Good Practice Guidance for assessing fisheries displacement by other licensed marine activities: Literature Review

A303088-S00-REPT-001-A02

June 2022

Scottish Government
Riaghaltas na h-Alba
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www.xodusgroup.com

Published by Marine Scotland Science

ISBN: 978-1-80435-251-9 (web only)

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This report presents the results of work commissioned by Marine Scotland.

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Table of acronyms and abbreviations

Abbreviation / Acronym	Definition
BERR	Department for Business, Enterprise and Regulatory Reform
BOEM	Bureau of Ocean Energy Management
CaP	Cable Plan
CBRA	Cable burial risk assessments
CES	Crown Estate Scotland
(C)FLO	(Company) Fisheries Liaison Officer
CFWG	Commercial Fisheries Working Group
CIFA	Community Inshore Fisheries Alliance
COP	Construction and Operation Plan
DCO	Development Consent Order
EIA	Environmental Impact Assessment
EU	European Union
FFSRG	Fish and Fisheries Specialist Receptor Group
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables
FMMS	Fisheries Management and Mitigation Strategy
FPSO	Floating Production Storage and Offloading
GVA	Gross Value Added
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICES	International Council for the Exploration of the Sea
ICPC	International Cable Protection Committee
IRENA	International Renewable Energy Agency
JNCC	Joint Nature Conservation Committee

m	metres
MASTS	Marine Alliance for Science and Technology for Scotland
MRE	Marine Renewable Energy
MPA	Marine Protected Area
NM	Nautical mile
ORE	Offshore Renewable Energy
OWF	Offshore Wind Farm
PEMP	Project Environmental Monitoring Programme
PhD	Doctor of Philosophy
PIER	Preliminary Environmental Information Report
PO	Plan Option
ScotMER	Scottish Marine Energy Research
SFF	Scottish Fishermen's Federation
SWFPA	Scottish Whitefish Producers Association
TAC	Total Allowable Catch
TCE	The Crown Estate
CES	The Crown Estate Scotland
UK	United Kingdom
UKFEN	United Kingdom Fisheries Economic Network
USA	United States of America
VMS	Vessel Monitoring System

Glossary of technical terms

Co-existence	Two activities existing at the same time and / or in the same space.
Creels	Pots and traps, generally used to catch crab and lobster.
Demersal fish	Fish that live on or near the seabed.
Demersal trawl	Cone shaped net towed along the seabed.
Displacement	The relocation of fishing activity (i.e. pressure or effort) into another area as a result of restricted access to or closure of an area.[1]
Environmental Impact Assessment (EIAs)	Process of evaluating the environmental impacts of a proposed project or development. An EIA is required when a development qualifies as an EIA project under the relevant regulations.
Not Take Zones	An area of the seabed in which all forms of exploitation are prohibited (including fishing).
Pair trawling	Demersal trawl net towed by two vessels simultaneously.
Pelagic fish	Fish that live in the water column.
Round 4 seabed leasing round	The most recent offshore wind leasing round in English and Welsh waters, launched by The Crown Estate[2].
Scallop dredge	Rigid triangle-frame structure with 'teeth' which rake the seabed to collect scallops into a chain mail bag.
ScotWind leasing round	The most recent offshore wind leasing round in Scottish waters, launched by Crown Estate Scotland[3].
Seine net	A triangle shaped net with long weighted ropes attached on each side. The net is shot in a circular motion from a vessel and then towed to close the net and herd fish.

[1] For the purposes of this guidance, displacement is defined as occurring as a result of other licenced activity or infrastructure.
[2] Offshore Wind Leasing Round 4 | Offshore Wind Leasing Round 4 (thecrownestate.co.uk)
[3] Crown Estate Scotland

Total Allowable Catch (TAC)	Catch limit set for a particular fishery.
Vessel Monitoring System	Vessel satellite tracking system, operated on vessels > 12 m in EU waters.

1 Introduction

The displacement of fishing activity into other areas as a result of another marine activity has been a concern of fisheries stakeholders, regulators and conservation organisations for many years. There is a paucity of research into the impact of displacement on the commercial fishing sector itself, and there is no standardised methodology which is easily applied to offshore impact assessments.

The UK and Scottish governments have established clear goals for the expansion of renewable energy production, including a significant increase in offshore wind which has led to a considerable increase in the areas of seabed available to lease. There has been a concurrent increase in the number of designated and potential Marine Protected Areas (MPAs) and No Take Zones[4] in British waters (e.g. NatureScot, 2021; JNCC, 2021). This increase in Marine Renewable Energy (MRE) projects, along with technology advancements in offshore infrastructure reducing limitations on developments such as water depth, have highlighted the need for better understanding of the impacts of displacement of commercial fishing activity for commercial fisheries stakeholders.

The scope of this report is to review available information and studies which are relevant to displacement of fishing activity to better understand displacement and the interacting factors which may cause or be caused by it, and identify the main constraints on developing a methodology for the assessment of fisheries displacement within Environmental Impact Assessments (EIAs). This work has been commissioned with the objective of producing a Good Practice Guidance document which is accessible and concise, to help clarify the assessment process for stakeholders, regulators and developers.

[4] No-Take Zones are areas set aside by the government where no extractive activity is allowed (e.g. fishing, drilling, mining).

2 Background

Over the last ~15 years, the UK offshore wind industry has seen unprecedented growth and expansion, with increasing financial, political and social support and global recognition of the necessity and economic potential of the renewable energy industry, in particular offshore wind. The shared offshore environment of the marine licensed activities necessitates spatial coexistence, and subsequently can result in impacts to other users of the offshore environment, including commercial fisheries.

The Round 4 seabed leasing in the waters around England and Wales, and the ScotWind seabed leasing round in the waters around Scotland bring a definitive future increase in the number of offshore wind projects over the next 5 to 10 years (The Crown Estate, 2019; Crown Estate Scotland, 2020). With the planned increase in developments and changes to design of projects (such as floating infrastructure, larger and more powerful turbines) which may be present in Scotland's waters, guidance on the approach and methods for assessing impacts on commercial fisheries is necessary to ensure that the potential adverse effects are accurately and consistently identified and assessed during the EIA process. This need for guidance has been highlighted as a priority evidence gap in the Scottish Marine Energy Research (ScotMER) fish and fisheries evidence map (Brown and May Marine, 2021; ABPmer 2017; Marine Scotland, 2018).

The cultural and economic importance of the commercial fishing industry is recognised by Scotland's National Marine Plan, together with the need to facilitate coexistence between development sectors and activities within the Scottish Marine area (Scottish Government, 2015). As such, commercial fisheries are identified as a key receptor and stakeholder, which will require robust consideration during the EIAs that will be conducted to facilitate future marine developments.

Although there is existing research and development of methodologies for the assessment of impacts to commercial fisheries (e.g. Chollett *et al.,* 2017; Bastardie *et al*., 2015; ABPmer, 2017 and references therein), no standardised methodology which is suitable for consistent application in EIAs has been developed for the assessment of the potential impact of displacement of commercial fishing activity, as a result of offshore developments and other licensed activities. This impact pathway has been consistently raised as a concern by commercial fisheries stakeholders, from the beginning of the offshore wind leasing rounds, and recognised by Scottish Government through the ScotMER evidence map (Brown and May Marine, 2021; ABPmer 2017; Marine Scotland, 2018).

This Literature Review and the associated Good Practice Guidance has been commissioned by Marine Scotland in response to the ScotMER evidence map programme work and in the context of the feedback from consultees across the fisheries industry, offshore energy and regulatory sectors.

The objective of this Literature Review document is to collate and analyse existing guidance, data, studies and stakeholder feedback relevant to the potential impact of commercial fisheries displacement. This Literature Review will inform clear and

accessible guidance for assessing the potential impact of the displacement of fishing activity into other areas, as result of a licensed marine activity.

3 Relevant Marine Scotland and Scottish Government guidance and plans

There are several guidance documents, plans and strategies which are relevant to marine spatial planning, MRE developments, fisheries management and fishing activity displacement.

The guidance which is of relevance for activities within Scottish waters includes but may not be limited to those listed in Table 3.1.

Table 3.1 Marine Scotland and Scottish Government plans and guidance

Guidance/Plan	Description
Offshore Wind and Marine Spatial Planning Policy	
Scottish Government (2015) National Marine Plan[5]	Scotland's National Marine Plan provides a planning framework for the implementation of the Marine (Scotland) Act 2010. The plan sets out objectives and policies for protecting and enhancing marine environments and promoting marine industries, including commercial fisheries. Several of the general policies are relevant to co-existence in the marine environment such as consideration of the potential impact of fisheries displacement from various marine developments as part of the marine spatial planning decision making process (*Fisheries 2* policy). Co-existence should also be considered in terms of all activities within the marine space.
Scottish Government (2020a) Sectoral Marine Plan for Offshore Wind Energy	The Sectoral Marine Plan identifies sustainable options for future commercial-scale offshore wind development as part of the Crown Estate Scotland (CES) ScotWind leasing round. The selected Plan Options (POs) were chosen with the intention of minimizing adverse impacts to marine receptors, including other sea users. The POs were refined and selected through an iterative process, with stakeholder feedback sought at each iteration of the selection process alongside evidence for social, environmental and economic factors. The potential impact to the commercial fishing industry has been a key factor in the selection of the POs. For instance, Draft Plan Option (DPO) NE5 was removed as a PO due to the potential for cumulative impacts on the fishing sector. Several of the other PO areas were modified to avoid areas of highest fishing activity, as highlighted by the fishing sector. The Sectoral Marine Plan provides indicative sensitive environmental receptors and requires that offshore wind farm (OWF) consent applications consider potential impacts on commercial fisheries within the EIA process, which is a major consenting risk for offshore wind developments.
Marine Scotland (2018; 2021) ScotMER Evidence Maps	Marine Scotland established the ScotMER programme to identify and address knowledge gaps, improve understanding and identify potential environmental and socio-economic impacts of MRE developments. There are 7 specialist research groups, including the Fish and Fisheries Specialist Receptor Group which is tasked with identifying the key topics relating to fish and commercial fisheries where knowledge gaps exist, their priority and areas of recommended research. 'Accurate and validated method to predict fisheries displacement

[5] Please note that the Scottish National Marine Plan is currently under review with the potential for changes in future policies. Legislation requires the Plan to be reviewed every 3 years, the first review was undertaken in 2018, and there is currently a review ongoing (2021).

Guidance/Plan	Description
	levels and locations' was identified as a knowledge gap, and this is of high priority for Scallop dredge fishery and *Nephrops* fishery.
Scottish Government (2020b) Offshore Wind Energy in Scottish Waters - Regional Locational Guidance	The Regional Location Guidance supports Scotland's Sectoral Marine Plan for Offshore Wind. The document provides a baseline description of the environmental conditions present within Scottish waters, with a focus on the Plan Options (POs) being offered for offshore wind developments as part of the ScotWind leasing round. The document describes fishing activity within the east, northeast, west and north regions of Scottish waters. This highlights the distribution of fishing activity for different vessel sizes and methods. Extensive consultation was carried out to inform this guidance, providing a national-scale insight into stakeholder concerns.
Scottish Government (2020c) Social and Economic Impact Assessment Report – Final	This document supports Scotland's Sectoral Marine Plan for Offshore Wind and identifies the potential economic and social effects of developments within the proposed POs. This assessment assumed that fishing activities would not be displaced from the developments within the POs, but instead that all grounds were lost. Hence, the economic impact of displacement was not quantified. The social impact was noted as potentially being increased costs as a result of increased steaming times and impacts associated with increased competition and conflict.
Fisheries Management/Guidance	
Marine Scotland (2020a) Draft Fisheries Management and Mitigation Strategy ("FMMS") Guidance Document	This draft guidance sets out key topics which need to be provided within a FMMS, which is a requirement under some Marine Licenses and Section 36 consents. The guidance recommends that developers align for the most part with the FLOWW (2014, 2015) guidance, and recommends procedures such as dropped objects, fishing gear snags/damages and linkages with other relevant consent plans such as Navigational Safety Plans.
Scottish Government (2020d) Scotland's Fisheries Management Strategy 2020 – 2030	This document sets out the management approach for sea fisheries from 2020 - 2030, with the aim of achieving developing a management approach which aims to inform a balance of potential marine environmental and socio-economic outcomes. The approach of the management strategy aims to align with the Scottish National Marine Plan, and among other areas of focus, and provides potential approaches to aid coexistence between the fishing industry and other marine users. Improvements for monitoring of fishing activity include plans to implement Remote Electronic Monitoring (REM) (pelagic and scallop fisheries) and funding for advancements in fishing gear technologies.
Marine Scotland (2015) Inshore Fisheries Strategy	This strategy outlines the key strategies for Marine Scotland's inshore fisheries management and focusses on improving fisheries evidence-base, streamlining fisheries governance and embedding inshore fisheries

Guidance/Plan	Description
	management into wider marine planning. The aims of this strategy include implementing an inshore vessel monitoring system to improve the evidence-base for decision making processes and baseline data.
Marine Scotland (2012) Management of Scottish Inshore Fisheries – Assessing the Options for Change	This report assessed the impacts of restriction on the use of mobile gear in Scottish waters between 0-1 Nautical Miles (NM) and 0-3 NM from the coast. One of the aspects that this report assessed was the potential implications of these restrictions on gear conflict, and the authors used a modelling approach in their assessment. The document also provides background information on gear conflict. For the study, a questionnaire survey was conducted to identify gear conflict locations and frequency. The questionnaire revealed that conflict occurs between static gear operators and static and mobile operators, but rarely between mobile gear operators.

3.1 Existing guidance for fisheries displacement assessments

Existing guidance documents which are relevant to fisheries displacement assessments are listed in Table 3.2.

Table 3.2 Existing guidance for assessments of commercial fisheries displacement

Guidance	Description
Displacement of fishing effort from Marine Protected Areas (ABPmer, 2017)	The guidance includes a detailed Literature Review on displacement of fishing effort from MPAs and other closed areas as well as a protocol for assessing displacement of fishing effort as part of the impact assessment for MPAs.
Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments (Seafish and UKFEN, 2012)	This document provides best practice guidance for conducting commercial fisheries impact assessments in relation to loss of, or restricted access to, fishing grounds. The guidance note specifically considers the implications of displacement and includes a list of displacement impacts which should be considered within an impact assessment. An approach for assessing vulnerability to displacement is also provided and as well as an approach for assessing displacement impacts and the key assumptions which may have to be made as part of the assessment.
Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison (FLOWW, 2014)[6]	This guidance document was produced collaboratively by the commercial fisheries, offshore energy and regulatory bodies (the FLOWW committee) to promote co-existence between the MRE industry and the fishing industry. Key topics include the lines of communication between and offshore development and the fishing industry, recommended approaches for maximizing engagement and guidance on evidence-based mitigation measures
Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds (FLOWW, 2015)[6]	This guidance sets out guiding principles for MRE developers to address any residual impacts to the fishing sector which remain following the application of other mitigation measures and fisheries liaison. The guidance provides important factors which should be considered and planned for by both parties and key information which may be required to develop an evidence based mitigation such as individual cooperation payments to a static gear operator who is asked to relocate their

[6] Please note the FLOWW Best Practice Guidance documents are currently being updated. No publication date for the updated guidance has been released at the time of writing.

Guidance	Description
	gear prior to construction. Effective and regular communication from the (Company) Fisheries Liaison Officer ((C)FLO) is also recommended.
Options and Opportunities for marine fisheries mitigation associated with windfarms (Blythe-Skyrme, 2010)	This guidance document was produced to identify options for mitigation for impacts of OWFs on commercial fisheries. The document presents an overview of the UK fishing industry, interactions between the fishing industry and offshore wind and appraises different mitigation options available to developers. Several of these mitigation options are aimed at reducing the potential loss of access of grounds or compensating for this impact.
International Cable Protection Committee - Fishing and Submarine Cables - Working Together (IPCP, 2009)	This document provides guidance to fishermen on how to avoid snagging cables and what to do if this does occur. It also provides details on cable systems and technical specifications, the potential for cables to become exposed, how different fishing methods can damage cables, the dangers of snagging cables and potential measures to reduce these if snagging does happen and also how to reduce the potential for snagging in the first instance.

4 Definition of displacement

For the purpose of this Literature Review, displacement of fishing activity refers to the relocation of fishing activity (i.e. pressure or effort) from an area into other area(s) as a result of the presence of other licensed marine activities and/or associated infrastructure ('the development') (Vaughan, 2017; Slijkerman & Tamis, 2015; Gruss, 2014).

Displacement of fishing activity due to other marine licensed activities is usually an indirect effect of the loss of, or restricted access to, fishing grounds. Displacement may occur as a direct result of the other licensed marine activity (primary displacement), but also indirectly to existing fisheries which are operational within the areas which fishing activity is displaced to, potentially resulting in further displacement impacts (i.e. into a subsequent additional area) (secondary displacement).

The potential impact pathway of loss of grounds can be a result of any phase of an offshore energy development from pre-construction to decommissioning (Gill *et al.,* 2020). Further information on this impact pathway is provided in Section 7. Hereafter, where the word 'displacement' is written it is referring to the displacement of commercial fishing activity alone.

4.1.1 Overview of commercial fisheries EIA methodology

In order to apply for consent, offshore energy projects (including offshore wind) are required to assess potential impacts of activities to the offshore environments, sea life and other sea users, including commercial fisheries. When this assessment is carried out, the methodology which is applied in most cases is to assign a receptor-specific sensitivity score (for example by considering the operational range of a fishing fleet) and an impact-specific magnitude of effect score. The magnitude of effect is often based on the impact parameters such as temporal duration and spatial extent. This enables an assessment of whether the impact is expected to have significant effects on a receptor, or not (CIEEM, 2018; SNH, 2018).

4.1.2 Sensitivity of receptor and magnitude of effect

The magnitude of effect of displacement of fishing activity into other areas may also be affected by influential factors which are not associated with the marine licensed activity. These include but are not limited to changes in stock availability, quota, weather and local/national legislation. The factors which may influence the sensitivity of a commercial fishery to displacement can be summarised by the list of key factors provided by Natural England's guidance for assessing displacement related to MPAs (ABPmer, 2017) include:

- Availability of alternative grounds – including the range, distribution and seasonality of target species;
- Fishing vessel operator's knowledge of alternative grounds;
- Individual fisher's behaviors and strategies;
- Distance from home port (i.e. operational range and steaming time);

- The potential for spillover effects within or in proximity to the displaced area; and
- Regulations, quotas and fisheries management measures.

In consideration of the recent updates to the ScotMER Fish and Fisheries Evidence Map, along with consultation with the fishing industry, the following fishing methods have been identified as key areas of focus in relation to the assessment of fisheries displacement:

1. The Scottish king scallop dredge fishery;
2. Demersal trawling, including pair trawling, twin trawling and *Nephrops* trawl fishery;
3. The Scottish seine net fishery; and
4. Static fishing gear (creels).

In relation to Scottish inshore fisheries (mainly operating static fishing gear) the Fish and Fisheries Specialist Receptor Group (FFSRG) recommended the area of research to be focussed on reduced availability of fishing grounds (for example where mobile gears are typically operated) due to relocation of creeling. Although this was not identified as a priority by the ScotMER evidence map, displacement of creeling is covered in brief within this report as smaller vessels have less capacity to relocate their fishing effort over large distances.

In relation to mobile fishing methods, the sensitivity to displacement is likely to be subject to several vessel and operating practice characteristics, which are provided in Section 7.1 and in the Good Practice Guidance.

4.1.3 Potential impacts of displacement

4.1.3.1 Potential impacts to the marine environment

ABPmer (2017) discusses some of the potential impacts which fisheries displacement may have on the marine environment and commercial fisheries receptors. The impacts on the marine environment, including those to the benthic environment and fish stocks, are dependent on the fishing methods displaced and the levels of fishing effort, both in the area which effort is being displaced from and in the area which effort is being displaced to. For instance, if fishing effort by mobile fishing methods in direct contact with the seabed are displaced to areas which are ordinarily infrequently fished or when fished the activity causes low levels of natural disturbance, this can negatively impact benthic communities, especially for species which require longer periods of time to recover following disturbance (ABPmer, 2017; Dinmore *et al*., 2003). The potential impact of commercial fisheries displacement on benthic habitat and other ecological communities depends on the amount of effort which is displaced (including any increased fishing effort to compensate for lost catches) and how this effort is redistributed. Fisheries displacement may also negatively impact fish stocks in areas where fishing effort increases as a result of relocated or increased intensity of fishing activity. (ABPmer, 2017).

This Literature Review and associated Good Practice Guidance focuses on the impacts of displacement on commercial fisheries receptors, however further investigation into the potential impacts of fisheries displacement on the marine environment and how this could align with marine spatial planning is a suggested research area.

4.1.3.2 Potential impacts to commercial fisheries receptors

The potential impacts of displacement on commercial fisheries receptors depends on a number of factors. Depending on the fishery, different phases (i.e. construction and installation, operations and maintenance and decommissioning) of an offshore development may result in different impacts, and last for varying durations. The following list provides examples of potential impacts according to stakeholder consultation and existing research:

- Increased competition for fishing grounds and conflict between and within fishing methods;
- Potential decreases or changes in catch of certain target species (loss of access to fishing grounds in reference to previous area/productivity); and
- Increased steaming time to access the alternative fishing grounds.

5 Information sources and approach to literature review

An internet search for documentation relevant to the Good Practice Guidance was conducted between February and April 2021 using internet search engines such as Google and Google Scholar, as well as the Marine Scotland and Planning Inspectorate websites[7]. The literature sources which are relevant to fisheries displacement and assessment methodologies for MRE developments comprise the majority of the search. However, literature sources relevant to fisheries effort displacement associated with other marine licenced activities, MPAs or fisheries management measures were also included within the review.

Some limitations to obtaining relevant information were highlighted as part of this review process which included the following:

- Accessibility issues to technical reports and fisheries data, for example due to the necessary protections of personal or commercially sensitive information;
- Limited data providing coverage by fishing method on a UK-wide scale which is relevant to all fishing vessels (<10 m and >10 m vessels);
- No reliable data on fishing activity by vessels <10 m in length at a scale of less than one ICES rectangle;
- A paucity of published information on the impact of commercial fisheries displacement on the fishing industry, with a focus on the relationship between the displaced fishing activity on the environment the activity has been located to; and

[7] Welcome to Marine Scotland Information | Marine Scotland Information

- Language barriers for non-UK data and research.

Further limitations and areas of recommended further research are detailed within the knowledge gap analysis (Section 9).

The information sources have been distinguished into the categories which are provided in Table 5.1. Each information source was documented and subsequently reviewed to identify key considerations for the Good Practice Guidance, with consideration of feedback received during stakeholder consultation meetings (Section 8).

Table 5.1 Data/Literature categories reviewed

Data/literature category	Geographical coverage
Existing Good Practice Guidance for commercial fisheries impact assessments	UK
Peer-reviewed journal articles (reviews and research papers) and PhD theses relevant to fisheries displacement and the co-existence of fisheries with marine licensed activities	UK and European Union (EU) Waters
Government/fishing industry publications and reports on marine spatial planning, fisheries management, fishing effort displacement and co-existence	UK
Offshore Wind EIAs and accompanying stakeholder responses	UK, Europe, USA
Marine Licenses, Development Consent Orders and associated conditions / requirements relevant to commercial fisheries which are set out within decision notices for marine licensed activities	UK
Meeting minutes from Commercial Fisheries Working Groups (CFWG), including the Forth and Tay Commercial Fisheries Working Group (FTCFWG) and the Moray Firth Commercial Fisheries Working Group (MFCFWG), and The Fishing Liaison with Offshore Wind and Wet Renewables (FLOWW) Group meetings	UK

6 Stakeholder consultation

Consultation was carried out with the intention of ensuring coverage of multiple interested parties which may be in some way be affected by the impact pathway of displacement.

Consultation was undertaken with the FFSRG. This group was originally established by Marine Scotland to inform the development of the ScotMER Evidence Maps and is considered to also be relevant for the current scope of work. Marine Scotland during the development of the receptor group aimed to ensure balanced representation from each of the fishing and offshore wind industries,

Marine Scotland (multiple relevant branches), Regional Inshore Fisheries Groups, research institutions, and government advisory bodies.

Consultation has been a key information source for the literature review, and has ensured all relevant interested parties have had the opportunity to provide feedback for inclusion, where possible, into the Good Practice Guidance itself, or where applicable to highlight knowledge gaps which may require further research.

Three 1- hour consultation workshops were carried out with the FFSRG, with additional consultation undertaken by phone/email as needed. The workshops included a round-table discussion on the approach and methodology of the Literature Review and Good Practice Guidance, with targeted questions on the aspects of the documents which were considered to be a primary focus for stakeholder feedback, including data sources to inform the Literature Review and Good Practice Guidance, details on commercial fishing operating practices, knowledge gaps and areas of future research, and commercial fisheries data and presentation. Draft versions of the Literature Review and Good Practice Guidance were also issued to the FFSRG for comment over a three-week period.

The list of consultees from the FFSRG is provided in Table 6.1. A summary of the feedback which was received during the consultation process is provided in Section 8.

Table 6.1 Representatives in the Fish and Fisheries Specialist Receptor Group

Organisation
Marine Scotland Science
Marine Scotland Planning and Policy
Marine Scotland Licensing Operations Team
Marine Scotland (Inshore Fisheries Policy)
NatureScot
Joint Nature Conservation Committee (JNCC)
Crown Estate Scotland (CES)
The Crown Estate (TCE)
Scottish Renewables/ Forth and Tay Developers / EDF Renewables
Scottish Fishermen's Federation (SFF)
Moray Firth Developers/Ocean Winds
Scottish Regional Inshore Fisheries Group

Organisation
Community Inshore Fisheries Alliance (CIFA)
Marine Alliance for Science and Technology (MASTS) MRE Forum
Fisheries Innovation Scotland
Sustainable Inshore Fisheries Trust
Scottish Whitefish Producers Association (SWFPA)

7 Literature Review

7.1 Commercial fishing activities and operating practices in Scotland

According to an economic analysis performed by Marine Scotland (2020b) in 2018, Scotland's commercial fishing industry generated 0.2% of the overall Scottish Economy Gross Value Added, with over 4,500 people employed within the fishing industry.

Commercial fishing activity is temporally and spatially variable, depending on several factors which include the following:

- The distribution and abundance of commercially exploited fish and shellfish species;
- The Total Allowance Catch (TAC) and quotas which are allocated to each fishery[8];
- Licensing for certain species such as a shellfish entitlement or salmon fishing license;
- Seasonal and/or spatial restrictions on fishing activity, fishing methods, gear specifications and vessel sizes; and
- Environmental conditions such as weather.

The landings by Scottish vessels account for a large proportion of the overall value of landings in the UK (60% of all landings by UK vessels in 2019) (Marine Scotland, 2020b). In Scotland, pelagic species which are mostly targeted by trawlers in the mid-water column comprise the greatest proportion of landings weights (~60%). Demersal trawling and shellfish fisheries comprise approximately 24% and 16% of landings weights respectively. Shellfish landings includes those from static gears, *Nephrops* trawlers and scallop dredgers. Demersal, pelagic and shellfish fisheries each comprise around $^{1}/_{3}^{rd}$ of the landings values from Scotland (Marine Scotland, 2020c).

In relation to commercial fisheries displacement, based on the priority research areas which have been identified by the ScotMER FFSRG and the consultation which has been carried out to date by Marine Scotland, the fishing methods which have been highlighted as the priority focus on within this report are demersal trawling (including pair trawling and *Nephrops* trawling), scallop dredging, seine netting and creeling.

A description of these fishing methods is provided in Sections 7.1.1 to 7.1.4, which has been primarily informed by Seafish (2015, 2021[9]), commercial fisheries technical reports and consultation with fisheries stakeholders.

[8] For information on the allocation of TAC and quota in the UK can be found here: UK and England quota management rules - GOV.UK (www.gov.uk)
[9] Fishing Gear Database | Seafish

7.1.1 Demersal trawling

Demersal trawlers operate one or more (twin rigs) funnel-shaped nets which are towed over the seabed to catch demersal fish and shellfish species. The net is held open laterally by trawl doors on either side (otter boards) and vertically by floats attached to the headline of the net. Where the net is in contact with the seabed (groundline), the materials used often depend on the ground conditions and target species. Demersal trawlers working over uneven, rocky grounds may use rockhopper gear, where bobbins (rubber discs) are attached to the groundline. Demersal trawlers which work over soft sandy and muddy substrate (such as *Nephrops* trawlers) may use lighter materials in the groundline, due to the need to disturb seabed dwelling species in these habitats. Demersal trawl vessels can reconfigure their gear to target different species, depending on season and stock for example *Nephrops* to squid. Demersal trawlers typically steam at between 2.5 to 3.5-4 knots when operating the trawl net (Seagreen, 2017; Seafish, 2021).

Demersal trawls are operated by vessels of a range in size, under 10 m to well over 15 m in length. The distance between the trawl doors typically ranges from 50 to 200 m and the length of the net (from trawl door to end of net) can be up to 200 m (SFF, 2020). The manoeuvrability of smaller vessels is higher than that of larger vessels, and as the gear is likely to be lighter for smaller vessels the seabed penetration depth may be less. In general, demersal trawls are operated to minimise seabed penetration in order to protect the fishing gear and avoid gear fastenings (Seafish, 2021).

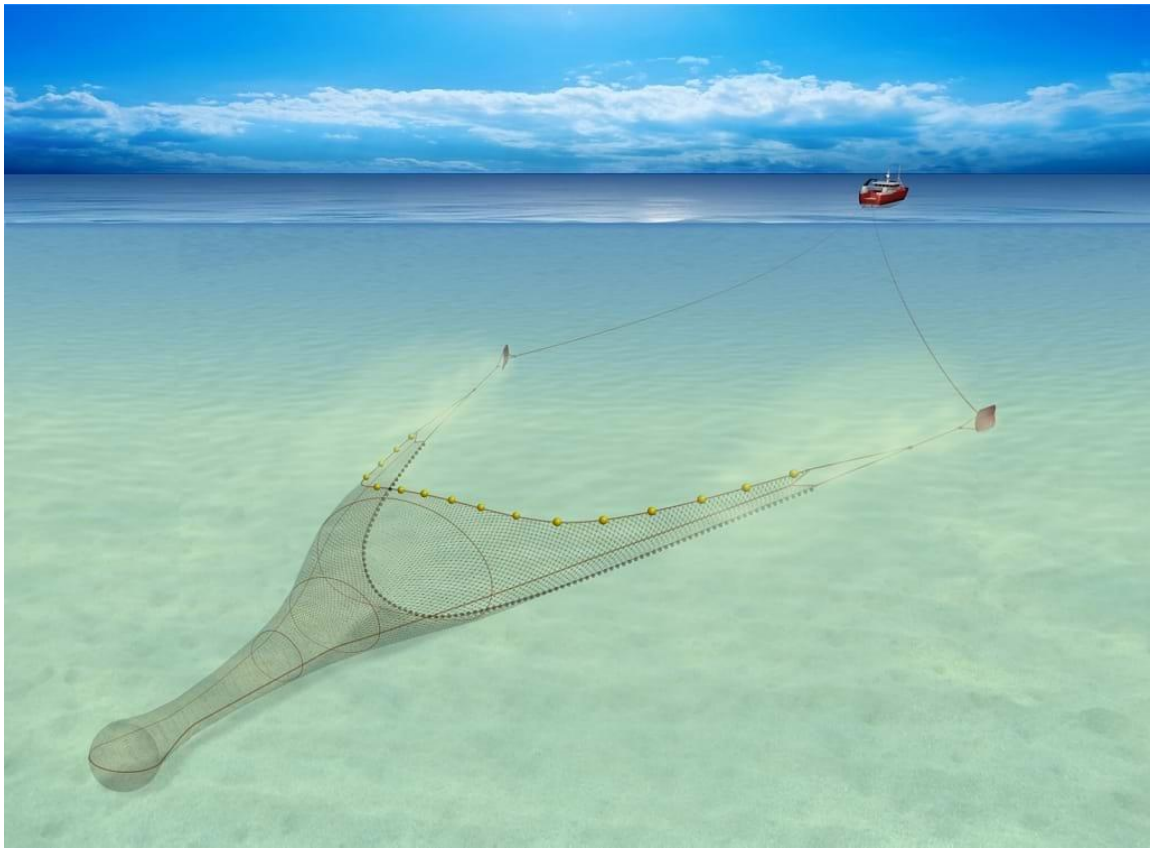

Figure 7-1 Demersal trawl (Seafish, 2021)

7.1.1.1 Pair Trawling

Demersal pair trawling involves two boats towing a single net. The net is similar to that of a single trawl, however, rather than using trawl doors, the net opening is maintained by the distance between the two vessels, which is usually 300 – 600 m (SFF, 2020; Seafish, 2015; 2021). The distance between the vessel and the start of the net is typically 1.5 km (SFF, 2020). In comparison to single-rig trawls, pair trawling enables a larger net to be operated while reducing drag of the gear. By way of the method of operating pair trawls, the overall required area is greater and manoeuvrability, once the net is deployed is lower than that of single-rig trawls.

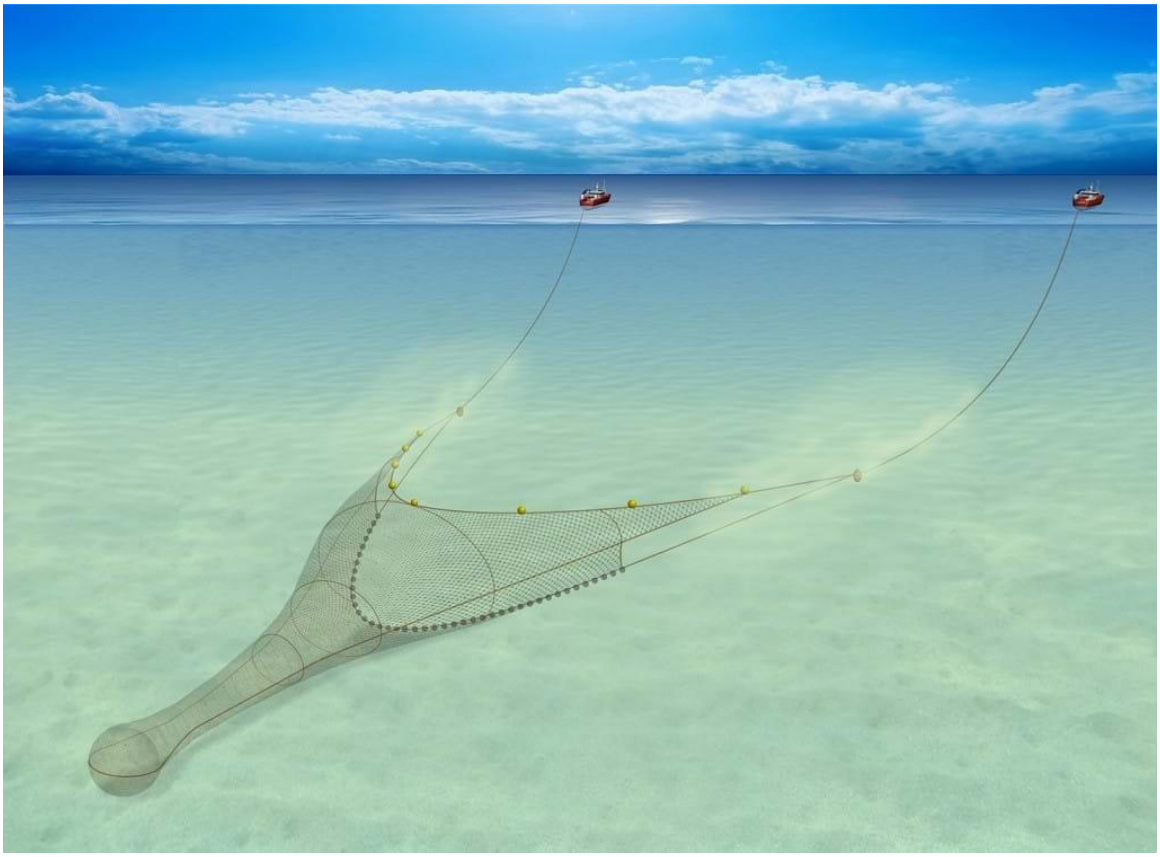

Figure 7-2 Pair trawling (Seafish, 2021)

7.1.2 Scallop dredging

Scallop dredging vessels operate a rigid metal frame onto which is attached a chain mail bag and at the mouth a series of spring-loaded teeth which penetrate the seabed, dredging the scallops which are mostly sedentary and are seabed dependent. The dredges are attached to a spreading bar which is often attached to one of two beams, on either side of the fishing vessel. Each scallop dredge is approximately 0.75 m wide and the number of dredges which are operated can vary from 3-4 on a small vessel to up to 20 dredges. In Scotland there are specific regulations about the maximum number of dredges which can be operated within specific parts of the territorial sea (The Regulation of Scallop Fishing (Scotland) Order 2017: 8 dredges per side between 0 – 6 NM and 10 dredges per side between 6 and 12 NM). Scallop dredging activity is often carried out by very large nomadic vessels, which show episodic intensive periods of activity for approximately 2 years and then move to another area. The grounds are usually left for around 5-7 years before dredgers return and repeat the cycle (Seagreen, 2017). The typical penetration depths for scallop dredges is between 2-6 cm, based on a single tow (Currie & Parry, 1996; Løkkeborg, 2005, as cited in Catherall & Kaiser, 2014). Over time, dredges may penetrate deeper into the seabed if there is a high potential for repeat activity.

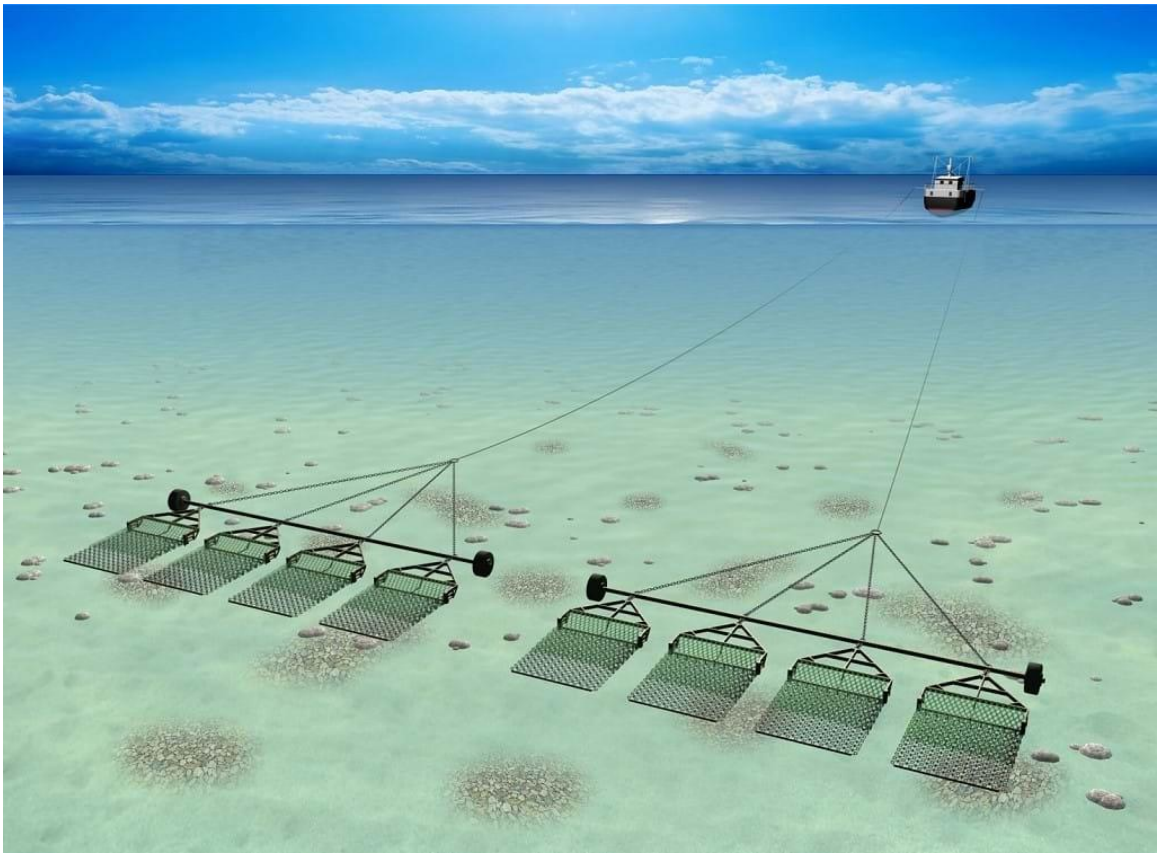

Figure 7-3 Scallop dredging (Seafish, 2021)

7.1.3 Scottish seine netting

Seine netting includes beach seine, Danish seine and Scottish seine netting. The main seine netting fishing method operated in Scotland is Scottish seine netting and this was historically the primary demersal fishing method in Scotland. Many seine netting vessels converted to operate demersal trawls, although seine netting is still in operation, mainly in North and North East Scotland and Shetland. Despite this, there has been a resurgence of this fishing method in recent years, with boats being purpose-built for seine netting (Seafish, 2015).

Scottish seining is typically operated over soft sediments, as the gear can become damaged when operated on harder substrates (Seafish, 2021). This fishing method involves shooting a net in a circular motion, with the net being at the mid-point of this circle, with ropes either side which are attached to the vessel. The ropes on either side of the net pull the net closed as the vessel tows the gear, herding demersal fish into the net. The net is then hauled by the vessel via a winch. The rope on either side of the net can be 1.7 to 3 km long and the area of seabed encircled by the net ranges from 600 to 1000 m diameter (Seafish, 2021).

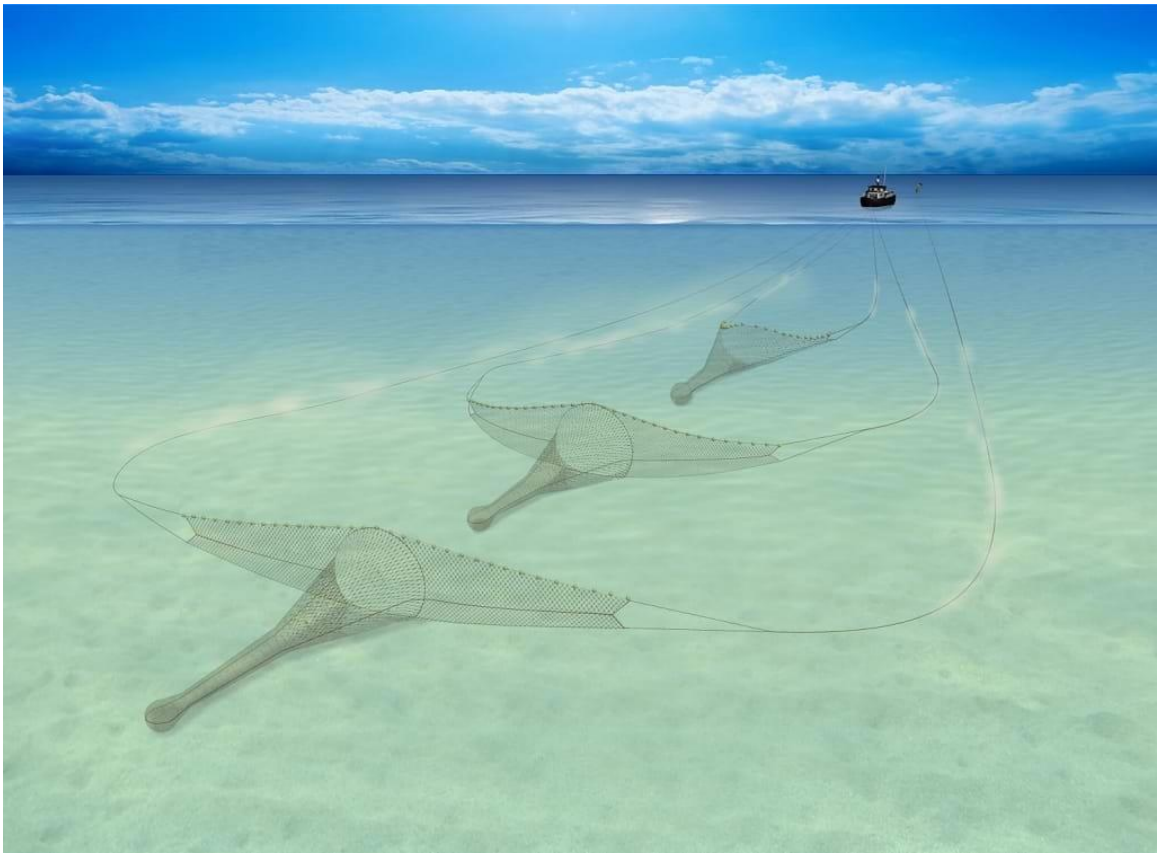

Figure 7-4. Seine netting (Seafish, 2021)

7.1.4 Creeling

Creeling (pots, traps) for crab and lobster occurs throughout UK waters although the design of creels may vary depending on region and target species. Typically, all creels have one or more “funnel” shaped entrances for the shellfish to enter and are assembled in fleets of between 10 and 50 creels per fleet (in a string). Larger static fishing vessels will have greater capacity to operate longer strings of creels over large areas of ground, with the strings of creels varying from 100 to 500 m in length. Once deployed the strings are anchored at each end. Full-time creelers will often attempt to turn over (haul, empty and reset) their creels every 12-24 hours to maximise catch (weather-dependent). Larger vessels with a greater number of creels may require longer periods of time to haul, empty and reset their gear (up to three days). Creels by law, should be marked with flagged dhans (marker flags), buoys or cans. Vessels engaging in creeling are generally under 10 m in length, with crew members typically varying from one to three.

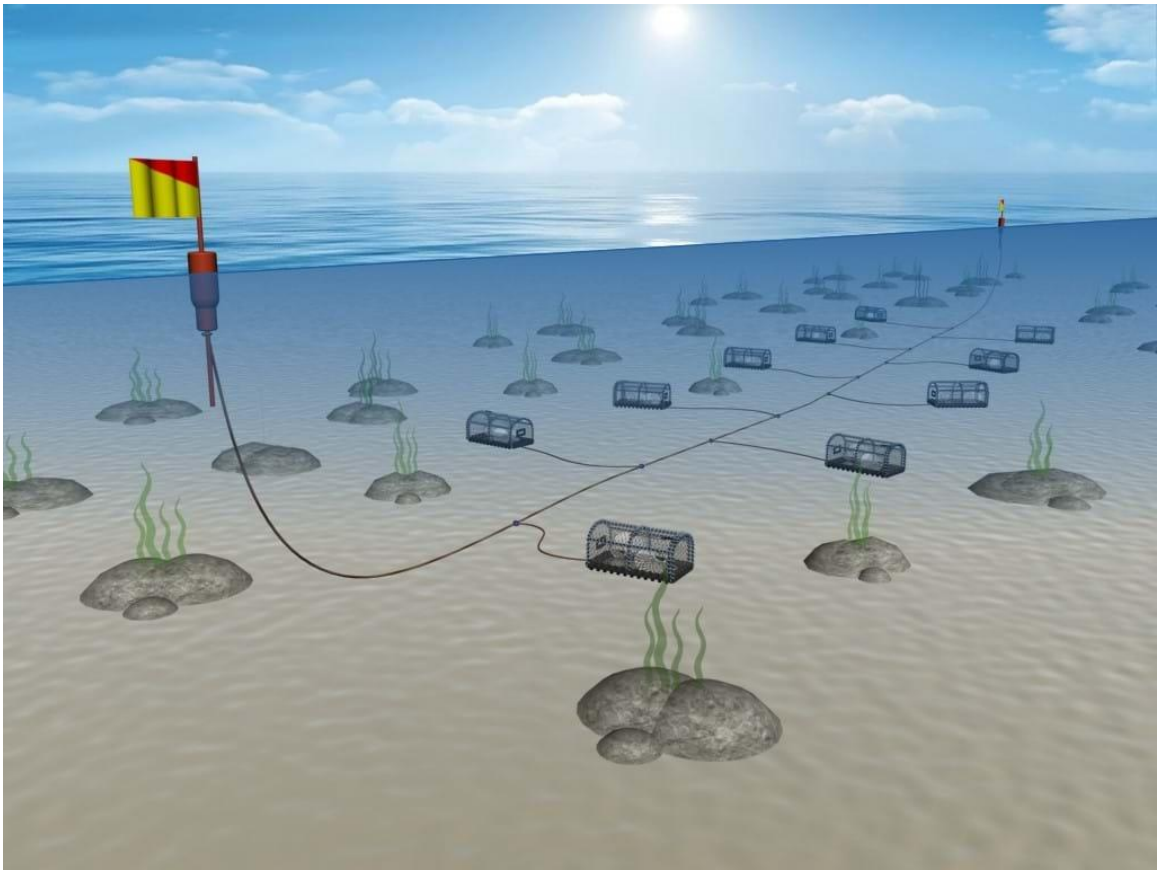

Figure 7-5. Creeling (Seafish, 2021)

7.2 Licensed marine activities

There are various licensed marine activities which may overlap spatially within the marine environment with the fishing industry. The way in which an offshore development's activity or infrastructure influences commercial fishing or displacement can depend on the structures which are installed, the methods which are used for installation and maintenance and the mitigation measures which are implemented.

A description of licensed marine activities which are understood to be most relevant to fisheries displacement are described in Sections 7.2.1 and 7.2.2.

7.2.1 Marine Renewable Energy (MRE) projects

MRE developments mainly comprise equipment and associated infrastructure to harness offshore wind, wave and tidal energy. MRE projects range from a single device to an array of devices across a wider development area. The design, layout, installation and maintenance of a MRE development varies depending on the conditions and the environmental constraints.

7.2.1.1 Offshore wind

The technology which is available to offshore wind developers has advanced rapidly in the last 10-15 years in terms of the design and size of offshore turbines, the materials and protection types for cables and in the methods of installation and maintenance. These advancements allow for a more efficient energy generation process with lower consumer and operator costs using the same resource quality and enabling access to a larger number of options for locations of varying conditions (IRENA, 2019).

Offshore wind turbines are comprised of above sea surface and subsurface components. The above surface turbine infrastructure is composed of several (usually 3) rotating blades (rotors) which are connected to a central hub which comprises multiple interacting parts including the generator which converts mechanical energy to electricity. This electricity is passed to the turbine tower. The tower is then connected to the subsurface portion of the turbine, known as the foundation. The foundation can either be fixed to the seabed or floating within the water column (Offshore Renewable Energy (ORE) Catapult, 2019). The foundation can either be fixed to the seabed or floating within the water column (ORE Catapult, 2019).

7.2.1.1.1 Fixed wind turbine generators

Fixed turbines have foundations which are fixed to the seabed and support the surface component of the turbine. These devices can be installed in nearshore or offshore environments with different installation techniques and foundation structures depending on the project design and the local site conditions. Examples of fixed bottom foundations include monopiles, gravity bases or jackets/tripods (Figure 7-6) (ORE Catapult, 2019).

Typically in commercial fisheries impact assessments for Offshore Wind Farms (OWFs) with fixed foundations, it has often been assumed by the practitioner that access to fishing grounds would resume, potentially under the assumption of certain necessary changes to operation practices, the type of fishing gear they are operating and depending on the perception of safety of the skipper of the vessel (Ørsted Hornsea Project Four Ltd, 2020, Moray Offshore Windfarm (West) Ltd, 2017, Seagreen, 2018).

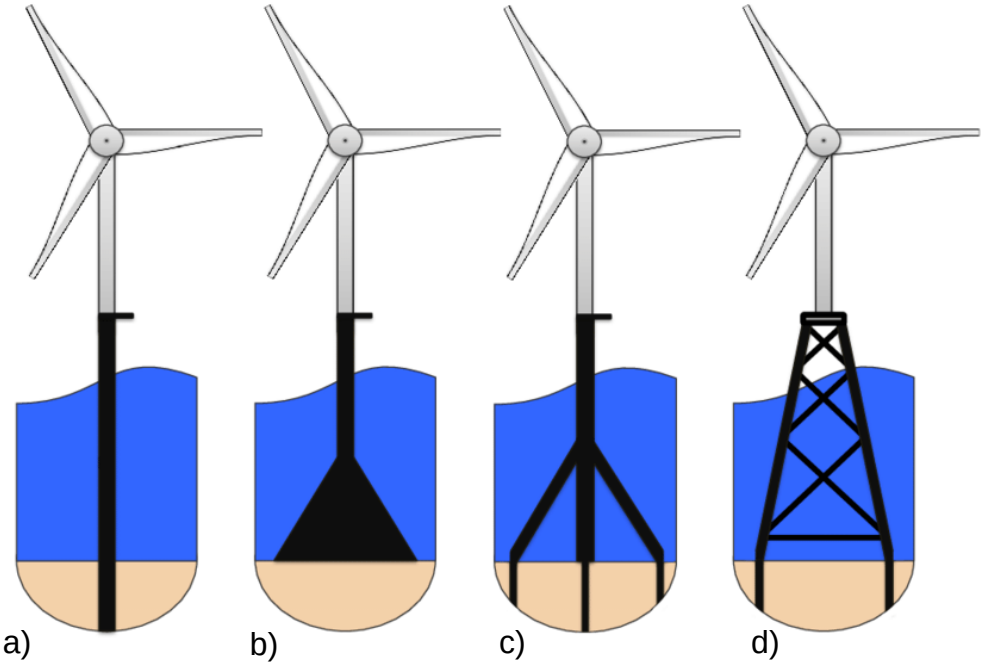

Figure 7-6 Offshore wind turbine fixed-bottom foundation types: a) monopile, b) gravity based, c) tripod and d) jacket (Van der Valk, 2014)

7.2.1.1.2 Floating turbines

In water depths of greater than 60m, the traditional fixed turbine design is generally not practical. In these waters, it is expected that floating turbines will be used. Floating turbines are buoyant and anchored to the seabed via mooring lines (ORE Catapult, 2019). Examples include semi-submersibles, tension leg platforms and spar buoys (Figure 7-7) (Rixen, 2014).

The presence of mooring lines connecting the floating turbines and dynamic cables free-hanging in the water column reduces the likelihood of a resumption of access to fishing grounds following installation.

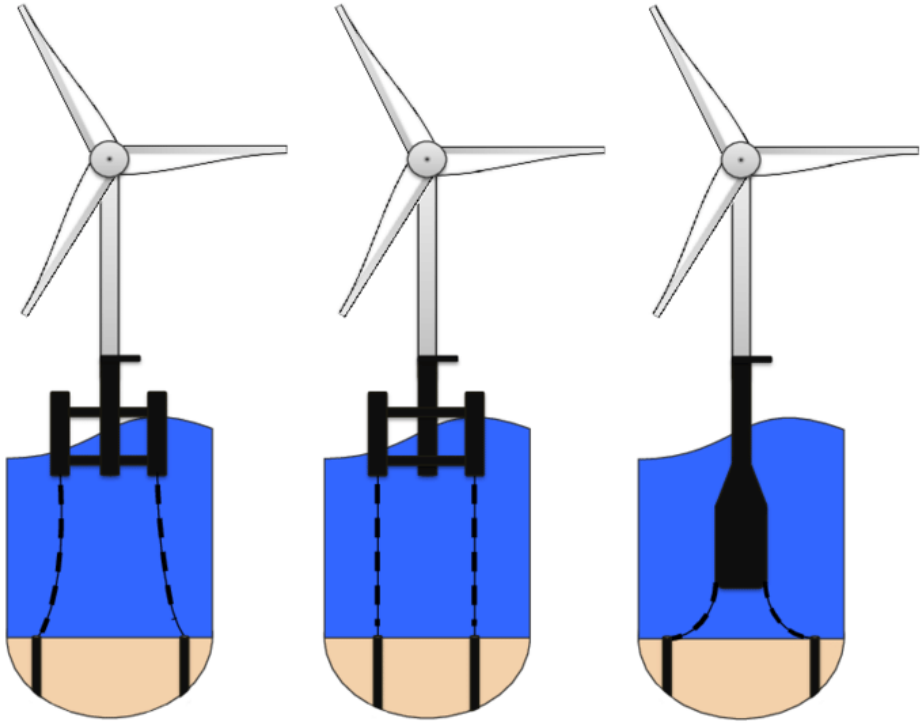

Figure 7-7 Offshore wind turbine floating foundation types: a) semi-submersible, b) tension leg platform, c) floating spar buoy (Van der Valk, 2014)

7.2.1.1.3 Tidal turbines

Tidal projects are predominantly composed of submerged devices anchored on or fixed to the seabed with structures which rotate or oscillate with the tidal stream (Aquaret, 2008a) (Figure 7-8). Tidal devices may be fixed or tethered to the seabed via mooring lines (e.g. kite designs) and are primarily located within tidal streams in the nearshore environment, such as in the headlands around islands (e.g. Minesto, 2016).

There are four consented tidal arrays in Scotland to date. Two of these, MeyGen and Bluemull Sound are operational in the inner Sound of the Pentland Firth and between the Islands of Yell and Unst in Shetland, respectively (Scottish Government, 2020b).

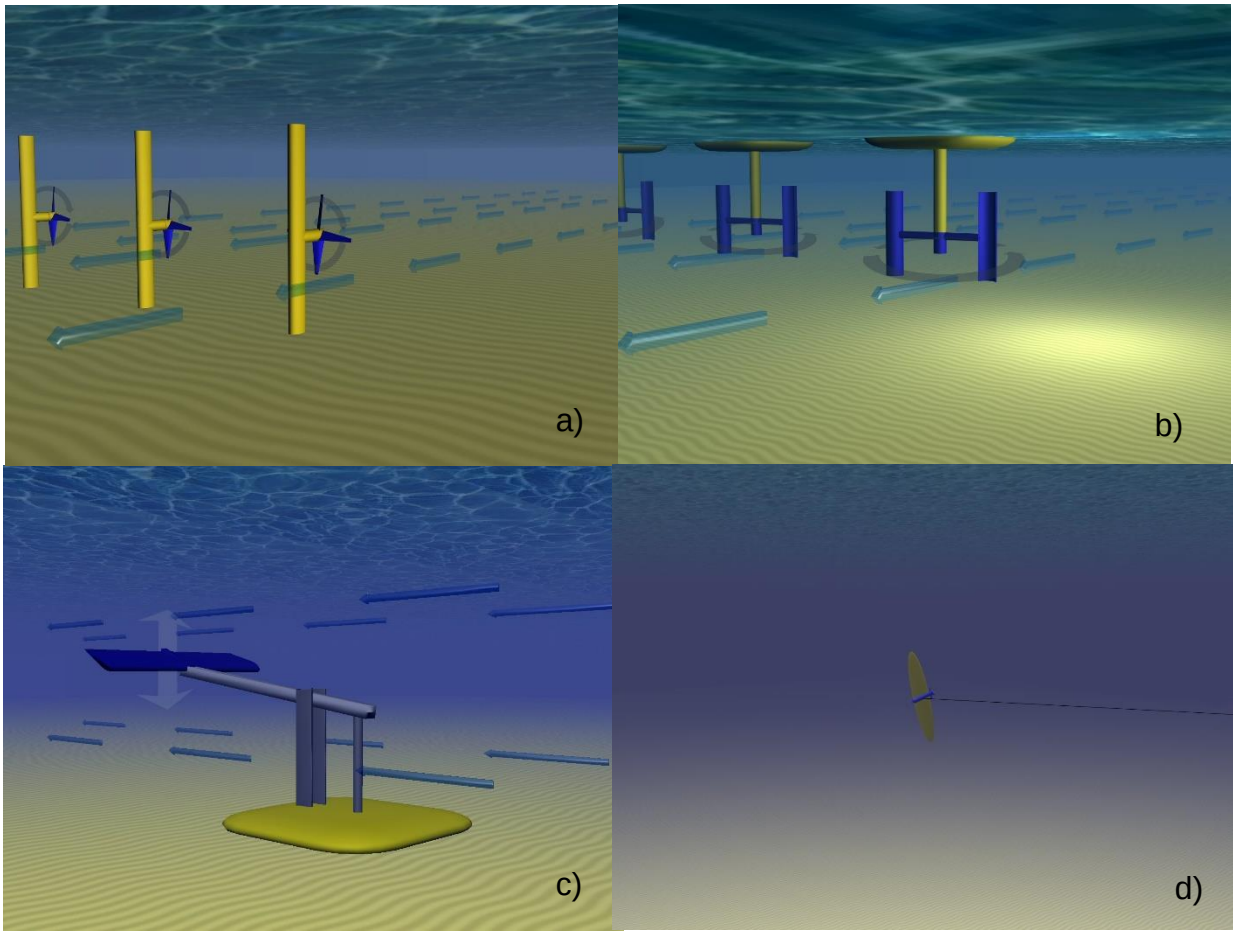

Figure 7-8 Examples of tidal turbines: a) horizontal axis turbines, b) vertical axis turbines, c) reciprocating hydrofoils and d) tidal kite (Aquaret, 2021)

7.2.1.1.4 Wave energy devices

Wave energy devices may contain above-surface, surface and/or subsurface components and may be fixed or tethered to the seabed via mooring lines or other methods. There are various design options for wave energy developments which can be located nearshore and offshore (Figure 7-9). Wave energy technology currently remains a novel technology, with various prototype designs being tested (Aquaret, 2008b). There are currently no consented commercial wave arrays in Scotland (Scottish Government, 2020b).

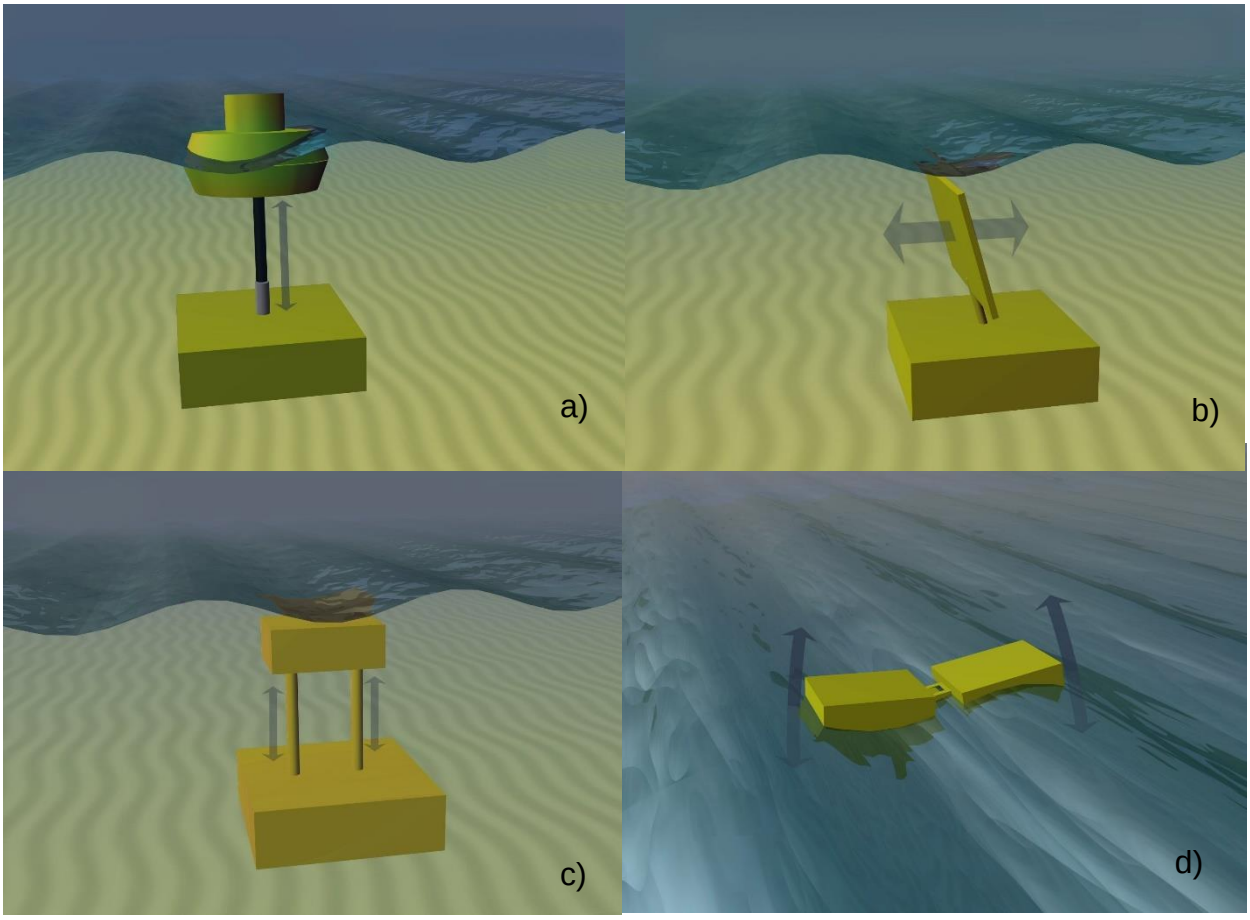

Figure 7-9 Examples of wave energy devices: a) surface point absorbers, b) oscillating wave surge converter, c) submerged pressure differential device, and d) attenuator (Aquaret, 2021)

7.2.1.2 Other renewable infrastructure

The energy generated from renewable energy developments is transported to the onshore electrical grid network via electrical transmission infrastructure (Figure 7-10). Within a renewable development, this typically includes inter-array cables, which connect turbine devices to each another and to offshore substation(s). Offshore substations collect, transform and transfer energy from the turbines, and are composed of surface infrastructure (i.e. topsides) attached to the seabed via a foundation (e.g. jacket infrastructure). Export cable(s) then transmit the energy from the from the offshore substation to shore (ORE catapult, 2019). For renewable energy arrays which are located farther offshore and transmitting High Voltage Alternating Currents (HVAC), a 'booster' station may be construction at the mid-way point of the export cable, which is of a similar design to the offshore substation (Ørsted, 2020).

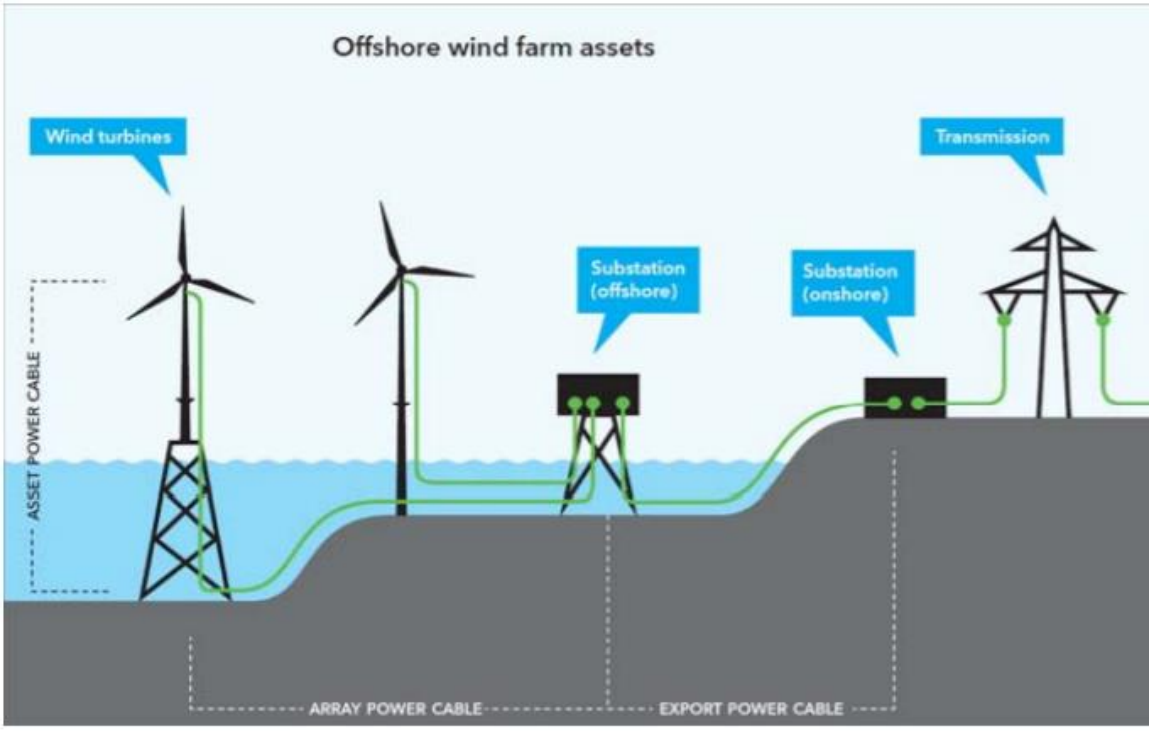

Figure 7-10 Offshore Wind Farm Infrastructure (DNV GL, 2014)

Inter-array and export cable infrastructure can be installed with different techniques and equipment. BERR (2008) provides a comprehensive review of different cable installation and protection techniques. In brief, cables may be laid and buried simultaneously (e.g. plough installation) or laid and buried sequentially (e.g. jet trencher). Target burial depths are estimated prior to construction through cable burial risk assessments (CBRAs) which consider local ground conditions, cable installation techniques and interactions with other sea users. If burial cannot be achieved, mechanical protection may be placed such as articulated half shells (tubular product), rock and concrete mattressing (Figure 7-11).

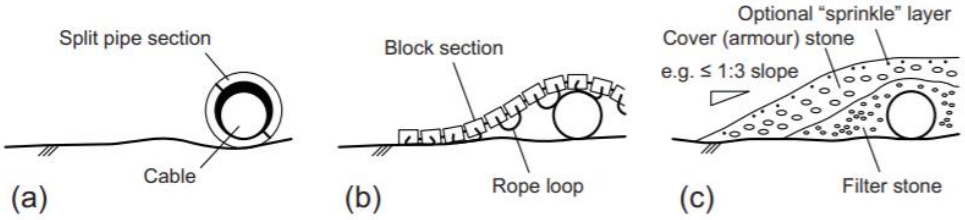

Figure 7-11 Cable protection. (a) tubular product (e.g. articulated half shells), (b) mattress, (c) rock placement (DNV, 2016)

7.2.2 Oil and gas and other developments

In the UK, oil and gas infrastructure is concentrated in the North Sea, offshore of the east coast of the UK. There are various types of infrastructure associated with the oil and gas industry, both surface (e.g. platforms and Floating Production Storage and Offloading (FPSOs) and subsurface (e.g. manifolds, pipelines, umbilicals, risers, and wellheads). Safety zones (which prohibit or advise, against the presence of other sea users such as fishing vessels) are typically in place around subsurface structures such as manifolds and wellheads, as well as surface infrastructure such as platforms and FPSOs (Health and Safety Executive, 2008).

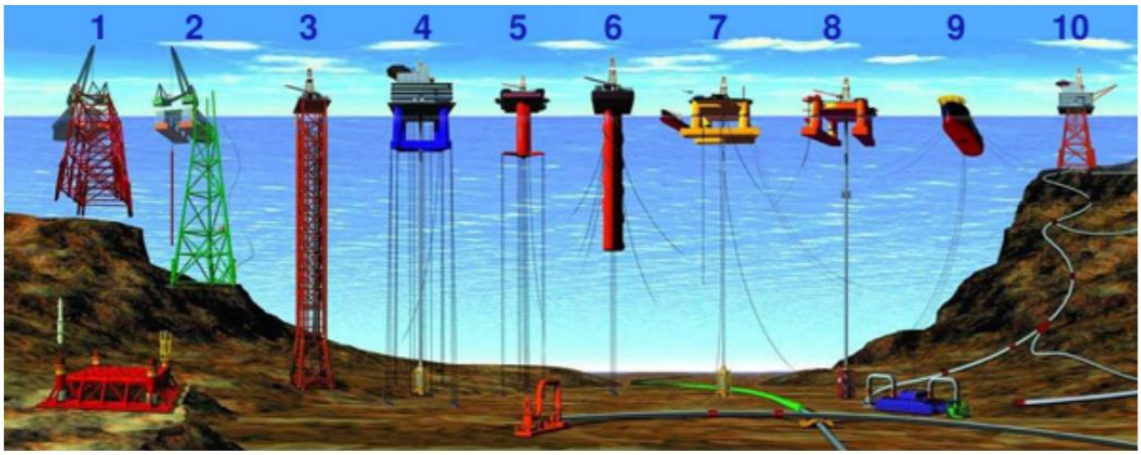

Figure 7-12 Examples of oil and gas infrastructure: 1 & 2) conventional fixed platforms; 3) compliant tower; 4 & 5) vertically moored tension leg and mini-tension leg platform; 6) spar; 7 & 8) semi-submersibles; 9) floating production, storage, and offloading facility; 10) sub-sea completion and tie-back to host facility (Sadeghi, 2007 cited in Pascual & Greenhill, 2018).

Aggregate extraction is another industry which has the potential to lead to displacement of fishing effort. Aggregate extraction occurs in licenced areas in UK waters, concentrated in the south and south east of England. Aggregate dredging vessels operate within the licenced area to extract minerals and sands and gravels (The Crown Estate, 2021). The licensed areas are split into active dredge zones, which represent the area available to be dredged at any one time (British Marine Aggregate Producers Association, 2021). This is in the aim of reducing the spatial footprint of the dredging activity. Fishing effort may be displaced whilst a dredging vessel is operating within an active dredge zone.

Additional industries which might potentially lead to displacement of fishing vessels include aquaculture, Carbon Capture and Storage (CCS) and defence.

7.2.3 Marine protected areas with fisheries management measures

Fishing activity can be managed through plans, policies and restrictions related to MPAs and wider fisheries management (Scottish Government, 2021). Management measures for MPAs may include reducing or removing fishing pressure either permanently or seasonally throughout the MPA, or within defined zones (Marine Scotland 2014; ABPmer, 2017; JNCC *et al*., 2020). Fisheries management measures may also be in place outwith MPAs, to promote the sustainable harvest of fish stocks and the protection of the marine environment. These measures include but are not limited to setting catch limits through fish quotas (e.g. TACs), placing limits on time at sea, setting restrictions on fishing gear and equipment and applying spatial closures (Scottish Government, 2021).

Fisheries management measures may lead to displacement for one or all fishing methods operating within the areas in which the management measure applies (Marine Scotland, 2014; Scottish Government, 2020e; ABPmer, 2017). Displacement impacts occur in a similar manner as to those relating to other licenced marine activities, leading to reduced availability of grounds and increased competition and conflict, and is likely to be most severe where fishing activity is excluded as a result of spatial closures (Scottish Government, 2020e). Crucially, displacement from MPAs and fisheries management measures can further restrict the availability of grounds for fisheries, in addition to the other licenced activities described in Section 7.2.1 and 7.2.2.

7.3 Existing research and approaches

This section provides a summary of the existing research into the potential impact pathways relevant to commercial fisheries displacement. This section includes a brief summary of some of the existing studies on ecological impacts to commercial fisheries displacement, and then on commercial fisheries receptors themselves. The ecological impacts will not be of key focus within the Good Practice Guidance which will focus only on commercial fisheries impacts.

7.3.1 Ecological impacts of commercial fisheries displacement

With the exception of EIAs and consent applications, the majority of the methods for assessing displacement which were identified in the Literature Review focus on temporary or permanent closures associated with no take zones, limitations on fishing methods and gear specifications, or other fisheries management measures (Chollet *et al*., 2016; Slijkerman & Tamis, 2015; Greenstreet *et al*., 2009; Bastardie *et al*., 2015).

In many cases it is understood that the net environmental and ecological benefits of a protected area where fishing activity is restricted will improve the fish or shellfish stock and lead to a beneficial impact on commercial fisheries through increased availability and improved habitat condition for exploited species.

Kenchington *et al.,* (2018) reviewed studies investigating the influence of no-take marine reserves on the marine environment, and also fisheries stakeholders. The review concludes that no-take marine reserves show a trend of an overall positive

effect on parameters such as in increased stock, spill-over of adults and larvae and increased egg production. The conclusion of a benefit is usually limited to specifically monitored parameters, and the need to involve all stakeholders in the marine spatial planning of such spaces is highlighted.

Goñi *et al*., (2008) investigated the spillover impact of 6 MPAs in the Mediterranean. It was observed that displaced fishing effort was concentrated near fisheries closures due to the spillover effect of commercially exploited fish creating productive waters around the MPAs.

It is important to note that, assuming the fishing activity is not stopped entirely, the pressure of fishing effort would be redistributed and not reduced. The impact of this displaced fishing activity is difficult to predict due to the complex and variable patterns of fishing activity, especially within a new environment. Several modelling studies have indicated that displacement resulting from fisheries closures can have a detrimental effect on the marine environment on the area to which fishing is relocated, especially when an area which typically supports high levels of fishing effort is closed (as referenced in ABPmer, 2017). Feedback from stakeholders also indicated that closures may also result in increases in benthic species (e.g. starfish), some of which can adversely affect fish stocks.

The potential impacts of OWFs on the marine environment has also been investigated, although to a lesser extent when compared with no-take zones and fisheries management measures. Methratta and Dardick (2019) conducted meta-analysis to understand the potential impacts of OWFs on fish populations. The results indicated that fish abundance inside wind farms was generally greater compared to nearby reference sites. The MMO also conducted a review of post-consent monitoring for OWFs in English waters, which indicated that although some changes in the fish and shellfish environmental baseline were apparent, this was not attributed to the OWF, as similar differences were recorded in reference areas (MMO, 2014).

Roach *et al*., (2018) studied the impact of a short-term closure of lobster fishing grounds within the Westermost Rough OWF, associated with construction activities. The temporary closures lead to increased abundance and size of lobsters, with a short-term increase in catch rates following the re-opening of the fishery. Roach *et al*., (2018) suggest that these temporary closures could act as a management tool to protect spawning stocks and offset the economic loss of permanent closures.

Degraer *et al*., (2020) observed increased plaice catch rates and landings around operational wind farms when compared to the wider area. This trend was not observed for sole where the catch rates within and around operational wind farms remained similar to those of the wider area.

7.3.2 Current approaches for the assessment of commercial fisheries displacement

A comprehensive review of the available tools for assessing displacement is provided in ABPmer (2017). Several of these sources developed complex behavioural or economic models in order to predict where fishing is likely to be redistributed to, and the associated impacts of this displacement, in terms of the fishing fleet or the marine environment (e.g. benthic environment or fish stocks). However, due to the complexity in predicting fishing activity and the behavior of a skipper under variable sea conditions, these models require several assumptions to be made, and this limits their use as a robust tool for assessing displacement for other licensed marine activities (Campbell, 2015; MMO, 2014; ABPmer, 2017).

Alternative studies on the assessment of fishing displacement focused on assessing the availability of alternative grounds, using Vessel Monitoring System (VMS) data and spatial data on sediment types (Campbell *et al*., 2014; Marine Scotland, 2014). For example, when assessing the impact of various management options for 16 MPAs in Scotland, Marine Scotland (2014) assessed the potential availability of alternative grounds within 20 NM of the MPA, using VMS data, ScotMap data and information on sediment type (e.g. mud burrowed habitat for *Nephrops* grounds). This study also assessed whether the fishing grounds would be able to 'absorb' the effort that was likely to be displaced into these areas as a result of the management option, based on the availability of grounds within 20 NM and the amount of fishing effort being displaced. Overall, levels of fisheries displacement were considered to be low and this is partly due to the management and planning measures avoiding the most valuable fishing areas where possible (Marine Scotland, 2014). In 2020, the Scottish Government released a report which reviewed the socio-economic impact of the MPAs designated in 2016 using a quantitative and qualitative approach (Scottish Government, 2020e). The results indicated that since 2016, the landings by towed gear in non-MPA ICES rectangles had increased in comparison to ICES rectangles which contained MPAs, but that this trend was only observed for landings effort of > 10 hours and > 50 hours in an MPA. Landings of > 200 hours in MPAs, decreased across all ICES rectangles in 2016. It should be noted that this study also acknowledges that other factors will influenced landings aside from the MPA regulations. Stakeholder consultation carried out during this project indicated that fishermen were concerned about the potential increased conflict and competition for fishing grounds resulting from the displacement from the MPAs. Fishermen also indicated that fishing was displaced to areas on the edges of the MPA for smaller vessels, but potentially at more distant fishing grounds for larger vessels.

7.3.3 Fisheries displacement from MREs

There are few studies available which specifically investigate fisheries displacement in relation to MREs. These have been reviewed within the Literature Review carried out by Brown and May Marine (2021) to inform ScotMER evidence gap FF02, where more details are provided on each study (Marine Scotland, 2018).

Gray *et al.* (2016) analysed fishing activity data in areas within and relevant to 6 operational windfarms in the Irish Sea. The findings of this study showed an overall reduction of fishing effort by demersal trawling vessels, which was explained in part by changes in TAC allocations. Displacement of activity by *Nephrops* trawlers was observed in relation to Walney 2, whereas for all other operational OWFs in the study no significant displacement of this fishery was recorded. This study highlights a limitation in the assessment of displacement specifically in relation to a development, as fishing activity is influenced by many environmental and legislative factors, especially since the departure of the UK from the EU and Common Fishery Policy.

Campbell *et al*., (2015) analysed VMS data to predict the potential displacement effects of a wave MRE development and an MPA in South West England. Maps of gear-specific VMS were produced to understand the distribution of fishing activity and the spatial overlap with the MRE development and MPA. The results indicated that beam trawling and demersal trawling were widespread in the region, and that these fishing methods were present at low effort levels within the MRE development and MPA. On the contrary, some static gear fishing methods (longlining and gill netting) had a more localised distribution which overlapped with the MRE development and MPA. It was predicted that these fishing methods would be displaced into other areas, which could result in increased competition or conflict, especially with mobile-gear users.

De Groot *et al.* (2014) provide a stakeholder-based study of the coexistence of the fishing and MREs. The findings highlighted a need for more robust data to quantify displaced fishing activity, for robust methodologies for assessment and standardised consultation process which is agreed upon by MRE developers and fisheries stakeholders.

7.3.3.1 European studies of commercial fisheries displacement

A number of studies have also been carried out in European waters, where fishing is prohibited within operational windfarms by several member states. The potential health and safety issues of permitting fishing, and particularly demersal trawling to resume within an operational OWF in Europe has been highlighted in several studies (Primo Marine, 2019; Stelzenüller *et al.*, 2020), which is of ongoing concern and focus in the UK, in particular in reference to overtrawlability and subsea cables, and uncertainties of the definition of sufficient spacing between two OWF turbines for a demersal trawler to fish, given any trawling vessel is subject to the specific operating practices and decisions of the skipper.

Degraer *et al.,* (2020) studied fishing activity (effort, landings and catch rate) over an eleven-year period to investigate the impact of the offshore wind developments

in Belgian waters. As fishing is prohibited within OWFs in Belgian waters, fishing activity stopped within the OWF area following installation. Fishing effort around the edges of OWFs slightly increased following construction, especially in the case of OWFs located further offshore. Landings of sole from waters around the edge of OWFs were not discernable from the wider region, however, landings of plaice from these waters were slightly higher.

Several EU studies are also available which discuss the potential for co-existence between commercial fisheries and the MRE industry to reduce the impact of spatial exclusion. These are provided in Brown and May Marine (2021), and inform ScotMER evidence gap FF14:

- In the Netherlands, Primo Marine (2019) concluded that the cost of energy would increase for operational wind farms if demersal fishing activity continued within the site, as a result of the health and safety risks, insurance claims as well as project design implications and costs for cable repairs. The study recommended that the cost should be weighed against the benefits of continued access for the fishery.
- Stelzenüller *et al* (2020) reviewed the potential for co-existence between MRE developments and commercial fisheries in Europe, including best practice and lessons learned and suggested potential solutions for co-existence between the two industries. The study predicts that spatial conflict will increase in the near future as MRE developments increase, and that the impacts will mostly occur to mobile fishing methods targeting demersal species and crustaceans. Best practice examples of co-existence, co-location and co-operation are provided, such as in Denmark, where fishing industries are consulted with in order to negotiate mitigation measures. Stelzenüller *et al* (2020) also list mitigation measures which could reduce conflict potential which include early communication and stakeholder consultation, and co-design approaches to reduce the impact potential on fisheries
- Dupont *et al* 2020 characterised the conflicts between OWFs and the fishing industry, such as health and safety risks and insurance claims, and reviewed their occurrence within the EU and how conflicts have been addressed. Potential solutions to mitigate against conflicts and improve co-existence were also provided in the study, such as stakeholder engagement and socio-economic impacts assessments (at a cumulative and project-specific level). This study also suggests the potential for designing fishing compatible MRE developments to reduce spatial exclusion in and around MRE developments. It was identified that the operation of static fisheries within an MRE development may be possible, but that seabed fisheries operating within a MRE development was unlikely, especially for seine netting and pair trawling. The study suggests wider corridors within MRE developments could improve co-existence with commercial fisheries and reduce the potential for long-term exclusion impacts.

Key actions which may encourage coexistence of the fishing and MRE industries were consistently highlighted as stakeholder engagement, consideration of fishing activity in the design of OWF projects, and consideration of socio-economic impacts as part of the assessments (Dupont *et al*, 2020; Schupp *et al,* 2021).

7.3.4 EIA case studies

In order to understand the typical methodologies which have been used to assess displacement of fishing activity as a result of other licensed marine activities, a number of EIAs which were submitted as part of consent applications for various types of offshore activities have been reviewed and are summarised within this section.

The review revealed that the methodology used to assess displacement within EIAs is not consistent. Importantly, fisheries displacement from other licensed marine activities differs from restrictions on fishing associated with MPAs, assuming that access to fishing grounds is expected to resume following construction of a development. Resumption of access to fishing grounds differs from the perceived ability to fish within a development area (such as an OWF) which depends on many factors including the compatibility of the fishing activities with the infrastructure and the level of risk perceived by the individual skipper (Brown and May Marine and Marine Scotland, 2021).

The differences in methodologies which are used is logical due to the to the spatial and temporal variation in the fishing activity, operating practices and fishing effort in the areas of the developments. In most case studies, displacement of commercial fishing activity has been assessed on the basis of the assessment of temporary or long-term loss / restricted access to fishing grounds. In some EIAs the two impact pathways of loss / restricted access to fishing grounds and displacement of fishing activity are assessed together.

Typically, during installation, a safety zone will be in place around active installation works/infrastructure or project vessels which are restricted in their ability to manoeuvre. In the case of mobile gears, this safety zone is often assumed to be the area of potential loss of access to grounds, with fishing vessels being required to adhere to COLREGs. For creelers, the area of potential loss/restricted access to fishing grounds is often assumed to temporarily be parts of or the whole development, in consideration that static fishing gear will often be requested to be relocated in order to carry out project construction activities. In this case, the relevant mitigation which is recommended is in line with FLOWW (2014, 2015). For operational projects, there may not be mandatory safety zones in place, and the assessment of displacement is based on the operational infrastructure characteristics and fishing activity in that area.

In the UK, as there are no legal closures of operational OWFs to fishing, the ability for fishing activity to resume is subject to a number of project and vessel specifications, as highlighted in Brown and May Marine (2021). These include the following:

- Minimum spacing and width of corridor clear of infrastructure between turbines;
- Windfarm design, layout and configuration;
- Foundation type (floating vs. fixed foundations);
- Approach to cable installation, burial, protection and monitoring;
- Fisheries liaison and communication strategy;
- Free-hanging dynamic cables in the water column (for floating offshore wind);
- Target species presence following construction;
- Vessel manoeuvrability, operating patterns, and gear type (active vs. passive) and dimensions; and
- Level of contact of the fishing gear with the seabed (i.e. seabed penetration depths).

Gray *et al.,* (2016) also highlighted the following key deterrents for fishing within a wind farm:

- Health and safety risks, including snagging and risk of collision in the event of engine failure; and
- Financial risk due to risk of damage to fishing gear.

7.3.4.1 Good Practice Guidance - Offshore Wind Farm (OWF) EIAs: summary

As noted in Section 7.3.4, displacement of fishing effort/activity is often assessed within OWF EIAs as a function of the impact of loss or restricted access to traditional fishing grounds, as the latter may lead to displacement, assuming fishing activity is relocated and not stopped. In these assessments, the potential loss of access to fishing grounds is often considered to have the same or greater level of impact than the potential impacts of displacement, due to the primary focus of displacement and the most sensitive receptor (particularly during construction) being of static gear operators in EIAs to date.

The assessment methodologies for loss or restricted access to fishing grounds often incorporate several factors which are relevant to displacement, such as the fleet characteristics which determine the sensitivity to this impact (e.g. the operational range (often correlated with vessel size availability of fishing grounds and target species, and adaptability / flexibility of gear). Aspects of the impact that determine the magnitude of effect, such as the spatial extent and duration of the assessed activities, and the value and effort of fishing activity within the grounds that overlap with the impact area compared to the overall operational range or grounds available are also relevant to the assessment of displacement.

As detailed in Brown and May Marine (2021), for UK OWF EIAs, it is often assumed that access to fishing grounds will resume post-construction, in consideration of the factors listed in in Section 7.3.4. It should be noted that, with advancements in OWF technology and increased capacity of wind turbine generators, the required turbine spacing for fixed turbines (a function of the length of rotor blades) will increase, which may improve the access to fishing grounds once an OWF is operational. However, it is also understood that in cases where installed infrastructure does not provide the required space to fish, or the foundations are floating, that resumption of fishing activity for some fishing methods, in particular mobile fishing methods, is unlikely to occur following construction of the OWF.

The displacement methodology case studies from EIAs which were reviewed are summarised in Table 7.1. The review focused on UK OWF developments, however, other case studies were also reviewed, as well as non-UK developments. No EU EIAs (or similar) which were identified during the Literature Review considered displacement. However, there were limitations to this review, as several of the EU EIAs identified during the internet search were not available in English. Several of the EU environmental impact assessments (or summaries) were developed to assess the environmental impact or suitability of offshore wind zones in EU waters as part of that nation's marine spatial plan which were conducted the relevant governmental body. The EIA and two Construction and Operation Plans (COPs) for USA OWFs that were reviewed, assessed the significance of 'Impact Producing Factors' associated with project activities (e.g. presence of physical structures).

Table 7.1 EIA Case Studies

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
Scotland					
Moray West OWF (consented) (Moray Offshore Windfarm (West), 2017)	Moray Firth (Scotland)	• Up to 85 fixed-bottom turbines (spacing of 1.2 km) • Up to 2 offshore substation platforms (OSP) • 290 km inter-array and inter-OSP cables with 10% requiring external protection • 500 m construction safety zones and 50 m operational safety zones around installed infrastructure • Two cable circuits of 65 km for the export cable Transmission infrastructure assessed in separate EIA report.	• Creel fleet • Mackerel jigging fleet • Demersal trawl fleet (Nephrops, squid, and whitefish) • Scallop dredging fleet • Scottish seine net fleet Impacts assessed on a fleet-by-fleet basis.	The impact of fisheries displacement from the development activities was assessed as being a function of the loss or restricted access to traditional fishing grounds within the EIA. Accordingly, the sensitivities which were applied to the fisheries operating within the development and magnitude of effects for loss or restricted access to traditional fishing grounds were considered to be applicable to displacement for the construction, operation and decommissioning phases of the development.	In relation to construction, for sensitivity, the assessment considered the operational range of the vessels operating within the site and their adaptability in terms of target species/gear types, as well as the value and effort levels (based on VMS, landings statistics, surveillance sightings and consultation data) within the development in comparison to the wider region. The magnitude of effect was based on the duration and spatial extent of the impact. For the operational period, the potential for fishing vessels operating mobile gears to resume access to the site was assessed, based on the minimum separation distance between turbines and the fishing gear widths of the fishing methods operated within the site (gathered from consultation). The EIA also considered the estimated target cable burial depths and the estimated % of the cable which may require mechanical protection.

[10] The year refers to the year of the consent application.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
Hywind OWF (Operational) (Equinor, 2015)	North East Coast of Scotland	• Up to 5 floating turbines over 15 km^2 area (spacing of 0.8 - 1.6 km between turbines - with radius of mooring lines from centre being 0.6 - 1.3 km) • 150 - 850 m of 3 mooring line per turbine with up to 15 anchors in the wind farm (with potential scour protection) • 15 km inter-array cables • 35 km export cable requiring 2 km of external protection • 500 m safety zones during construction and installation	• Scallop fishery • Crab and lobster fishery • Whitefish fishery (finfish, Nephrops and squid) • Herring and mackerel fishery (pelagic and hand-line) Impacts were not assessed on a fleet-by-fleet basis.	The impact of fisheries displacement from the development activities was not assessed directly within the EIA but was instead incorporated into the assessment of loss or restricted access to fishing grounds.	For the sensitivity of fisheries to this impact, the assessment considered fishing effort and value within the development area in comparison to wider region (based on landings statistics, ScotMap data and VMS). The availability of other grounds was also considered, and the smaller operational ranges of inshore vessels was taken into account. The magnitude of effect was assessed in terms of the spatial extent and duration of the impact, with a consideration of the availability of alternative grounds. The operational impact of export cable was considered to be negligible, with no discernible impact on fishing activities expected.
Seagreen OWF (consented) (Seagreen, 2018)	Forth and Tay (Scotland)	• Up to 120 fixed-bottom turbines with 1 km spacing • 325 km of inter-array cabling with 10% requiring external protection • Up to 5 OSPs • Up to 6 export cables of approx. 190 km in length Transmission infrastructure assessed in separate EIA report.	• Scallop fishery • Squid fishery • Lobster and crab fishery • Whitefish fishery Impacts assessed on a fleet-by-fleet basis.	. Fisheries displacement was assessed as being a function of loss or restricted access to traditional fishing grounds, with the sensitivities and magnitudes of these impact pathways being the same. However, the assessment did consider the potential for competition and conflict to arise as a result of fishing displacement. A qualitative assessment was provided to assess the potential for displacement of scallop dredges to inshore waters to result in conflict with static gear operators, in the context of the wide availability of grounds for scallop dredges and the fishing restrictions for these vessels in inshore waters.	The assessment of loss or restricted access to traditional fishing grounds, considered the sensitivity of fishing fleets to this impact, based on the operational ranges of vessels, availability of grounds, value and effort within the development (based on landing statistics, surveillance sightings, VMS data, ScotMap data and consultation data), adaptability and potential safety risks of resuming fishing within the array site (e.g. larger scallop vessels – difficulties for manoeuvrability within the site). The magnitude of effect of this impact considered spatial extent, duration, and potential to regain access. The potential for fishing to resume within the site was based on the minimum spacing between turbines alongside the gear widths of the principle fishing methods within the site.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
Neart Na Gaoithe (consented) (Neart Na Gaoithe Offshore Wind Limited, 2018)	Forth and Tay (Scotland)	• Up to 54 fixed-bottom turbines with 800 m spacing • Up to 2 OSPs • 140 km of inter-array and interconnector cables with 20% requiring rock protection • Up to 2 43 km export cables with 15% requiring rock protection	• Demersal otter trawling vessels targeting Nephrops and squid • Potting vessels targeting lobster, brown crab and velvet crab with creels and seasonally deploying hook and lines • Scallop dredging vessels targeting scallop Impacts assessed on a fleet-by-fleet basis.	The impact assessment focuses on the potential for conflict to arise as a result of fisheries displacement, especially between mobile gears and potters. The potential for mobile gear to be displaced and result in conflict to potters is assessed with reference to the impact of loss of grounds. Two scenarios are considered for – 1) alternative grounds are available with limited conflict; and 2) Alternative grounds are not available with the potential for conflict (although this is expected to be mitigated against). The sensitivity of potters is considered to be high as it is left unattended on the seabed. Displacement for mobile gear considers the potential for potters being displaced from the development to result in gear conflict and also the alternative grounds available. The sensitivity considers the availability of alternative grounds. The magnitude considers the fishing effort within the development area. For the operational phase, no reference is made to the potential return of fishing within the wind farm.	The sensitivity of fisheries to this impact was based on the availability of alternative grounds and operational range (based on landings statistics, surveillance sightings, consultation and VMS data). The magnitude of effect considered the value of the fishing grounds which overlapped with the development area, spatial extent and duration. For the operational phase, skippers of potter vessels were asked whether they would continue to fish within the operational site. The responses were mixed indicating that some believed that the wind farm would provide an opportunity to set gear with minimal conflict with mobile fishing methods, whereas others considered the risk to high. Considered that fishing can resume in the wind farm to some degree and at the discretion of the skipper. The assessment assumes that fishing will resume over the export cable following over-trawl surveys.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
Beatrice OWF (operational) (Beatrice Offshore Wind Ltd, 2012)	Moray Firth (Scotland)	• Up to 277 fixed-bottom turbines with a spacing of 0.6 km • 65 km export cable consisting of three cables • 350 km of inter-array cable • Up to 3 OSPs • Potential for 500 m safety zones for construction and major maintenance and potential for 50 m operational safety zones Transmission infrastructure assessed in separate EIA report.	• Scallop fishery • Nephrops fishery • Whitefish fishery (Scottish seine nets and demersal trawlers) • Squid fishery • Crab and lobster fishery • Artisanal fisheries • Salmon and sea trout fisheries Impacts not assessed on a fleet-by-fleet basis.	Fisheries displacement was assessed as a function of restricted access or loss of grounds within the EIA. The assessment considered the value and effort of fishing within the development area in the context of the wider region and assumed that some degree of access will be regained following construction.	For the sensitivity of fisheries to this impact, the assessment considered seasonality, value and effort within the development in context of the wider region (based on VMS data and landings statistics) and spatial overlap of grounds based on consultation data. For magnitude, the assessment considered spatial extent and duration. It was assumed that some fisheries will regain access to windfarm site once constructed to some degree and it was noted that there may be additional safety risks for fishing vessels operating towed gears within the wind farm.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
England					
Hornsea Three OWF (consented) (Ørsted Hornsea Project Three Ltd, 2018)	Norfolk Coast (England)	• Up to 300 fixed-bottom turbines with a spacing of 1 km up to 19 OSPs • 830 km of inter-array cables- assumption of 10% requiring external protection • 225 km of inter-connector cables - assumption of 10% requiring external protection • 168 km of export cables for 6 cables - assumption of 10% requiring external protection • 500 m construction safety zones and 50 m zones around incomplete structures	• UK demersal trawlers • Dutch demersal trawlers • Belgian demersal trawlers • German and French demersal otter trawlers • Danish sandeel industrial otter trawlers • Danish, UK, French, Swedish and Norwegian pelagic fleets • UK potters Impacts assessed on a fleet-by-fleet basis.	The displacement impact assessment was not assessed with direct reference to loss or restricted access to fishing grounds. The sensitivity of fishing fleets to displacement was assessed in terms of the availability of alternative grounds (based on VMS data) and operational range and vulnerability to gear conflict (e.g. static gear considered to have high vulnerability as it is left unattended at the seabed). The magnitude of impact was assessed with consideration of the potential for conflict to arise in terms of the fisheries being displaced from the development area and in terms of the fisheries operated in the area within which fishing effort is displaced to. This is assessed with consideration of the value and effort of fishing within the development area and the availability of alternative grounds. During the operational phase it was assumed that the magnitude and sensitivities for mobile fishing methods would be the same or similar to construction. For static fishing methods, this was considered to be lower, as it was assumed that fishing could continue within the site.	This impact was assessed on a fleet-by-fleet basis and was not considered as a direct function of loss or restricted access to grounds. The sensitivity of fisheries to this impact took the availability of grounds / dependency on the development, the operational range of the vessels and the adaptability of the fleets into account. The magnitude of effect considered the value and effort of fishing activity within the development (based on landings statistics and VMS data), It was assumed that fishing could resume within the array area to some extent once the site was operational.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
Hornsea Four OWF (PEIR submitted, pre-application) (Ørsted Hornsea Project Four, 2019)	Bridlington/Hornsea (England)	• Up to 180 fixed-turbines with 810 m spacing • Up to 10 OSPs • 600 km of inter-array cables - assume 10 % requires external protection • 654 km of export cables with 6 cables - assume 10% requires external protection • 500 m construction safety zones, 50 m safety zones around incomplete structures	• UK potting • UK dredging fleet • Dutch, German, Danish, French and Swedish pelagic fleet • Swedish sandeel industrial otter trawlers • Demersal mixed fisheries (Dutch and Belgian beam trawls, French and UK otter trawlers and demersal seines) Impacts assessed on a fleet-by-fleet basis.	Fisheries displacement was not considered to be a direct function of loss or restricted access to traditional fishing grounds. The sensitivity of fishing fleets was assessed based on the operational range of vessels and the wider availability of grounds (based primarily on VMS data). As for Hornsea Three, the potential impact of displacement from within the development area on nearby fishing grounds was assessed, as well as impact of vessels being displaced by the development. During the operational phase it was assumed that the magnitude and sensitivities for mobile fishing methods would be the same or similar to construction. For static fishing methods, this was considered to be lower, as it was assumed that fishing could continue within the site.	Assessed on a fleet-by-fleet basis. The sensitivity of fishing fleets to this impact considered the operational range and availability of grounds, which also took into account the specificity of the target fish habitat (e.g. scallop dredgers requiring specific benthos). The magnitude of effect was based on the effort and value of fishing within the development area (based on VMS and landings statistics). For potting vessels, an estimated revenue loss was calculated based on the proportion of overlap between the site and the ICES rectangle within which it is located to demonstrate the potential loss of earnings. The availability of target species was also considered (e.g. pelagic fish being mobile and sporadic rather than associated with seabed habitats). During the operational phase it was considered to what degree each fishery could resume fishing within the wind farm site, considering gear type, width, spread and skipper's risk perception and the reliance on nearby areas outwith the windfarm compared with within. For the export cable infrastructure, it was assumed that fishing will resume but that fishermen should remain cautious.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
East Anglia ONE North OWF (consent application submitted) (Scottish Power Renewables, 2019)	East Anglia (England)	• Up to 67 fixed-bottom turbines - minimum spacing of 0.8 - 1.2 km • Up to 4 OSPs • 200 km inter-array cables (10% external protection) • 75 km platform links (10% external protection) • 152 km export cable (2 cables) (10% external protection)	• Dutch fishing vessels (beam trawls and seine netters) • Belgian fishing vessels (beam trawl and otter trawling) • UK fishing vessels (local inshore fleet - potting, trawling and longlining and Anglo-Dutch beam trawlers) • French fishing vessels (demersal and pelagic trawlers) • Danish fishing vessels (industrial sandeel trawlers and pelagic trawlers) • German fishing vessels (beam trawlers) Impacts assessed on a fleet-by-fleet basis.	The sensitivity of fleets to this impact is based on their operational range and availability of grounds. The assessment considers the potential competition and conflict to arise as a result of static gear being displaced into nearby areas and also the impacts of larger trawlers being displaced into areas operated by static fishing gear. The potential for competition between fishing vessels that operate towed gear is also considered and it is assumed to be a direct function of loss or restricted access to traditional fishing grounds. The assessment assumes that fishing can continue over cables with limited displacement expected during the operational phase and that limited conflict would arise due to the potential for access to be regained within the wind farm site.	The sensitivity of fishing fleets is assessed, taking account of operational range, availability of grounds and potential for vessels to use multiple gear types. The magnitude of effect was determined by comparing the effort and value of fishing within the development to that of the wider area using VMS data, the overlap of the development with available grounds and the duration of the impact. During operation, it was assumed that fishing would be able to resume within the wind farm to some degree (with the exception of seine nets) and that cables would not present a material loss of normal fishing activity.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
Non-UK					
Borlselle Wind Farm Zone (Wind Farm Sites I and II) (Netherlands Agency, 2016a)	Netherlands	Wind farm zone in Netherlands of 344 $km^{2.}$ This EIA assesses 2 sites within that zone. Design possibilities for the wind farm sites are: • Up to 117 fixed-bottom turbines • At least 4 x rotor diameter spacing between each turbine	The document was only a summary of the EIA, however, individual fisheries not described or assessed within the document.	Not assessed.	It is noted that the developments would cause a loss of 0.6% of the fishable surface of the Dutch Continental Shelf and that it is a good fishing ground. No detailed assessment is provided within the summary document.
Hollandse Kust (zuid) (Wind Farm Sites I and II) (Netherlands Agency, 2016b)	Netherlands	Wind farm zone in Netherlands of 356 km^2. This EIA assesses 2 sites within that zone. Design possibilities for the wind farm sites: • 63 fixed-bottom turbines • At least 4 x rotor diameter between each turbine	The document was only a summary of the EIA, however, individual fisheries not described or assessed within the document.	Not assessed.	It is noted that the developments would cause a loss of 0.16% of the fishable surface of the Dutch Continental Shelf and that it is a good fishing ground. No detailed assessment is provided within the summary document.
Suitability assessment for N-3.7, N-3.8 and O-1.3) wind farm sites (Bundesamt Für Seeschifffahrt Und Hydrographie, 2020)	Germany	Assessment of three potential wind farm sites within the German Exclusive Economic Zone (EEZ). This document provides an assessment of the suitability of the sites ahead of the tender process of OWFs in Germany. No specific design parameters are provided.	Not described in document.	This assessment considered the conflicts of the wind farm sites with fishing and marine aquaculture and provided recommendations for issues which should be assessed as part of the planning process. This includes a review of the 'fundamental avoidance of further restricted and protected areas of fishing'.	It is noted that construction and operation could limit fishing activity in order to protect the integrity of the installations and that safety zones will be established during the construction phase and will be maintained during operation. It is also stated that the impairment of fishing is not considered to impact the suitability of the sites and that the potential impact to fisheries cannot be assessed at the time of the report, as this should be assessed in the context of the planning approval procedure.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
Kreigers Flak OWF (Kriegers Flak, 2007)	Sweden	• Up to 128 fixed-bottom turbines - expect spacing of 0.5 - 0.9 km • OSP • Four sub-sea export cables (approx. 30 km)	• Seabed trawling • "Yarn" fishing - assumed to be line fishing Impacts not assessed on a fleet-by-fleet basis.	Not assessed.	It was not clarified whether fishing would be expected to resume within the site during the operational phase, but the assessment considered the implementation of 500 m safety zones around the development, which would effectively restrict access to the OWF. There is a recognition within the assessment of potential loss of earnings (which was calculated based on the size of the wind farm footprint, the average catch in the area and statistics on the average price of cod per kilo), however, they also consider the potential positive impacts of a closure acting as a marine protected area and potentially having 'spillover' effects.
Vineyard OWF (BOEM, 2021)	East Coast of the USA	• Up to 100 fixed - bottom turbines - spacing of 1.4 - 1.9 km • Up to 2 Electrical Service Platforms (ESP)s (assumed to be synonymous with OSPs) • 275 km of inter-array cable - assumed 10% protection • 158 km of export cable (2 cables)	• Commercial and for-hire fishing assessed • Large landings for herring, menhaden, clam, squid, scallop, skate and lobster. Fisheries are not assessed on a fleet-by-fleet basis.	The EIA for the development assessed the potential impact of fisheries displacement and the potential for space use conflicts to arise as a result of the presence of structures. The spatial extent and duration of the impact is taken into account when assessing the significance of the impact, as well as the specialism of the fisheries operating within the site (e.g. competition expected to be higher for fishing fleets targeting less mobile species). The assessment also assumes that some fishing fleets may not opt to or be able to fish in alternative grounds.	The impact of the presence of the offshore wind and transmission structures is assessed within the EIA in terms of avoidance of structures during construction and operation. The 'revenue exposure' for commercial fisheries is assessed which calculates the value of fish caught within the wind lease area, assuming that fishing does not return within the site. It is acknowledged that displacement may occur if alternative grounds are available or if alternative fishing methods are used.
Ocean Wind OWF (Ocean Wind, 2021)	East Coast of the USA	• Up to 99 fixed-bottom turbines • 3 OSPs 3 export corridors	• Commercial and for-hire fishing assessed • Scallop fishery • Atlantic surfclam / Ocean quahog • Atlantic Menhaden • Blue crab fishery • American lobster fishery	The assessment used VMS data to assess the potential for alternative fishing grounds and this was used to assess the significance of the impact, alongside the duration of the impact and its spatial extent. Economic loss was considered to be minimized as a result of	The annual revenue in the area per km^2 of the wind farm area for the key fisheries was calculated as a % of the total revenue for the fishery to understand potential economic losses.

Development[10]	Location	Project description	Fishing methods assessed	Displacement impact assessment methodology	Loss or restricted access to grounds impact assessment
			Impacts not assessed on a fleet-by-fleet basis.	potential fisheries displacement to nearby areas.	
Non-Offshore Wind					
MeyGen Tidal Array (operational) (MeyGen, 2012)	Pentland Firth (Scotland)	• Phased development with up to 10 tidal turbines (fixed to seabed) (year 1), 20 turbines (year 2) and 86 turbines (year 3) with 45 - 160 m spacing • 1.3 km export cable	• Static gear (lobster, brown crab, velvet crab and scallops) • Recreational / game fishing Impacts not assessed on a fleet-by-fleet basis.	Impact not assessed on a fleet-by-fleet basis. The assessment of receptor sensitivity considers the availability of alternative fishing grounds adjacent to the development area and the adaptability of the vessels to modify fishing activities. The magnitude is based on the spatial extent and the importance of the area for fisheries. During operation it is assume that fishing will not occur over the turbine area.	Sensitivity of receptor was based on the level of fishing effort within the development area. The magnitude of effect is based on duration and spatial extent.
NorthConnect HVDC (consented) (NorthConnect, 2018)	North East Coast of Scotland to Norway	• Two 665 km HVDC cables from UK to Norway • Rolling advisory 500 m protection / safety zones	• Crab and lobster fishery • Herring and Mackerel fishery • Scallop fishery • Demersal trawl fishery • Salmon and sea trout fishery Impacts assessed for static vs mobile gear.	Not assessed.	The receptor sensitivity is based on availability of alternative grounds. The magnitude of effect is based on the spatial extent and duration of the impact. During the operational phase, the assessment assumes that fishing can continue, as external protection will be designed in line with industry standards in relation to fisheries preferences.
Alligin oil and gas field development (operational) (British Petroleum, 2018)	North Sea	• Two well subsea tie-backs (to existing infrastructure) • Pipeline • 500 m safety zones at Alligin drill centre, other infrastructure being laid in an existing 500 m exclusion zone	• Demersal mobile gear • Otter trawl from non-UK vessels Impacts not assessed on a fleet-by-fleet basis.	Not assessed.	High-level assessment of the impact of the vessels and drilling rig which recognises that towed gears may be in contact with subsea structures. However, the assessment determines that the subsea structures do not result in a snagging risk and are within an existing development area, and hence the impact is expected to be minimal.

7.4 Cumulative considerations for commercial fisheries displacement

Consideration of cumulative effects from other projects and activities which could occur at the same time as the relevant activity being assessed has not been directly defined on the basis of this review. There are many acknowledgements in existing studies and guidance that this is an area where detailed understanding is required. Further, this has also been identified as a key concern from stakeholders, with a need of a holistic view of the interactions between fisheries and OWFs (Mackinson *et al*., 2006; Hadgett *et al*., 2020; Marine Scotland, 2018). The types of activities which could cause a cumulative effect on displacement are closely associated with the factors which may increase a fishing vessel's sensitivity to displacement itself, and so an approach to address these areas by way of a standardised approach could improve the assessment process.

In existing EIAs for OWFs, the cumulative effect on the impact of displacement is often assumed to be of the same or less than the cumulative effects on the potential impact of loss of access to fishing grounds. For the most part, cumulative effects for impacts to commercial fisheries has been considered relevant during construction phase, and not once a project is operational. However, this is based on the fairly consistent assumption across offshore industries that access to fishing grounds will resume once the project is operational. For projects where the infrastructure above the seabed is relatively localised (e.g. a wellhead for an oil and gas project) the area being considered is relatively small. For larger projects such as floating OWFs more detailed studies are required. Dupont *et al.* (2020) highlighted the potential need for a more holistic and multi-national or even global approach to reducing conflicts from cumulative fisheries displacement, as the OWF industry continues to expand, and the need to consider industry-wide socio-economic impacts as part of Marine Spatial Planning processes.

The factors which influence displacement sensitivity, and the direct effect on the displaced fishery will directly influence the probability of a cumulative effect occurring.

8 Stakeholder feedback

As discussed in Section 6, stakeholder feedback on the Literature Review and Good Practice Guidance was sought. All stakeholder comments were compiled and incorporated into the documents where appropriate. Several key responses in relation to key topics were provided as part of feedback received for the Literature Review and Good Practice Guidance (Table 8.1).

Table 8.1 Key Topics Raised in Stakeholder Feedback for the Literature Review and Good Practice Guidance

Topic	Request / Feedback
Literature Review	
Definition of displacement	• Request for the consideration of secondary displacement (i.e. fisheries displacement resulting from the displacement of other vessels). • Request for the inclusion of the impacts of displacement on the marine environment.
Sensitivity of displacement	• Request that additional factors included which influence availability of grounds, including target species range, distribution and seasonality, other licensed activities and regulations. Other factors which influence sensitivity to displacement were also suggested, such as distance from home port.
Commercial fisheries activities and operating practices	• Clarity sought from fisheries stakeholders on operating practices and vessel parameters for the fishing methods considered to be primary research areas (demersal trawling, scallop dredging, Scottish seine netting and creeling).
Data sources	• Requested that greater emphasis on the Sectoral Marine Plan for Offshore Wind Energy (Scottish Government, 2020a) with a discussion around the consultation process. • Request for the inclusion of more EU studies within the Literature Review.
Co-existence	• Request for clarity on evidence for fishing returning in operational offshore windfarms and the factors that influence this. • Request for co-existence to be considered in terms of all sectors (e.g. those discussed within Scottish National Marine Plan).

Topic	Request / Feedback
Glossary	• Suggestion of including a glossary to define key terms.
EIA case studies	• Suggestion for inclusion of another Forth and Tay offshore wind farm.
Good Practice Guidance	
Definition of displacement	• Request for details on ‘primary’ and ‘secondary’ displacement to be added.
Impacts of displacement	• Request to include the impacts of displacement within the Good Practice Guidance.
Magnitude of displacement	• Consideration of displacement during pre-construction and operational surveys.
Commercial fisheries data	• Improvements to data on under 10 m vessel fishing activity needed • The importance of effective consultation was raised several times • Additional detail on how to analyse commercial fisheries data was requested (e.g. number of years of data required) • Request for the inclusion of an ‘other data’ section which details additional sources of data outwith the key sources already listed • Recommendation to include Regional Inshore Fisheries Groups as a key consultee for inshore fisheries • Additional suggestions for commercial fisheries data sources provided • Clarity on commercial fisheries data sources provided
Commercial fisheries gear configuration and operating practices	• Information from fisheries stakeholders provided on vessel parameters and gear configurations (see note[1]).

Topic	Request / Feedback
Assessment process	• Request for a worked example to be added to good practice guidance, or further details on the assessment process. • Requested information on how to assess where fishing activity is likely to be displaced to. • Request for additional details on FLO and FIR involvement in commercial fisheries assessments • Suggestion to include a flow chart of the assessment process
Cumulative impacts	• Request to include more detail on how projects for cumulative assessments are identified and how to assess these against the development • Request to include in-combination impacts.
Note[1] Fisheries representatives from the SFF and SWFPA and a representative from Seafish contributed to this section of the Good Practice Guidance.	

Topics raised by stakeholders, but that were considered to be outwith the scope of this Literature Review and Good Practice Guidance, have been included as knowledge gaps or areas of future research:

- Inclusion of socio-economic aspects of displacement within the Literature Review and Guidance;
- Request for guidance on post-consent monitoring of commercial fishing during construction and operation;
- Consideration of displacement from site investigation surveys which do not require licenses specific to commercial fisheries;
- Improvements to stakeholder consultation approach; and
- Need for improved commercial fisheries data accuracy and accessibility, especially for smaller vessels.

9 Knowledge gap analysis

Several knowledge gaps were identified during the production of the Literature Review and associated Good Practice Guidance. Although some knowledge gaps were identified by the project team, this was a key focus area for stakeholder consultation. The knowledge gaps are provided in Table 9.1. In cases where a knowledge gap relates to an existing knowledge gap presented in the ScotMER evidence map, this is identified in the table.

Table 9.1 Knowledge Gaps and Recommendations

Knowledge gap	Recommendation	ScotMER evidence map ID (if appropriate)
Monitoring of fishing activity in operational wind farms	• Study and monitoring of fishing activities at operational OWFs to understand displacement effects and the changes in fishing activities within and around the wind farm. • Development of Good Practice Guidance for pre and post construction commercial fisheries monitoring by OWF developers (i.e. in line with the requirements of the Project Environmental Monitoring Plan as set out in s.36 consent conditions).The GPG could delineate the benefits and limitation of monitoring commercially fished species vs commercial fishing activity. Any results should be caveated to assume that several factors may be influencing fishing activity such as weather, stock, behaviour and quota/regulations.	FF.01
Statutory and non-statutory guidance	• Production of guidance for statutory and non-statutory consultees reviewing consent applications on advice and guidance to provide to developers or EIA practitioners with respect to commercial fisheries displacement.	N/A
Commercial fisheries data – accuracy, availability and accessibility	• Improving spatial data for <10 m vessels. • Incorporating temporal variation by including monthly variation in spatial datasets. • Reviewing historic spatial data to understand longer-term patterns in fishing activity (e.g. to understand nomadic fishing patterns).	FF.01

Knowledge gap	Recommendation	ScotMER evidence map ID (if appropriate)
	• Improving accessibility to commercial fisheries data, especially transboundary data.	
Impact of fisheries displacement	• Study and monitoring to understand the impact of fisheries displacement on the marine environment (e.g. fish stocks, benthic environment). This study could also consider the impact of a licensed marine activity to the benthic environment and fish biology, in the levels of fishing effort before and after construction. • Study and monitoring to understand the socio-economic implications of fisheries displacement resulting from other licensed marine activities. A socio-economic impact assessment guidance is being produced as part of the ScotMER evidence map work. This guidance will not be specific to fisheries displacement, however, it may link to this work.	FF.02
Conflict and competition	• Study and monitoring to understand conflict and competition as a result of displacement from other licensed marine activities. This could investigate the conflict within and between fishing methods, and particularly the conflict between mobile and static gear • Monitoring the relocation of static gear during surveys or construction to understand where the gear is being relocated to, the proportion which is relocated vs brought to shore and the potential for conflict or further displacement.	N/A

Knowledge gap	Recommendation	ScotMER evidence map ID (if appropriate)
Availability of fishing grounds	• Study investigating the key factors which influence the availability of fishing grounds for key fishing fleets, considering other licensed marine activities (e.g. renewables, aquaculture), as well as the range, distribution and seasonality of key target species. This could also include research to identify existing and alternative fishing grounds, based on environmental factors and requirements for the fishing fleets.	N/A
Potential for co-existence between commercial fisheries and other licensed marine activities	• Study to understand gear configurations, minimum operating requirements and maximum seabed penetration depths for fishing activities. This study could focus on the fishing methods which have been identified as primary areas of research, but this could be expanded to include all typical fishing methods operated within the UK. This study could also discuss the design parameters of other licensed marine activities to understand potential for co-existence and compare the compatibilities of other licensed marine activities with commercial fisheries. This could be informed through consultation, compatibility studies and gear trials. • Research into the health and safety risks of fishing within an offshore windfarm or cable with suggestions for potential mitigation measures to reduce these risks. This study could be made accessible to fishermen. • Investigation and review of the potential for MRE developments to act as a fisheries management measure (e.g. spill-over effects and improved stocks).	FF.02, FF.05 and FF.14

Knowledge gap	Recommendation	ScotMER evidence map ID (if appropriate)
	• Production of a Good Practice Guidance for mitigation measures through project design which could enable or facilitate co-existence. This could also include the identification of survey or installation strategies which minimise displacement. • Investigating the barriers to fishing returning to OWF. This could also include research and guidance on the management of liabilities for fishing within wind farms, and research into various methods for monitoring the condition of subsea cables and how to make this information most useful for fishing vessel operators. • Wider review of the potential for co-existence of all sectors included within the National Marine Plan. This could include a consideration of measures which could improve coexistence across the marine space. • Integration of commercial fisheries consultation in the planning and programming of surveys and project activities, and development of strategies for coexistence between the two industries to minimize cooperation periods and avoid coinciding with other project activities (cumulative impact during site investigation surveys for example).	
EIA methodology	• Review of Commercial Fisheries EIA methodology which culminates in the production of a Good Practice Guidance which includes a step-by-step process for conducting a commercial fisheries impact assessment. This should include suggestions for improving the cumulative impact assessment	FF.04

Knowledge gap	Recommendation	ScotMER evidence map ID (if appropriate)
	methodology to incorporate impacts from other sectors which impact commercial fisheries (e.g. conservation areas, fishing policy).	
Aquaculture	• Research into the potential displacement impacts from aquaculture and guidance for assessing displacement from aquaculture, with consideration of the specific licensing and permitting processes.	N/A
Stakeholder engagement	• Production of a Good Practice Guidance for consultation carried out to inform commercial fisheries impact assessments (all potential impacts, not just displacement). Key areas are making this process more efficient, ensuring representation for all potentially impacted individuals, early identification of a Fisheries Industry Representative (FIR) and Fisheries Liaison Officer FLO) and processes for effective communication. This would align with the updated FLOWW guidelines.	N/A

10 Conclusions & objectives for the Good Practice Guidance

This Literature Review outlines the current understanding of fisheries displacement from other licenced marine activities and the current approaches for assessing the impact of displacement on commercial fisheries receptors. It is clear that displacement impacts depend on several factors that influence the sensitivity of a commercial fisheries receptor to displacement (e.g. operational range, gear configuration, availability of alternative grounds), as well as the project design of the other licenced marine activity.

Several different approaches for assessing displacement were identified, such as predictive modelling or the use of VMS data to understand the distribution of fishing effort and availability of alternative grounds. Predictive modelling was identified as requiring too many assumptions to be a robust tool for assessing fisheries displacement for an EIA.

Within the EIA case studies, there were varying approaches taken when assessing displacement, with some EIAs considering the potential for competition, conflict or further displacement in the fishing grounds where vessels are displaced to, whereas others considered displacement to be a function of loss of grounds, with limited consideration for the potential for conflict and competition.

It is clear that a standardised approach for assessing displacement is required in order to standardise how displacement is assessed within consent applications for other licenced marine activities. Therefore, the main purpose of the Good Practice Guidance is to provide a standardised approach for assessing displacement impacts, which is applicable across various industries and not only offshore wind.

Therefore, the key objectives for the Good Practice Guidance include:

- To provide a clear definition of commercial fisheries displacement;
- Provide guidance and key points for consideration for developers, EIA practitioners and stakeholders, relevant to the assessment of commercial fisheries displacement. A focus will be placed on defining the sensitivity of commercial fisheries receptors to displacement and using the project parameters to understand the magnitude of effect.

In addition to the above, it is also recognised that there is currently limited guidance on the most relevant data sources to inform commercial fisheries impact assessment and how to present these data. Therefore, to supplement the Good Practice Guidance for fisheries displacement assessments, and to provide a full picture of the assessment process, an overview of recommended data sources will be provided within the Good Practice Guidance as well as suggestions on how to best use and present these data including limitations.

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St Andrew's House
Edinburgh
EH1 3DG

ISBN: 978-1-80435-251-9 (web only)

Published by The Scottish Government, June 2022

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA
PPDAS1050030 (06/22)

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