/or fishing behaviour that occur in response to a new spatially explicit intervention (e.g. MPA management measure or other spatial restriction):

- Changes in fishing patterns represent temporal and spatial changes in fishing activity e.g. a relocation of fishing effort from a fishing ground affected by a management measure to a different area.
- Changes in fishing behaviour represent other strategic fishing choices made by fishers e.g. changes in vessels, gear type, target species.
- Opportunities from displacement: displacement of fishing effort from an area may offer the opportunity for fishers with other, non-excluded gear types to increase their effort within the area under management.

Management area is the area to which a management measure (or other intervention) is applied,

Fishing sector is characterised by one catching gear and a group of target species, operating in a given area during a given season, within which each vessel exerts a similar exploitation pattern on a particular species or group of species.

C.1.4 Who is this method for?

This method is aimed at fisheries and conservation regulators (IFCAs, MMO, Defra), policy makers (Defra), statutory nature conservation bodies (Natural England, JNCC), and contracted consultants carrying out work on their behalf.

C.1.5 Requirements for considering displacement

There are a number of legislative drivers that, explicitly or implicitly, place a duty on competent and relevant bodies to give due consideration to the issue of displacement as part of spatial management measure decision making. The main drivers are as follows:

- **MPA legislation:**
  - **The Marine and Coastal Access Act** (2009) provides the legal base for the designation of Marine Conservation Zones (MCZs). It requires that the environmental, economic and social impacts of MCZs are taken into account.
  - **The Habitats and Birds Directives** (Directive 92/43/EEC and Directive 2009/147/EC respectively) and Regulations (which transpose them into UK law) provide the legal base for the designation of marine Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) (Natura 2000 sites). The UK Regulations require that the environmental impacts of displacement are taken into consideration; but social and economic impacts are not usually a reason to limit the level of environmental protection. However, SAC and SPA impact assessments have followed HMT Green Book Appraisal Guidance, and included social and economic impacts as well as environmental, as UK Ministers require impact assessments to be carried out.
- **Fisheries management legislation:**
  - **Common Fisheries Policy**: Outside of 12nm, fisheries are regulated through the Common Fisheries Policy (CFP) (Regulation (EU) No 1380/2013 and associated

regulations). Fisheries management measures for MPAs outside of 12 nm must be implemented under Article 11 of the CFP, 'Conservation measures necessary for compliance with obligations under Union environmental legislation', in conjunction with the general provisions of Article 18 'Regional cooperation on conservation measures'. Within 12 nm, measures but can be implemented through UK legislation (Statutory Instruments (Orders), MMO or IFCA byelaws (within 6 nm)) or by the Commission (where the site straddles the 12 nm boundary). MMO could also implement measures through changes to UK fishing licences such as by changing allowable gear types or setting spatial restrictions. For English MPAs beyond 12 nm, the UK should reach agreement with other Member States and submit to the European Commission a joint recommendation. EU guidance on development management measures for Natura 2000 sites outlined eleven information requirements (see Annex A) in support of this, one of which (question 11) requires consideration of the displacement of fishing effort and its impact on new areas.

- **Marine policy and marine plans:**
  - The UK Marine Policy Statement highlights that marine plan authorities 'should have regard to the impacts of displacement [of fishing vessels] and whether it is possible for vessels to relocate to other fishing grounds. They should also consider the potential impacts of this displacement on the viability of fish stocks and on the marine landscape in the alternative fishing grounds. They will also wish to consider and measure the impacts on local communities of any reduction in fishing activity, redistribution of fishing effort or associated impact on related businesses as the result of a marine development'. This is articulated through regional marine plans (produced by the Welsh Government in Wales and the MMO in England). Currently the only adopted plans in England and Wales are the East Marine Plans (which includes a marine plan policy on displacement).
- **Other relevant environmental legislation:**
  - The Natural Environment and Rural Communities (NERC) Act 2006 places an obligation on public authorities to have regard for the conservation of biodiversity;
  - The Countryside and Rights of Way (CROW) Act 2000 provides for the protection of Sites of Special Scientific Interest (SSSIs) in England and Wales and the public right of access. IFCAs have powers to grant permissions to other parties to carry out proposed operations, and where such operations are likely to damage a SSSI, they must consult and take advice from Natural England.
  - The Marine Strategy Framework Directive (MSFD) (2008/56/EC). The MSFD requirement for the establishment of an ecologically-coherent network of MPAs is being implemented in English waters through the MCZs under the Marine and Coastal Access Act and the Birds and Habitats Directives (see above). Also relevant are measures of seafloor integrity (Descriptor 6) for the achievement of Good Environmental Status, which consider amongst other things the extent of the mobile demersal fishing footprint in the marine environment.

C.2 Using the method in the assessment process

C.2.1 The assessment scope

The development of a management measure for an MPA involves consideration of options that are expected to achieve the Conservation Objective, and assessment of the anticipated environmental, social and economic impacts (although in some cases only a single option may be available). An Impact Assessment is usually focussed on the social and economic effects; and in the case of the Habitats Directive, an Appropriate Assessment considers environmental aspects in relation to impacts

on designated features and potential for conservation objectives to be achieved. For significant licensing decisions, an Environmental Impact Assessment would consider the potential environmental impacts.

A sound understanding of the potential impacts of displacement of fishing effort, and therefore the net effects on the wider marine environment, fishers and coastal economies and society, are necessary to support sound environmental policy decision making and can support efforts to reduce and thereby minimise any potential negative impacts of such policy.

The potential for displacement of fishing effort, and its consequences (environmental, economic and social) are already considered as part of the overall assessment process. This guidance on assessing displacement should be used within that overall assessment process, to help structure the consideration of potential displacement effects and their impacts, to ensure all relevant aspects are considered (Figure C14).

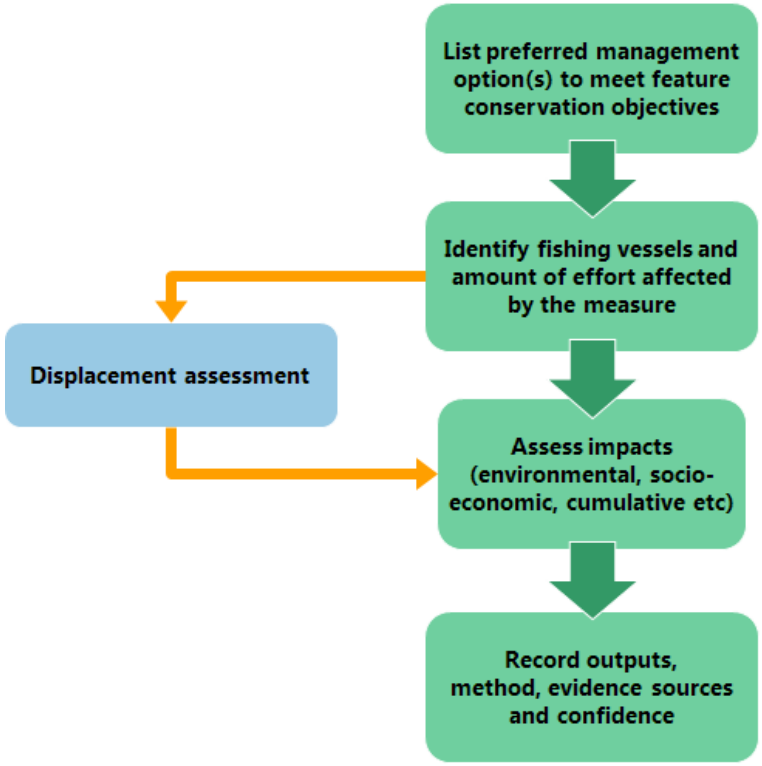

Figure C14. Assessment of displacement within the overall assessment process

With regard to MPAs, there are three stages at which consideration of displacement effects may be relevant:

- **Stage 1: MPA designation:** a fuller understanding of the impacts can support better design of options, i.e. are there MPA options that will meet the network's ecological coherence criteria but allow for the potential negative effects of displacement (ecological, socio-economic or safety risks) to be minimised?
- **Stage 2: MPA management measures:** a fuller understanding of the potential impacts can support better management, i.e. are there options that result in less adverse or more favourable displacement effects whilst still enabling the Conservation Objectives of the site to be achieved?

- **Stage 3: Review and revision of measures:** Management measures should be periodically revisited to ensure that they are still appropriate, relevant and are providing the required level of protection. This may form part of Adaptive Risk Management (ARM), where the results of monitoring feed in to the review and potential revision of management measures. In this situation, the guidance can help to identify potential displacement effects and impacts, which can be used to inform the design of monitoring and evaluation systems, and can also inform ways in which measures could be adjusted to reduce displacement impacts.

Stages 1 and 2 may be underpinned by two assessment approaches, which may be applied sequentially as part of the planning process:

- **Rapid appraisal for options development** (Figure C15)
  - This will typically require a relatively light-touch and rapid assessment of displacement in order to:
    - Screen whether displacement is likely to be a significant consideration and therefore whether additional effort is required to complete a full assessment;
    - Support the development and refinement of the options in an iterative process, with rapid appraisal of options and identification of their potential displacement impacts resulting in the refinement of options or development of alternatives, until a preferred approach is identified that achieves the objectives (e.g. Conservation Objectives or other objectives) whilst minimising displacement impacts. This may include consideration of the types of management measures available (e.g. zonation, effort management or technical measures that modify the level of impact from fishing gears) and the characteristics of management applied (e.g. size and location of areas zoned, effort limited or capped).
    - Scope issues to consider in the full assessment.
  - Management options need to meet the Conservation Objectives. There may be other practical considerations which limit the options that may be available. Among suitable potential options, other trade-offs may need to be considered, such as the pace of progress towards meeting conservation objectives. The template may be used to record outputs that contribute to the consideration of management options included in site risk assessments.
- **Full assessment of short-listed option(s)** (Figure C16)
  - This will typically require a fuller assessment of displacement in order to assess the preferred option(s) and consider the implications. It should be preceded by a rapid appraisal in order to refine the selection of the preferred option(s) and scope the issues that require the most attention.
  - The completion of the template as part of the full assessment may form a contribution to an impact assessment.

The method is appropriate for both rapid and full assessments, with the level of analysis and level of detail to be recorded being proportionate to the needs of the assessment being carried out.

The template (Annex I) provides a format for recording summary outputs of the displacement assessment; in the case of a full assessment, this may point to other sections of the overall Impact Assessment and other supporting documents where the information and underlying analysis is available in more detail.

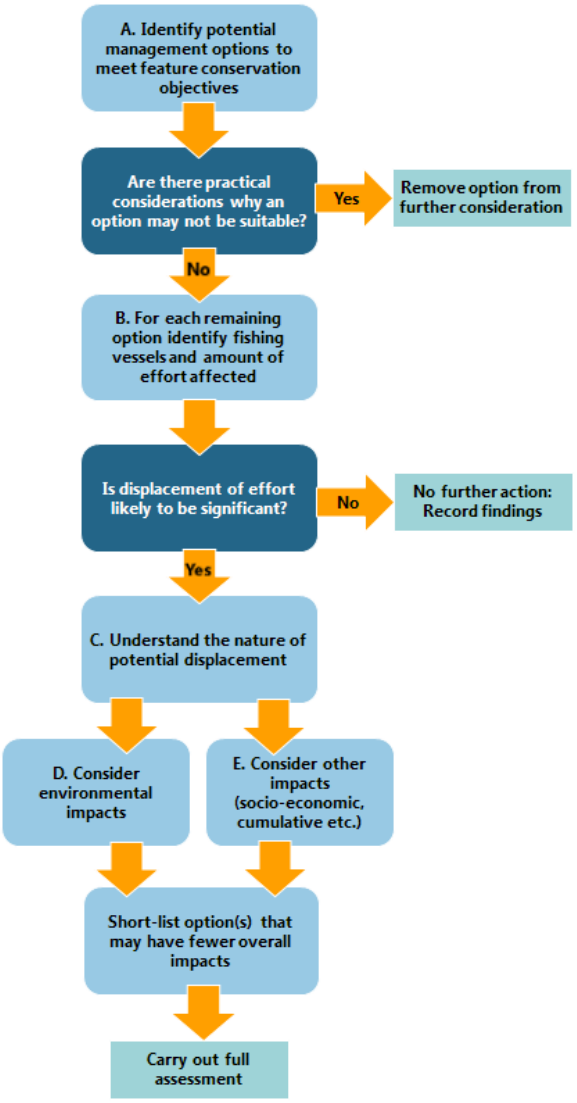

Figure C15. Rapid assessment process

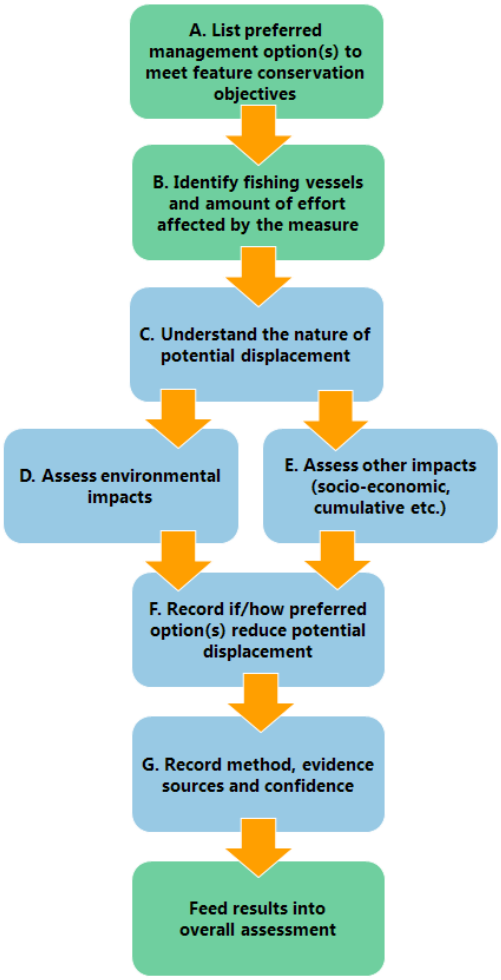

Figure C16. Full assessment process

Note: Green boxes represent those from the overall assessment process, where information will inform the displacement assessment.

C.2.2 Assessment principles

Assessment of displacement and its impacts should take place as part of the development of, overall assessment of and refinement of an MPA, management measure or other intervention.

Displacement impacts arise as a consequence of spatial management measures or other interventions that cause the displacement of fishing effort to other areas, species or gear types. The impacts may be environmental, economic or social. The assessment of potential displacement and its impacts provides for a more complete consideration of the net impact of proposed management measures on the environment and on socio-economic sectors.

Proportionality

The effort applied at each step should be proportionate to the significance of outcomes at stake, funds involved and the time available.

Accordingly, in the early steps of identifying and appraising options, normally only summary data are required. Later on, before significant funds are committed or decisions made, the confidence required must increase. As the stages of an assessment progress i.e. from options development to selection, data should be refined to become more specific and accurate. Despite this, significant uncertainties in assessing potential displacement and its impacts are likely to remain and should always be clearly recorded.

Spatial scale

The spatial scale at which potential displacement effects and impacts should be considered depends on the nature of the fishing sector affected. For example, displacement of 10m and under inshore vessels is likely to be limited to the surrounding area (unless vessels move to a different port, see section C.2), whereas displacement of larger vessels, or vessels that operate a nomadic fishing strategy such as larger scallop vessels, is likely to take place over greater distances and the spatial scale considered should be correspondingly larger.

Marginal impacts

Assessment seeks to appraise the impacts of the option(s) against the business as usual, or do nothing (or do minimum) option. The output of the appraisal is an analysis of the marginal changes in environmental, economic and social conditions brought about by the option under consideration compared to those conditions under the business as usual case. Comparison of the displacement impacts of different options (each of which should achieve the relevant objectives for which the measure is being introduced) can be used to support decisions on the preferred option (which will also take into account other considerations).

Cumulative and in-combination assessment

The template and method is designed to be used to assess a single management measure or series of management measures within a particular site. Where a site straddles different marine areas and several management measures are proposed to cover the different portions of the site (e.g. an IFCA byelaw within 6 nm, and/or an MMO byelaw in 6–12 nm, and/or a CFP Regulation beyond 12 nm), it is recommended to assess the management measures together as they are all necessary for achieving the conservation objectives of the site. However, advice should be sought from the decision making body to ensure that the subject of the assessment is aligned with the needs of the regulatory decision making process.

Other activities and interventions in the marine area may also result in the displacement of fishing effort. The effect of existing activities on fishing should be considered within the assessment of displacement in section C. The potential cumulative effect of planned and future activities on displacement of fishing activity should be considered through an assessment of the cumulative effects in section E. Depending on the nature and scale of other interventions, a more comprehensive assessment of cumulative effects may be required, where possible. Other activities and interventions that may result in cumulative effects are:

- Planned or proposed management measures in other MPAs that also affect the same fishing sectors[28];
- Other planned or proposed marine activities such as offshore wind farms that may also cause displacement of fishing effort;
- Planned or proposed CFP and other fisheries management measures that may cause displacement of fishing effort.

Consideration of these aspects is necessary as this may affect the potential areas where fishing activity could be displaced to, or these may result in future additional displacement of fishing effort, with additional environmental impacts.

The effect of existing measures and existing activities should be taken into account in the assessment of potential displacement, and will influence the potential areas to which fishing effort might be displaced to.

Addressing impacts

Consideration of a range of options, and the iterative application of rapid assessments should support the development of options that minimise the potential impacts of displacement where possible. Nevertheless, it may not be possible to avoid all impacts and the assessment of potential displacement may identify potential environmental, social or economic impacts.

An understanding of these potential impacts and consequences of the displacement of fishing effort may feed in to the development of further actions, such as monitoring to identify whether the expected effects and impacts occur in practice, and/or whether other unanticipated consequences arise may be. An understanding of what the potential impacts are, from the displacement assessment, can also contribute to the identification of further actions that may be required, and can be taken forward by appropriate agencies or organisations. This may include addressing any identified environmental impacts or supporting displaced fishers to adapt to the new management and adopt fishing strategies that minimise environment impacts, or retrain.

[28] A fishing sector is characterised by one catching gear and a group of target species, operating in a given area during a given season, within which each vessel exerts a similar exploitation pattern on a particular species or group of species.

C.3 Assessing Displacement

The following sections describe the considerations for assessing displacement of fishing and its impacts. Where the guidance refers to a single 'measure', this can be read as 'measures' if several measures are being considered together in the assessment.

A template (Annex I) is provided which can be used to record the outputs of the assessment. The guidance is therefore phrased in terms of completing the sections in the template, but can also be used independently of the template if appropriate.

Information presented in the template should be concise (approximately 4–6 pages in total), presenting either a rapid appraisal, or a summary of a more in-depth assessment. In the latter case, this is likely to be supported by additional, more comprehensive documents that detail the methodology, analysis, data sources, confidence in assessment etc. for different parts of the assessment. The template should be completed once for each management option being assessed, on a site basis, i.e. if a combination of several measures is required in different parts of the site (within 6 nm, 6–12 nm, beyond 12 nm, they should be considered together.

A Background information and document control

The purpose of this section is to record basic information about the measure being assessed in the template, and information about the version of the document, authorship, date etc., if required.

A.1 Management measure name:

Provide the name of the management measure or measures being considered.

A.2 Site name(s) (if applicable):

If the measure relates to an MPA or MPAs, provide the site name(s) to which the measure applies, and the type of MPA (e.g. SPA, SAC, Ramsar, MCZ, SSSI etc.).

A.3 Regulators:

Lead regulator: Provide the name of the lead regulator for the measure.
Other regulators: List any other relevant regulators for the measure.
Conservation adviser: Identify the conservation adviser for the measure.

A.4 Brief description of the management measure:

Provide a brief description of the management measure, to include:

- The type of instrument (e.g. voluntary measure, byelaw, statutory instrument, CFP measure etc.);
- The feature protected, or the reason the measure is needed;
- The gear types affected;
- The nature of the measure (e.g. permanent closure to the affected gears, closure during specific times, the area over which the measure applies such as the whole site or portions of it).

It is recommended to consider all of the management measures for fishing across the whole site together in relation to their displacement effects. However, if measures in individual portions of the site are assessed separately (e.g. an IFCA byelaw within 6 nm, and an MMO byelaw in 6–12 nm), then

the effects of the measures together should be considered in the cumulative/in-combination assessment.

A.5 Area to which the measure applies:

Tick boxes to identify whether the measure applies to: within 6 nm (<6 nm), between 6 and 12 nm (6–12 nm), or beyond 12 nm (>12 nm), or a combination of these. Additional text can be added for clarification if needed.

Document control fields:

Record the version type (e.g. draft, revised, final), date, authors and approver for the assessment.

B Fishing effort affected by the management measure

This section aims to identify the type and amount of fishing effort affected by the management measure that may be subject to displacement, with the objective of better understanding the potential nature and impacts of displacement in sections C and D.

Information on questions B.1 and B.2 are likely to already be considered as part of the overall assessment process (e.g. for a regulatory impact assessment, MPA assessment, Habitats Regulations Appraisal) and the information should be drawn from there; responses may summarise the information and point to the relevant detail in the full assessment. The two questions are likely to be analysed together, but it is helpful to record the information separately.

B.1 Which fishing activities will be directly affected by the management measure(s), and how is this distributed across sectors?

Purpose: To identify the fishing sectors[29] directly affected by the management measures and thereby present an understanding of the key characteristics of the affected fleet which may subsequently influence the nature of displacement and/or its impacts.

Output: Detailed information about the individual fishing sectors affected by the management measure i.e. the characteristics of the affected fishing activities. A fishing sector is typically defined in terms of the vessels' nationality (flag state), size, gear type and target species; however a number of additional contextual factors should be considered where these are likely to be relevant for subsequent analyses (see Box B.1). The level of detail to which fishing sectors are defined will depend on the level of differentiation required (e.g. in relation to different fishing patterns and potential for displacement between different vessel types) and level of detail in the data available (more detail may be available for UK vessels compared to non-UK vessels). Where there is limited information on fishing sector or gear type, expert knowledge could be used, or gear codes could be taken from the EU Fleet Register.

The different levels of detail likely to be required are:

- **Rapid appraisal:** a simple characterisation of relevant fishing sectors using expert opinion and readily accessible information;

[29] A fishing sector is characterised by vessels with similar characteristics operating the same catching gear for a (group of) target species. They may demonstrate similar exploitation patterns, engine power, home port, landing ports etc.

- **Full assessment:** a comprehensive characterisation of relevant fishing sectors drawing on all appropriate data sources and articulating all relevant characteristics identified during the scoping stage (questions B/C) as relevant for the assessment.

Box B.1: Variables for characterising fishing sectors

Core aspects:

- Nationality (relevant for 6–12 nm and beyond 12 nm areas);
- The gear types used by the vessels of each size category (including alternative gear types that they already use, but that are not affected by the management measure);
- The size of vessels affected (presented as a minimum as 10m and under, 10–15m; 15m and over, with more detailed or bespoke classification where appropriate);
- Target species.

More detailed considerations:

- Home port and principal landing port locations;
- Vessel range / distribution of regular fishing grounds;
- Seasonality;
- Typical fishing trip duration;
- Vessel licence and quota access.

Information sources:

- Expert knowledge:
  - Local fisheries managers;
  - Local and national fisheries organisations / representatives;
  - Individual fishers' data and knowledge;
- IFCA and MMO sightings data;
- Vessel Monitoring System (VMS) and inshore VMS (iVMS) data, if available;
- MMO iFISH database with landings by ICES rectangle;
- Stakmap under-15m data layers by gear type (available from MMO);
- UK National Inshore Fishing Activities Data Layer (available from https://www.cefas.co.uk/cefas-data-hub/fishdac/).
- MMO vessel registry (to identify number of vessels at home ports in the vicinity of the measure.
- EU Fleet Register (ec.europa.eu/fisheries/fleet/index.cfm).

B.2 How much fishing effort is likely to be directly affected by the management measure?

Purpose: To quantify the amount of fishing effort affected by the management measure, in overall terms, to support later assessment of its potential displacement and resulting impacts. This can be presented in terms of number of hours fished, fishing days, number of vessels or other appropriate measure.

Output: Description or quantification of effort affected by the management measure, by fishing sector.

Considerations:

The information required is likely to be needed as part of the overall process of developing and assessing management measures. This section provides guidance on what measures can be used and where the information can be sourced from, but the information should ultimately be drawn from the overall assessment.

Fishing effort is the amount of fishing gear of a specific type used on the fishing grounds over a given unit of time e.g. hours trawled per month, number of hooks set per day or number of kilowatt hours of effort per month or year. Total effort for the purpose of appraisal may be set against an annual time unit.

Several years' data should be considered. For example, an average over the last five years can be used, or a longer time period can be considered, if the area is used less frequently on a rotational basis.

The different levels of detail likely to be required are:

- **Rapid appraisal:** provide best-available information based on expert knowledge or easily-available information sources;
- **Full assessment:** more detailed investigation into extent of fishing effort affected by the proposed management measure, proportionate with the significance of the measure.

An initial assessment of fishing effort that will be affected by the management measure should be made in terms of the number of vessels and/or the volume and value of landings directly affected by the measure:

- Number of vessels, including any important seasonal variation – this may be estimated from:
  - expert knowledge;
  - catch returns;
  - sightings records;
  - VMS data;
  - Stakmap under-15m data layers by gear type (2012) but this only provides information on the number of vessels per grid cell per month, and not more detailed information on effort or volume or value of landings, and is likely to underestimate fisher numbers;
  - UK National Inshore Fishing Activities Data Layer;
  - consultation with affected fishers.
- Annual volume and/or value of landings affected, including any important seasonal variations — this can be estimated in various ways, depending on the data available and the level of precision required (see Seafish & UKFEN, 2013 for further details[30]):
  - Landings from the ICES rectangle (from the relevant gear type) pro-rated according to the proportion of the ICES rectangle affected by the management measure;
  - Landings from the area affected by the management measure by the relevant gear type, based on VMS data linked with logbook data (so that a value and volume of catch is associated with each fishing ping) (data from MMO). This is only possible for over-15m vessels with VMS, and (for more recent years, over-12m vessels). For non-UK vessels, VMS data with landings value would need to be obtained from the flag state's competent authority and there may be a charge for them to prepare such data. In this case, alternative measures can be used (see below 'number of VMS 'fishing' pings', which provide an indication of the number of hours fished, and for which MMO has for all vessels in English and Welsh waters);

[30] Seafish and UKFEN (2013). Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments. Guidelines based on outputs from a technical workshop organised by the UK Fisheries Economics Network. 2nd Edition. Revised 2013. 53 pages. Available at http://www.seafish.org/media/1133259/ukfen%20ia%202nd%20ed%20final%2011dec13.pdf [Accessed 23/02/17].

- MCZ Fisheries Model, which combines mapped fishing areas (Fishermap) for under-15m vessels with landings data for the ICES rectangle, and distributes the landings value across the identified fishing grounds. However, this is based on data from 2007–2010 and is now quite out-of-date.

Further measures that more specifically reflect fishing effort which may be considered, depending on the availability of data and their appropriateness for the case under consideration, include:

- Number of fishing days or number of trips;
- Number of kilowatt hours;
- Number of VMS 'fishing' pings (which provides an indication of the number of fishing hours);
- Number of fishing days multiplied by number of hauls per day;
- Number of or extent of static gear (e.g. number of pots, length of nets, number of hooks).

Information sources

- Consultation with fishers and fishing associations;
- Expert knowledge of local fishery officers, IFCA data sources;
- MMO and IFCA sightings data;
- IFCA fishing effort surveys if available;
- Landings by ICES rectangle;
- VMS data;
- MCZ Fisheries model (publications.naturalengland.org.uk/file/1958806);
- Stakmap under-15m data layers by gear type (number of vessels) (available from MMO);
- UK National Inshore Fishing Activities Data Layer (available from https://www.cefas.co.uk/cefas-data-hub/fishdac/).

Note that information on 10m and under activity and landings has significant uncertainties due to the reporting requirements for this part of the fleet.

B.3 Is this considered significant, or likely to generate significant effects that require further investigation?

Purpose: To identify whether displacement and its impacts are likely to be significant and require further investigation.

Output:

- Indicate 'Yes' if the level of fishing effort affected by the management measure is expected to be significant (judgement of 'significance' needs to be on a case-by-case basis, as this may vary from fishery to fishery and from region to region). In this case, the remaining questions in the guidance should be considered, and the assessment should continue under sections C to F.
- If the level of fishing effort affected by the management measure is not expected to be significant, yet there are concerns or indications that it may generate significant effects that require further investigation (on the environment, on other fishing sectors or on other marine sectors), then 'yes' should be ticked, and the assessment should continue under sections C to F.
- If the level of fishing effort affected by the management measure is minimal, and it is not expected to generate significant effects on the environment, on other fishing sectors or on other marine sectors, then 'No' should be ticked, and a justification for this judgement should be recorded. There is no need to continue further with the assessment.

C The nature of predicted displacement

This section aims to understand how much of the fishing effort identified in part B might be displaced (C.1), where it might be displaced to, either spatially (C.2) or to other gear types (C.3), and whether there is the potential for other gear types to move into the area subsequently (C.4). This will then feed in to the assessment of potential impacts of displacement in section D. There are likely to be many uncertainties in predicting the nature of potential displacement; where it is not possible to make a prediction for a question, or there is a high level of uncertainty in potential outcomes, this should be recorded.

C.1 How much fishing effort is likely to be displaced from the management area?

Purpose: To identify whether and how much of the effort affected by the management measure is likely to be displaced, and how much may be lost or removed from the sector.

Output: Consideration of the scale and proportion of the affected fishing effort that is likely to be displaced (e.g. by fishers choosing to increase effort on other fishing grounds), and the scale and proportion that may be lost (e.g. by fishers choosing not to increase effort elsewhere, or leaving the sector). Ideally this will presented, by metier and in aggregate, quantitatively through indicators such as vessel numbers, value of landings and other measures of effort. A qualitative assessment should be made where this is not feasible.

Considerations:

- The assessment of how much fishing effort is likely to be displaced is based on B.2 (amount of fishing effort affected by the management measure), but should consider the potential for fishers to forego the displaced effort or exit the fishery altogether (which could be considered as 'onshore displacement', to activities or other employment opportunities on land; this may create additional 'latent' effort that may have the potential to re-enter the fishery at a later date).
- Fishers that do not exit the fishery are likely to displace their fishing effort to other areas or gear types.
- Where a fisher chooses to exit the industry, the level of effort and value of landings lost equates to the total level of effort / value of that fisher, not just that directly displaced by the management measure.
- As a worst-case scenario (in terms of the impacts of displacement), it can be assumed that 100% of the effort affected will be displaced.

The different levels of detail likely to be required are:

- **Rapid appraisal:** best-available information based on expert knowledge or easily-available information sources;
- **Full assessment:** a more comprehensive assessment of the potential for displacement or for effort to leave the fishery, based on consideration of the relevant factors in Box C.1. This may be based on expert judgement, consultation with fishers, and/or more in-depth analysis of financial performance.

An understanding of the financial situation of the affected fishers will help identify whether the implementation of the management measure could result in their businesses becoming unviable. The value of landings affected by the measure as a proportion of turnover may inform whether the effect is likely to be significant. This can be informed by information from the Seafish Fleet Economic Survey which includes turnover and profitability for different fleet segments. Depending on the detail required for the assessment, this could be done on an aggregate level, or down to the level of

individual vessel. This was considered as part of the in-depth Scottish NCMPA displacement work, which considered, for individual vessels, the proportion of turnover expected to be affected by the MPAs, and the impact it would have on their profitability.

If all fishers will exit the fishery, questions C.2 and C.3 do not need to be considered. However, in most cases this is unlikely to occur. In cases where fishers are expected to exit the fishery, licences and quota associated with their fishing operations may be sold or leased and therefore the effort may not be completely removed from the system. However, this is likely to be difficult to quantify.

Box C.1: Relevant factors

Factors that may influence whether a fisher is likely to stop fishing in response to a management measure (see literature review in the main report for more details):

- The proportion of the fisher's overall fishing grounds, quota, effort or turnover that is likely to be affected by the measure. The larger the proportion of fishing grounds, effort or turnover affected, the more likely it is that they would stop fishing.
- This is likely to be more significant where opportunities for compensatory fishing effort are constrained e.g.:
    - Inshore fishers or 10m and under vessels with a limited operating range, with limited ability to safely travel to more distant fishing grounds that are not affected by the measure;
    - Measures that affect a large proportion of a habitat type or fishing ground in an area;
    - Fishers have limited knowledge of other grounds and limited access to other gears.
- The financial situation (profitability) of the fishing operation; fishers operating in a loss-making situation or with low profitability may be more likely to stop fishing.
- Other socio-economic factors e.g. fishing employment status (part-time / full-time); employment history and education; access to alternative employment opportunities; age.

Information sources:

- Expert knowledge;
- Consultation with affected fishers;
- The Seafish Economic Fleet Performance dataset contains information on financial performance by fishing sector for the UK fishing fleet:
    - http://www.seafish.org/research-economics/industry-economics/seafish-fleet-economic-performance-data.

C.2 Where might fishing effort be displaced to?

Purpose: To identify the areas where fishing effort might be displaced to, which will then feed in to the consideration of potential impacts of that displacement on the environment, on other fleet segments and on other sectors.

Output: An indication, quantitatively where feasible (e.g. number of vessels, value of landings or units of effort), of possible areas to which fishing effort might be displaced. This should be considered separately for each fishing sector displaced.

Considerations:

- Existing fishing grounds, based on areas already exploited:
    - Where are the current fishing grounds for the fishing sector that are not affected by the management measure?

        - This might be in the vicinity of the measure, or further afield (see bullet point below on 'Attachment to home port vs nomadic fishing strategies').
        - If part of a fishing ground is affected by the management measure, effort might be expected to be displaced (at least initially) to the boundaries of the management area, increasing the level of effort in the area immediately surrounding the closure.
        - If the existing fishing grounds are limited, or are already heavily exploited, the potential for interference and conflicts between vessels will be greater, and there is more chance of effort being displaced into new grounds (see below).
    - What is the current distribution of effort in the existing grounds, and what is the expected redistribution of the displaced effort? This could be assumed to be in proportion to the current relative distribution of effort.
- Potential for new fishing grounds to be explored, based on habitat type:
    - Are there other areas of suitable habitat that might be explored as new fishing grounds?
        - Habitat maps can be used to identify other potential areas of suitable habitat that might be explored as new fishing grounds. This may be more appropriate for fisheries that have a strong linkage with a particular habitat type (e.g. flatfish on sandy substrates; *Nephrops* on subtidal mud; scallops on sand and gravel substrates). However, it should be noted that not all habitats that appear suitable will be in practice, and there are many other environmental parameters that determine the quality of fishing grounds.
        - If there are no other suitable habitat areas, then displaced fishing effort may be concentrated into existing fishing grounds. In the inshore area, there are unlikely to be any new fishing grounds as coastal waters have been extensively fished for many years.
- Vessel size (as a proxy for vessel range):
    - The availability of alternative fishing grounds should be considered in relation to the operating range of the vessels involved.
    - Smaller vessels (e.g. 10m and under), have a limited operating range and therefore the alternative fishing grounds that they could exploit are limited spatially.
        - For example, the displacement assessment for Scottish Nature Conservation MPAs considered a 15 nm distance from port, based on the assumed operating range for a single fishing day for an inshore vessel.
- Attachment to home port vs nomadic fishing strategies:
    - Some vessels operate only out of a single home port and show long-term fidelity to known fishing grounds. Other vessels have more nomadic fishing strategies, exploiting opportunities in different regions and at different times.
    - For example, the larger scallop and crab vessels are nomadic, with movements of vessels determined by a range of factors including season and weather conditions, management restrictions and the time of spawning. They operate in a wide geographical area around the UK and rotate different areas over a period of several years.
    - Even smaller vessels have the potential to move home port and exploit a fishery in a different region, particularly those that operate a semi-nomadic fishing strategy, such as some whelk potting vessels. However, this is likely to be the exception rather than the norm for smaller vessels, and may cause conflict with other fishers (see E.1).
- Other constraints:
    - Fishing activity is restricted by the availability of licence entitlements to target particular species, and quota availability in different ICES areas. If possible, these aspects should be taken into account when considering possible areas where effort might move to, or may not be able to move to.

  - Are there existing expectations about developments in other marine sectors (e.g. wind farms) or indications of potential future development priorities in marine plan policies that may constrain the opportunities for displaced fishers to target alternative grounds in the future? Such information may be available from: the MMO Marine Information System (other licensed activities), or via consultation with the MMO or sectoral representatives. This should be reflected in the cumulative assessment (see question E.4).
- If, based on consideration of the above, fishing effort is not able to be displaced to alternative grounds, then question C.1 should be revisited and this information should be reflected there.

Information sources:

- Consultation with affected fishers.
- Expert knowledge of the range of existing fishing grounds, both in the vicinity of the measure as well as further afield.
- Maps of fishing grounds (some IFCAs have produced maps of fishing grounds for different species, Fishermap or Stakmap might also help identify existing fishing grounds for inshore fishers):
  - Stakmap under-15m data layers by gear type (available from MMO);
  - Eastern IFCA Fisheries Mapping Project: www.eastern-ifca.gov.uk/about/fisheries/fisheries-mapping-project/.
- Habitat maps to identify other areas of suitable habitat for fisheries which have a strong relationship with habitat type.
- UKSeaMap 2016 provides a broadscale habitat map for the UK: http://jncc.defra.gov.uk/ukseamap
- VMS data for a specific gear type (or, if possible, gear type and target species combination), might also provide an indication of the extent of fishing grounds (contact MMO for details).
- MMO Marine Information System (MIS) and MMO and sector representatives.

C.3 Might the affected vessels switch to a different gear type?

Purpose: To identify the potential for the fishing effort affected by the management measure to be displaced to other gear types.

Outputs: An indication, quantitatively where feasible (e.g. number of vessels, value of landings or units of effort), of possible gears for which the level of effort might increase, and if possible an understanding of the areas in which they might operate.

Considerations:

- This is likely to be an aspect of potential displacement response that is very difficult to predict with any level of certainty. Fishers that are affected by a management measure may decide to switch to a different gear type that is still permitted within the area, in order to continue operating in the area. However, effort may switch gear type and also move to other areas.
- Flexibility in gear switching may be informed by the following:
  - Do the vessels affected by the management measure already operate multiple gear types for different species, and/or in different seasons? If they do (for example, polyvalent vessels, particularly smaller-scale inshore vessels that may use nets, pots, lines and other gears), it may be relatively easy to switch between gear types and for effort to be displaced to a different gear. Note, however, that this does not guarantee that suitable fishing opportunities would be available and the loss of one part of the overall fishing strategy may make the whole fishing business unviable (see question C.1).

- Could the fishing sector's target species be caught with other gears (that are not affected by the management measure)? For example, cod could be caught with nets or pots instead of trawls.
- Are there other fisheries that the fishers might switch to targeting? This may be informed by a knowledge of stock abundance, market demand and prices for different species.
- What are the barriers (regulatory, cost, safety, functionality) to vessels changing to another gear type? Regulations and licence restrictions, existing investment in gear, the cost of reconfiguring a vessel and purchasing new gear, together with safety considerations and whether it is physically possible to reconfigure a vessel, will affect the potential for vessels to switch to an alternative gear type.

Information sources:

- Expert knowledge;
- Consultation with affected fishers;
- Information on the fishing sectors, their different gear types used for other fisheries and fishing strategies.

C.4 Could there be an increase in effort by other fishers using different gear types in the management area?

Purpose: To identify whether the removal of some gear types from the management area might open up the possibility for other gear types to operate in the area.

Outputs: An indication, quantitatively where feasible (e.g. number of vessels, value of landings or units of effort), of the potential for an increase in effort within the management area by gear types that are still permitted within the area.

Considerations:

- Is the activity of the fishing sector to be removed from the management area incompatible with the operation of other gears?
  - For example, potters and netters are unlikely to be able to exploit the same area at the same time as towed demersal gears. If the towed demersal gear effort is removed from the management area, there is the potential for static gear to increase in response.
- Is the area a good fishing ground for other species that could be caught with other gears that were previously excluded from the management area?
- Is there any information on how much fishing effort might be deployed in the area (e.g. based on the number of vessels that may start fishing there and their capacity)? Is this likely to be additional effort or a redistribution of existing effort from elsewhere?
- Might there be an increase in infringements by some vessels into the management areas, due to for example reduced availability of fishing grounds and greater fishing pressure on the open grounds leading to a drop in catch rates.

Information sources:

- Expert knowledge of other fisheries in the area;
- Consultation with affected fishers;
- Information on the fishing sectors, their different gear types used for other fisheries and fishing strategies.

D Environmental impacts of predicted displacement

This section aims to identify the environmental impacts of the predicted displacement, with the objective of determining the potential risk of increased environmental damage after the implementation of the proposed management measure compared to before. It considers potential impacts on habitats (D.1), species (D.2) and commercially exploited stocks (D.3). It builds on the identification of fishing effort displaced (section B), and the consideration of the nature of predicted displacement (section C).

Quantitative information and certainty about potential impacts is likely to be difficult to obtain, particularly given the uncertainties in predicting where fishing effort may be displaced to, gaps in the primary evidence about impacts of different gear types on different habitats (particularly in relation to impacts at different levels of fishing intensity), feature condition assessments, and habitat (type and condition) outside of designated sites. The potential risks, and a consideration of the relative impact before and after implementation of the proposed measure, can therefore form the basis for a qualitative assessment of the potential environmental implications of displacement. Where information is not available, or it is not possible to assess a particular question due to a lack of evidence, this should be recorded.

The responses to these questions should consider the following (which can be detailed separately, and/or considered in aggregate):

- Potential impacts of the fishing effort that has been displaced, either to other areas or to other gear types, both within and outside the management area (C.2, C.3);
- Potential impacts within the management area of increased use of other gear types (C.4); and
- Within both of the above, the amount of fishing effort displaced (C.1).

D.1 What are the potential impacts of predicted displacement on habitats and benthic communities

Purpose: To identify the potential impacts that predicted displacement might have on the habitats and benthic communities where it is displaced to, taking into account designated status and conservation objectives, gear impacts and habitat or biotope sensitivity to those impacts.

Outputs: An indication of the balance of probability of habitat impacts as a result of the displacement predicted in questions C.1–C.4. A quantitative assessment with any degree of certainty is likely to be difficult to achieve, but by taking into account the points elaborated under 'Considerations', it should be possible to make a judgement on the potential net impacts on habitats of the proposed management measure.

Considerations:
To answer this question, it is necessary to consider the different aspects of displacement already described in Section C:

- Spatial displacement of effort to other areas; and
- Potential for an increase in effort of other gear types within the management area.

In making a judgement on the potential impacts of predicted displacement on habitats, the points below should be considered, and advice from Statutory Nature Conservation Bodies (SNCBs) may feed in to this assessment. An indication of how a basic assessment and an advanced assessment may consider each point is provided. Basic and advanced do not equate to rapid and full assessments (e.g. a full assessment may still employ the 'basic assessment' approach below), but relates more to the

level of resources, data and expertise available for the assessment, which should be determined based on the expected significance of the potential level and impact of displacement.

Spatial displacement of effort — the area where effort is displaced to:

- Considerations:
  - Is the area to which effort is displaced to within a designated site? If so, will the displaced fishing effort take place on designated features of the site? What is the sensitivity of the features to the gear type and is this likely to affect the potential for achievement of the conservation objectives of the site? This should take into consideration whether a proportion of the feature will have the effort removed from it and thus be allowed to recover, compared to the marginal increase in effort on the part of the feature that remains open to fishing.
  - Are the habitats listed as habitats of principal importance under the NERC Act 2006, or on the OSPAR List of Threatened and/or Declining Species and Habitats, and are they sensitive to the type of fishing gear displaced? Will the displaced effort have an effect on obligations to protect these habitats?
  - Are there any particularly sensitive features? For example, are the biotopes making up the habitat relatively more sensitive to fishing impacts than those from which the effort was displaced? Are the areas important spawning, feeding or nursery grounds (regardless of protected status)? (The subsequent impact on the species involved should be considered under question D.2.)
- Basic assessment: Qualitative assessment based on expert judgement.
- Advanced assessment: Quantitative assessment of the amount of effort displaced, and the potential effect of that on designated features, protected and sensitive habitats.

Level of pre-existing fishing effort (of the gear type) in the area where effort is displaced to:

- Considerations:
  - If the area is already fished, the marginal increase in additional effort may not result in a significant increase in level of environmental impact.
  - If the area is not already fished, the potential environmental impact of new effort on previously unfished areas will be greater than the impact of increased effort on already-fished areas, for two reasons:
    - The first pass of a fishing gear does a disproportionate amount of damage to the benthic ecosystem[31], therefore displacement of fishing effort to new (previously unfished) areas will cause greater habitat damage than the continuation of effort on existing grounds;
    - The lack of knowledge of skippers of the new fishing grounds means that explorative fishing strategies may be adopted initially, resulting in effort being spread over a larger area than in established grounds where skippers know the areas they want to target.
- Basic assessment: Qualitative assessment based on expert judgement of whether effort is likely to be displaced to areas that are already fished or not.
- Advanced assessment: Quantification of the level of existing fishing pressure and percentage increase in effort that will be generated; consideration of this against the level of effort of the gear type that the habitat can withstand without suffering degradation.

31 Jennings, S. and Kaiser, M. J. (1998). The effects of fishing on marine ecosystems. *Advances in Marine Biology*, 34: 201–352.

Proportion of fishing effort in the area that is displaced

- Considerations:
  - Is the effort displaced a 'significant' proportion of fishing effort in the area — would remaining fishing grounds be able to absorb the additional effort?
  - This can be considered at different scales: within the MPA (if a zoned approach to management is adopted, e.g. in the offshore area); within the ICES rectangle; at the scale of the region (an appropriate region would need to be defined, this could be based on e.g. IFCA districts, marine plan areas, ICES subareas, as appropriate).
  - The Scottish MPA displacement work used rule-of-thumb percentages to determine whether the remaining open grounds were considered able to absorb the extra (displaced) effort without significant impacts (see Box D.1). Further work is required to determine if these thresholds are appropriate for the English situation.
- Basic assessment: Qualitative judgement on the proportion of fishing effort that is displaced, and whether this can be absorbed by remaining areas.
- Advanced assessment: Quantitative assessment of the effort displaced as a proportion of the effort in the MPA, ICES rectangle, and/or region as appropriate.

Level of effort required to maintain catches:

- Considerations:
  - If the fishing effort is displaced onto less productive fishing grounds (i.e. where catch per unit effort is lower), then more effort would need to be applied to maintain catches. If this occurs, then the environmental footprint of fishing per unit catch increases (both in terms of habitat impact and carbon footprint e.g. from fuel use). If it is assumed that fishing effort currently takes place in the optimal areas (taking into account productivity, catch rates, species mix against quota availability, fishing costs such as steaming time, fuel use), then moving fishing effort to different areas would be less optimal, and more fishing effort would be required to maintain catches, therefore potentially increasing habitat impacts.
- Basic assessment: Expert judgement (and consultation with skippers) of whether they would increase effort to maintain catches, and comment on the implications of this.
- Advanced assessment: Behavioural modelling of fleet or individual vessel behaviour to quantify the level of increase in effort required from alternative grounds, and the implications of this for benthic habitat condition.

Effort displaced to another gear type:

- Considerations:
  - This includes the directly displaced effort changing to another gear type, and the indirect displacement of other gears increasing within the management area:
  - What are the potential impacts of the gear types (and anticipated level of effort) on habitats?
  - Similar considerations to those identified in 'spatial displacement of effort: the area where effort is displaced to' also apply, for example whether the effort will be on a designated feature, protected habitat etc.
- Basic assessment: Expert judgement of level of effort of the other gear type and its potential impacts on habitats, and consideration of whether those habitats are designated, protected or sensitive. The risk rating in the revised approach matrix for the gear/habitat interaction could be considered for an indication of whether impacts might be of concern.
- Advanced assessment: Quantitative assessment of the amount of effort of the other gear type within and outside sites, to identify the level of effort of the other gear expected. Consideration of the level of effort the habitat withstand without suffering degradation, and whether the level of effort likely to be exerted is within this limit? Will it affect the conservation objective (if applicable)?

Box D.1: The Scottish MPA displacement study

The Scottish MPA displacement work used rule-of-thumb percentages to determine whether the remaining open grounds were considered able to absorb the extra (displaced) effort without significant impacts. Further work is required to determine if these thresholds are appropriate for the English situation.

The percentages used were:

- Displaced effort less than 10% of the effort within MPA (for the particular fishing sector). Note that for management measures that close the whole MPA area to a gear type, by definition 100% of the effort of that gear type within the MPA would be displaced.
- Displaced effort less than 10% of the effort within the ICES rectangle (for the particular fishing sector).
- Displaced effort less than 1% of the effort for the region (for the particular fishing sector).

If the level of effort displaced was below thresholds at all three scales, it was considered to be an indication that the habitat impacts would not be significant. Where any of the thresholds were exceeded, additional work was undertaken to further understand the potential impacts.

Information sources:

- Expert knowledge;
- Site conservation objectives;
- Habitat maps;
- Maps of spawning and nursery grounds;
- Habitat sensitivity information;
- Gear impact information;
- Cefas MPA Tool[32];
- Advice from Statutory Nature Conservation Bodies.

D.2 What are the potential impacts of predicted displacement on species?

Purpose: To identify the potential impacts that predicted displacement might have on species[33] in the areas where it is displaced to, taking into account gear impacts on different species and their conservation status.

Outputs: An indication of the risk of additional impacts on species as a result of the displacement predicted in questions C.1–C.4. A quantitative assessment with any degree of certainty is likely to be difficult to achieve, particularly given the uncertainties involved in predicting displacement and the mobile nature of species. However, by taking into account the points elaborated under

[32] The Cefas MPA Tool provides scenario analysis of different closures to specific gear types in terms of habitat recovery. It is based on VMS data and calculation of swept-area ratios, the habitats present and their resilience to fishing pressures and rate of recovery when pressure is removed. It can calculate the length of time for the biomass to reach a steady state for a given level of fishing pressure. It does not consider the effects of the displacement of fishing effort, but rather considers the result of the removal of fishing effort from the MPA area. By changing the parameters of the level of different gear types in the area, this could however, be used to explore the effect of an increase in some gears within the MPA as a result of the removal of other gears. However, given that it is based on VMS data, it may not provide accurate scenario outputs for areas where there is a significant proportion of under-12m effort.

[33] Species may refer to mobile species (e.g. birds, fish, marine mammals, etc.) which may be affected through incidental catch in fishing gears, or sessile species that warrant being considered separately from the benthic habitats (D.1) on which they occur. This may be the case, for example, for MCZ species features of conservation interest.

'Considerations', it should be possible to make a judgement on the net impacts on species of the proposed management measure.

Considerations:
To answer this question, it is necessary to consider the different aspects of displacement already described in Section C:

- Predicted spatial displacement of effort to other areas (C.2); and
- Potential for an increase in effort of other gear types, from the affected vessels changing gear type (C.3) or from other gears moving into the management area (C.4).

In making a judgement on the potential impacts of predicted displacement on species, the following points should be considered:

- For fishing effort that is displaced spatially (same gear type, change of location):
    - Is an increase in effort in the area to which effort will be displaced likely to cause additional impacts on species?
    - If it is a species that is in one of the following categories (see Box D.2 for examples of species), any potential additional impacts as a result of displacement may be of particular concern:
        - Listed in the Annexes to the Habitats and Birds Directives;
        - Protected under the CROW Act 2000;
        - Protected as a designated feature in an MCZ;
        - An OSPAR threatened species;
        - On the International Union for Conservation of Nature (IUCN) red list;
        - A Biodiversity Action Plan (BAP) priority species/grouped plan list;
        - A Species of Principal Importance under the NERC Act 2006.
    - Is effort displaced to an area that is an important breeding, feeding or nursery ground for the above species?
- For fishing effort that is displaced to another gear type (including both the effort displaced from the site changing gear type, as well as other gears increasing in effort within the site as a result of the removal of effort):
    - Is an increase in effort of the alternative gear type likely to cause increased impacts on species, including in particular those species protected through legislation identified above?
    - Is the alternative gear effort likely to occur in an area that is an important breeding, feeding or nursery ground for those species?
- Examples of impacts that might be considered are: a switch from trawling to netting could result in increased bycatch of seabirds or cetaceans; a change in fishing area could result in fishing effort taking place in an area where bycatch of species is more likely.

Box D.2: Species of conservation concern

Marine mammals

All cetaceans (whales and dolphins) are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (and amendments)[34], under which it is an offence to take, injure or kill these species. Disturbance in their place of rest, shelter or protection is also prohibited. All species of cetacean are protected under the European Union (EU) Habitats Directive 1992 (92/43/EEC)[35] at Annex IV and under the Bern Convention[36]. Harbour porpoise and bottlenose dolphin are also protected under Annex II of the Habitats Directive 1992. In addition, harbour porpoise are also listed as an OSPAR threatened species[37] listed in Appendix II of the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals)[38] 1982.

Birds

All UK bird species are protected under the Wildlife and Countryside Act 1981 (and amendments), under which it is an offence to intentionally take, injure or kill these species. This protects all birds, their nests and eggs (a wild bird is defined as any bird of a species that is resident in or is a visitor to the European Territory of any member state in a wild state). This legislation has been amended in England and Wales by the CROW Act 2000[39] which contains measures to strengthen the enforcement of the species protection provisions of the Wildlife and Countryside Act 1981. All species of naturally occurring birds in the wild state in Europe (applies to birds, their eggs, nests and habitats) are also protected under Directive 2009/147/EC on the conservation of wild birds (The Birds Directive)[40] implemented in the UK through the Habitats Regulations.

Fish

Certain fish species are protected under a range of legislation including the EU Habitats Directive, the Wildlife and Countryside Act 1981 (and amendments) and the Bern Convention, as well as being on OSPAR threatened species list, International Union for Conservation of Nature (IUCN) red list[41], BAP priority species/grouped plan list[42] and NERC Act 2006 Species of Principal Importance[43]. Some fish species are also on the list of prohibited species in the CFP TACs and Quotas regulation. If accidentally caught they must be promptly released, e.g. common skate and porbeagle[44].

Other species

A number of threatened, rare, or declining species are protected through spatial measures as MCZ features, including benthic invertebrates such as stalked jellyfish, amphipod shrimp, and Grateloup's little-lobed weed.

Information sources:

- Expert knowledge;
- Advice from Statutory Nature Conservation Bodies.

34 www.legislation.gov.uk/ukpga/1981/69/contents
35 eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043
36 www.coe.int/en/web/bern-convention
37 www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats
38 www.cms.int/
39 www.legislation.gov.uk/ukpga/2000/37/contents
40 eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32009L0147
41 www.iucnredlist.org/
42 jncc.defra.gov.uk/page-5717
43 www.legislation.gov.uk/ukpga/2006/16/section/41
44 eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R0127

D.3 What are the potential impacts of predicted displacement on commercial fish and shellfish stocks?

Purpose: To identify the potential impacts that predicted displacement might have on commercial stocks (fish and shellfish), taking into account stock dynamics and mixed fishery considerations.

Outputs: An indication of the risk of impacts on commercial stocks as a result of the displacement predicted in questions C.1–C.4 (including potential habitat impacts identified in question D.1 where these relate to nursery or spawning grounds of commercially exploited species). A quantitative assessment with any degree of certainty is likely to be difficult to achieve, particularly given the uncertainties involved in predicting displacement and knowledge of stock dynamics. However, by taking into account the points elaborated under 'Considerations', it may be possible to highlight known concerns about potential impacts on commercial stocks.

Considerations:
To answer this question, it is necessary to consider the different aspects of displacement:

- Spatial displacement of effort to other areas; and
- Potential for an increase in effort of other gear types within the management area;
- Displacement of effort to other target species (using the same or a different gear type).

In making a judgement on the potential impacts of predicted displacement on commercial fish stocks, the following points should be considered:

- For fishing effort that is displaced spatially (same gear type and target species, change of location):
    - Will effort be displaced to an area where there is a higher abundance of juveniles?
    - Will effort be displaced to an area where the species mix is likely to result in higher levels of discarding (for non-quota species, or for quota species prior to the landings obligation coming into force for those species), or increased choke species problems for the fleet? (In the case of the latter, this should be reflected in the response to question E.2.)
    - Will effort be displaced to an area that is an important spawning or nursery ground (this should be identified through question D.1)?
- For fishing effort that is displaced to another gear type (including both the effort displaced from the management area changing gear type, as well as other gears increasing in effort within the management area):
    - Is an increase in effort of the alternative gear type likely to cause increased impacts on commercially exploited species?
- For fishing effort that is displaced to other target species:
    - What is the status of the other stocks to which effort may be displaced, and can they absorb extra fishing pressure whilst still remaining within sustainable limits?
    - Due to existing restrictions on catching stocks managed under quotas, fishing effort may be more likely to be displaced to non-quota stocks, putting them under increased pressure.

Information sources:
- Expert knowledge;
- Consultation with fishers;
- Fisheries managers;

- Research survey data, particularly trawl surveys:
  - Cefas' Fisheries Data Archive Centre (FishDAC) https://www.cefas.co.uk/cefas-data-hub/fishdac/
  - ICES Database of Trawl Surveys (DATRAS) http://www.ices.dk/marine-data/data-portals/Pages/DATRAS.aspx

E Other implications of predicted displacement

The purpose of this section is to consider other potential impacts of displacement, for example the potential economic impacts on the vessels displaced, the potential impacts of displaced effort on other fishing segments, and the potential implications for other sectors. These aspects should be identified here as relating to displacement, but should feed in to the overall assessment of the management measure.

It may not possible to assess a particular question, or there may be a high level of uncertainty in potential outcomes, due to the uncertainties in predicting the nature of potential displacement, and further uncertainties of the potential knock-on effects on other fishing sectors and other marine sectors. Where this is the case, this should be recorded.

E.1 What are the potential implications for other fishing sectors?

Purpose: This question aims to identify other fleet sectors that may be affected as a knock-on consequence of the displaced effort generated by the management measures, and implications for those fleets.

Output: Information about the individual fishing sectors affected in the areas identified in C.2 by the primary displaced effort i.e. the characteristics of the affected fishing activities. A fishing sector is generally defined in terms of a common vessel size, gear type and target species (see Box B.1 for further characteristics and variables to consider).

Considerations:
Implications for those fishing sectors may include: concentration of fishing effort and pressures upon the fishery resource, gear conflict between the displaced fleet and fleet where the fishing effort has been displaced to. Recreational fishers may also be considered as a separate fishing sector, or may be considered under other marine sectors in E.3. Associated consequential impacts should be completed under E.2.

Information sources
- Expert knowledge;
- IFCA and MMO sightings data;
- VMS data;
- MMO iFISH database with landings by ICES rectangle;
- MCZ Fisheries model;
- Stakmap under-15m data layers by gear type;
- UK National Inshore Fishing Activities Data Layer (available from https://www.cefas.co.uk/cefas-data-hub/fishdac/).

E.2 What are the potential economic impacts on the fisheries sector?

Purpose: To identify and assess the expected economic impacts, both the costs and the benefits, of displacement for the fisheries sector. It builds on the description of displacement already established in Section D and question E.1.

Output: A qualitative and, if feasible, quantitative assessment of the economic impacts, presented by fishing sector and in aggregate. The different levels of detail likely to be required are:

- **Rapid appraisal:** qualitative identification of the potential impacts and conclusion on those likely to be most significant and warranting further investigation;
- **Full assessment:** a comprehensive assessment of the significant impacts.

In all instances, effort should be made to assess in quantitative terms the value of landings that are expected be affected by the management measure. This would be expected as part of the overall Impact Assessment of the measure.

The subsequent changes in behaviour by fishers will in turn influence the extent to which compensatory landings are realised, which will reduce the economic impacts of the management measure. For example, the MCZ Impact Assessment assumed that 75% of effort would be displaced, and therefore scaled the value of landings affected to 25% to reflect the net economic impact.

Displacement of fishing effort, and attaining compensatory landings have additional costs associated (or further landings may be foregone if a fisher decides to exit the fishery), which should also be taken into account. This section therefore focuses on identifying what those additional costs may be, so that they can be quantified and should then be incorporated into or recognised in the overall impact assessment.

The anticipated changes and their effects on fishing costs and landings/revenues should be clearly identified and presented, quantitatively where feasible and proportionate to do so.

The following aspects may be considered:

- Effect on sector performance: The gross effect on landings (prior to allowance for change in fisher behaviours) and the net effect (incorporating for changes in behaviours) on landings and the financial performance of the sector should be set out by fishing sector and in aggregate. This should be set against the fishing sector average and/or total to provide context.
- Effect on sector economic output: The gross and net effect on sector output should be set out at the broad fleet segment and aggregate level (disaggregated by EU member state where relevant). This should be set against the regional or national sector total to provide context. Common indicators include the value of landing and Gross Value Added (GVA).

Step 1: Identify the fishing sectors that are expected to be affected by displacement and the nature of that displacement (this should already be articulated in Sections C and D and question E.1), including the value of landings expected to be displaced or otherwise affected.

Step 2: Identify the anticipated costs and benefits for each fishing sector, based on the nature of displacement. Example costs and benefits are shown in Box E.2.

Box E.2: Example costs and benefits of different displacement effects on the fisheries sector

Costs

Displacement effect	Potential costs
Longer steaming distances to fishing grounds	Effects on fishing costs: ▪ Increase in fuel costs ▪ Increase trip duration and hence labour costs ▪ Longer fishing hours and decline in working conditions, potential safety issues Effects on revenues: ▪ Reduce time spent fishing, and hence landings and revenues
Change in fishing efficiency e.g. compensatory increase in fishing effort on less productive fishing grounds, or reduction in catches for the same amount of effort	Increased compensatory effort on less productive fishing grounds; or an increase in the aggregate level of efforts on a fishing ground may reduce CPUE: ▪ Increase in fishing costs and/or reduction in landings and revenues
Change in the level of fishing effort (e.g. through a reduction of fishing days, hooks/pots)	Fishers may reduce fishing effort e.g. longer steaming times meaning less time for fishing; reducing overall effort where the residual grounds available are insufficient to support a viable fishing activity (e.g. for a seasonal fishery): ▪ Reduction in landings and earnings
Change in type of fishing gear used	Fishers may switch gear types in order to be able to take advantage of the remaining fishing opportunities. This may result in: ▪ Investment costs for new fishing gear ▪ Change in fishing costs, revenue and profits (including cost of lower catches while learning to operate the new gear optimally)
Change in the unit value of landings	Fishers may alter their target species, or find the species mix of catches changes, resulting in changes in costs, revenue and profits
Increased conflict over diminished fishing grounds	May result in: ▪ Costs from loss of static fishing gear ▪ Less efficient fishing patterns, reducing revenue or increasing fishing time (and hence costs)

Benefits

Displacement Effect	Potential Benefits
Where displacement provides opportunities for fishing activity. These are the inverse of displacement costs e.g. shorter steaming distances; increase in fishing effort, reduced conflict	Reduction in costs, and/or increase in landings and earnings
Improvement of fish stock characteristics from environmental protection e.g. protection of important habitats for commercial species (e.g. nursery or spawning areas).	Spillover benefits may influence fishing performance and hence costs, landings and earnings

Information sources and analysis

- Further guidance on data collection methods is set out in Seafish and UKFEN (2013) 'Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments. Guidelines based on outputs from a technical workshop organised by the UK Fisheries Economics Network. 2nd Edition.' Revised 2013. 53 pages:
  - http://www.seafish.org/media/1133259/ukfen%20ia%202nd%20ed%20final%2011dec13.pdf [Accessed 23/02/17].
- The Seafish Economic Fleet Performance dataset contains information on financial performance by fishing sector for the UK fishing fleet which can support financial and economic analysis:
  - http://www.seafish.org/research-economics/industry-economics/seafish-fleet-economic-performance-data.

E.3 What are the potential implications for other marine sectors and onshore activities?

Purpose: To assess the knock-on effects of displacement on upstream and downstream fishing-related activities and other marine activities. Assessment of such knock-on effects are likely to be of secondary importance to the assessment and may only be appropriate if the effects are likely to be significant.

Outputs: An indication of the potential implications on some or all of the following:

- Upstream and downstream fishing sector activities;
- Other sector activities which may be affected by changes in the distribution of fishing activity.

Considerations:

- Upstream and downstream fishing sector activities – impacts on these activities are commonly referred to as indirect impacts. Such impacts may affect:
  - Upstream operators: Is the net effect of the measure (after allowance for displacement effects) likely to change the demand (its distribution or volume) for upstream services e.g. boat repair, ports and other ancillary services)?
    - For example, if the implementation of the management measure results in a number of fishers leaving the fishery, or moving home port, might this result in a marginal change in the level of activity at a port, or will it breach a critical threshold that results in the port operation becoming unviable?
  - Downstream operators: Is the net effect of the measure (after allowance for displacement effects) likely to result in a change in the supply of fish (volume or species mix) to landing ports and/or fish processors?
    - For example, will a reduction in landings and reduction in supply of material for processing result in a marginal reduction in processing activity, can the supply be substituted by imports or by other species, or might this cause the processing operation to become unviable, resulting in a loss of employment?
  - What implications will this have for their costs and/or revenues?
  - Is this likely to be significant at the local or national level?
- Other sector activities:
  - Will displaced fishing activity have a detrimental effect on the ability of other sectors to operate? (In many instances the presence of other activities will often have implications for the opportunities for displaced fishers to target alternative grounds, rather than *vice-versa*; in which case this information should be included as part of the initial displacement analysis in Section C, or the cumulative assessment in question E.4).

    - What implications will this have for their costs and/or revenues?
- Surveillance and enforcement costs:
    - Will displacement of fishing activity (and potential for infringements in the management area) result in increased surveillance and enforcement costs, including the cost of pursuing prosecutions?

Where such impacts are anticipated, it is unlikely that they can be assessed quantitatively without primary data collection. As such, quantitative assessment should only be conducted where the impacts are expected to be significant. Defra is conducting some work on local economic and social impacts of the fisheries sectors, which may provide useful information about the nature of these linkages at the local level.

E.4 What are the potential cumulative effects of other planned or proposed management measures, plans or projects?

Purpose: To identify any cumulative effects from other planned or proposed management measures, plans or projects that may also result in the displacement of fishing effort.

Outputs: A summary of potential displacement as a result of other planned or proposed management measures, plans or projects, and consideration of their impacts in addition to the displacement impacts identified in section D and questions E.1 to E.3.

Considerations: Other interventions that may result in cumulative effects are:

- Planned or proposed management measures in other MPAs that also affect the same fishing sectors;
- Other planned or proposed marine activities such as offshore wind farms that may also cause displacement of fishing effort;
- Planned or proposed CFP and other fisheries management measures that may cause displacement of fishing effort.

Information sources:

- MMO and IFCAs for information on planned management measures in other sites;
- JNCC for information on management measures in offshore sites;
- NE and JNCC for advice on potential cumulative impacts;
- MMO Marine Information System for information on other licensed activities;
- Marine plans for information on areas prioritised for other sector activities.

F Consideration of ways to reduce potential displacement impacts

This section aims to identify ways in which identified potential displacement impacts may be reduced, for example through the consideration of alternative options for management measures or non-management interventions. It may be completed at the end of any rapid assessment to consider alternative options, or at the end of a full assessment to record whether and how the preferred option minimises potential displacement impacts (from a range of options that would all be expected to achieve conservation objectives), if appropriate.

F.1 What management options have been considered as part of the process to assess displacement?

Purpose: To record what other management options have been considered.

Output: A list of other management options considered, a short summary of their potential displacement impacts and reasons for their rejection.

Considerations:

- If conducting a rapid appraisal of a single management measure, this question does not need to be completed.
- If no other options were considered then this should be recorded and the justification for this stated.
- If the displacement assessment is being conducted as part of an overall impact assessment of the management measure then the options considered may already have been recorded elsewhere. This should be stated and a cross-reference provided. Further details on alternative options do not need to be repeated.

F.2 How does the preferred management proposal reduce or minimise impacts from displacement?

Purpose: To identify how the management proposal may reduce or limit any significant displacement impacts over alternative management options, whilst ensuring site conservation objectives are achieved.

Output: Information about how the type of management measure proposed (e.g. zonation, effort management or technical measures that modify the level of impact from fishing gears) or its characteristics (e.g. size and location of areas zoned, time frames applying to measures, effort limited or capped, monitoring regime requirements) reduce or limit displacement and any associated impacts.

F.3 Record any residual displacement issues arising in the assessment process that may need further consideration

Purpose: If significant residual displacement issues remain following identification of the preferred management option, these should be recorded so that, if required, they can be taken forward by appropriate organisations, for example to address any residual environmental impacts and/or address issues that may arise. This may include, for example, the need for increased surveillance and enforcement, and support for displaced fishers to adapt in ways which may help address the residual issues.

Output: A record of residual displacement issues identified in the assessment process that may need further consideration, and a description of any potential non-management interventions or opportunities that may reduce the likelihood of identified residual displacement effects occurring or facilitate fleet adaptation to changes brought about as a result of management proposals.

G Method, evidence sources and confidence

Section G can be filled in overall for the whole assessment, or in relation to each specific section or question.

Describe the methodology(ies) used for the assessment:

- Provide an overview of the methodology or methodologies used for the assessment.
- If the assessment was a rapid appraisal, based on expert knowledge, record this.

List evidence sources (papers, reports, data layers, datasets) used in the assessment:

- Note any specific sources of data and information used in the assessment.

Confidence in the assessment and limitations:

- Indicate the level of confidence in the assessment (e.g. low, medium, high), based on the quality and comprehensiveness of the data sources, methodologies, etc., and describe the key limitations.

Annex A: The 11 information requirements for requests for fisheries management measures for Natura 2000 sites under the Common Fisheries Policy

The use of best scientific advice is an important element in good governance. When preparing requests for fisheries management measures for Natura 2000, Member States should ensure their requests are accompanied by the necessary biological, economic, environmental, social, technical and any other information considered relevant for the Commission to undertake the assessments required to proceed with the appropriate EU legal act.

It is anticipated that Member States will provide an evaluation of the expected impacts of the measures they propose. For joint recommendations, where appropriate, the Commission can facilitate obtaining a scientific contribution from appropriate scientific bodies.

The Commission does not consider that a definitive list can be drawn-up of the information and data that should accompany a request for fisheries management measures for Natura 2000. It is believed, nonetheless, that the information points below, drawn from the 2008 document[45], represent a useful basis:

(1) Comprehensive description of the natural features and distribution within the site.
(2) Summary of the scientific rationale for the site's selection in accordance with the information provided in the Natura 2000 Standard Data Forms. Intrinsic value of its features. Specific conservation objectives established for the site.
(3) Basis for the spatial extent of the site boundary, and of the management area if different, justified in terms of conservation objectives.
(4) Threats to habitats and species from different types of fishing gear. List of other human activities in the area that could affect the habitats and species.
(5) Fleet activity in the area and in the region, distribution of fleets (by nation, gear and species), and information on target and by-catch species, all over the last 3 years.
(6) Seasonal fisheries patterns over the last 3 years.
(7) Proposed fisheries management measures to maintain or restore the habitats and species in favourable condition. Are they proportionate and enforceable? Other conservation measures that apply to the area.
(8) Control measures envisaged by the Member State, possible ecological and control buffer zones to ensure site protection and/or effective control and monitoring measures.
(9) Measures to monitor and assess the maintenance and/or recovery of the features within the site.
(10) Coordination with neighbouring Member States as appropriate.
(11) Evaluation of possible displacement of fishing effort and impact on new areas.

[45] European Commission, (2008). Fisheries measures for marine Natura 2000 sites: A consistent approach to requests for fisheries management measures under the Common Fisheries Policy.

Annex I: Template for Recording Outputs

Version: 31.03.2017

This version of the template is for recording outputs of an assessment of displacement of fishing effort as a result of a proposed MPA management measure, but may also be applicable to other situations in which fishing effort may be displacement (e.g. MPA designation, fisheries management measure, marine licensing decisions). It should be completed with reference to the accompanying Guidance for Assessing Displacement of Fishing Effort.

The principles for assessing displacement are applicable to both inshore (within 2 nm) and offshore (beyond 12 nm) areas; relevant factors and considerations may vary between the two, and on a case-by-case basis.

The template should be completed as part of, and will draw on information from, an overall assessment of a proposed management measure or intervention. The potential displacement of fishing effort and its impacts are difficult to predict and there are likely to be significant uncertainties and unknowns in an assessment. These should be recorded in the outputs of the assessment, and 'Not applicable' or 'Not known/insufficient evidence to assess' recorded on the template where necessary.

This template is provided as one of a series of outputs of the project 'Displacement of Fishing Effort from MPAs' and therefore references to 'the main report' are to the main report output of this project (not included here).

A. Background information and document control	
A.1 Management measure name:	**Version:**
A.2 Site name(s) (if applicable):	**Date:**
A.3 Lead regulator: **Other regulators:** **Conservation adviser:**	**Author(s):**
A.4 Brief description of the management measure:	
A.5 Area(s) to which the measure applies: ☐ **<6 nm** ☐ **6–12 nm** ☐ **>12 nm**	**Approved by:**

B. Fishing effort affected by the management measure
B.1. Which fishing activities will be directly affected by the management measure and how is this distributed across sectors?
B.2. How much fishing effort is likely to be directly affected by the management measure?
B.3 Is this considered significant, or likely to generate significant effects that require further investigation? ☐ **Yes** – *continue with assessment under sections C–F.* ☐ **No –** *record justification; no need to continue further with assessment.*

C. The nature of predicted displacement
C.1. How much fishing effort is likely to be displaced from the management area?
C.2. Where might fishing effort be displaced to?
C.3. Might the affected vessels switch to a different gear type?
C.4. Could there be an increase in effort by other fishers using different gear types in the management area?

D. Environmental implications of predicted displacement
D.1. What are the potential impacts of predicted displacement on habitats and benthic communities?

D.2. What are the potential impacts of predicted displacement on species?
D.3. What are the potential impacts of predicted displacement on commercial fish stocks?
E. Other implications of predicted displacement
E.1 What are the potential implications for other fishing sectors?
E.2 What are the potential economic impacts on the fisheries sector?
E.3 What are the potential implications for other marine sectors and onshore activities?
E.4 What are the potential cumulative effects of other planned or proposed management measures, plans or projects?
F. Consideration of ways to reduce potential displacement impacts
F.1 What management options have been considered as part of the process to assess displacement?
F.2 How does the preferred management proposal reduce or limit the impacts generated by displacement?
F.3 Record any residual displacement issues arising in the assessment process that may need further consideration
G. Method, evidence sources and confidence
Describe the methodology(ies) used for the assessment:
List evidence sources (papers, reports, data layers, datasets) used in the assessment:
Confidence in the assessment and limitations:

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