Ecological sensitivity analysis of the western Irish Sea to inform future designation of marine protected areas (MPAs)

Appendices

May 2023

Prepared for the Department of Housing, Local Government and Heritage by the MPA Advisory Group and team comprising:

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Appendix 1
Terms of Reference

Terms of Reference for Expert Advisory Group on Marine Protected Areas (MPAs)

in undertaking an ecological sensitivity analysis of the Irish Sea, 2022-2023

(MPA Advisory Group)

19 December 2022

Note: These draft Terms of Reference (TOR) were circulated before the 21 December 2022 meeting of the reconstituted MPA Advisory Group, and they were for consideration and adoption by the group on or after 21 December 2022. They were discussed in more detail on 11 Jan 2023 and finalised thereafter.

1. Purpose of this document

1.1 This document sets out the Terms of Reference for the MPA Advisory Group that was reconstituted in December 2022 on an administrative basis by the Minister for Housing, Local Government and Heritage. The group will hold its first meeting on Wednesday 21 December 2022 in Galway.

1.2 A concise context/background to this work of the expert advisory group is provided in Appendix 1.

2. Membership, roles and responsibilities of the group

2.1 The primary role of the advisory group is:

to scientifically evaluate the potential need for area-based conservation measures in the Irish Sea, in the form of new MPAs underpinned by forthcoming national legislation.

2.2 Professor Tasman Crowe, Director of the Earth Institute at University College Dublin (UCD), has been appointed by the Minister to Chair the group.

2.3 The advisory group reconstituted for the purposes of this study is made up of six senior scientific experts that were members of a larger multidisciplinary MPA Advisory Group first convened by the Minister in 2019-2020. The current group of six persons appointed by the Minister has extensive professional expertise in Life and Ocean Sciences.

A list of the group members and supporting personnel is contained in Appendix 2.

2.4 The primary roles and responsibilities of the group are:

I. To provide expert advice and recommendations on the need for area-based conservation measures for specific ecological features, species and/or habitats in the Irish Sea.

II. To focus the work of the group primarily around coastal and marine species and habitats that (a) are not afforded protection under the Birds and Natural Habitats Regulations (2011) and (b) are currently vulnerable to environmental degradation and/or sensitive to human maritime activity including future ORE development.

III. To also consider key uses of the Irish Sea by maritime sectors and associated stakeholder interests in the region.

3. Irish Sea sensitivity analysis - Project objectives

Objective 1. To undertake a comprehensive scientific screening exercise for possible future MPAs in a defined marine region off the east and south-east of Ireland. This will be done through a process and using selection criteria and features that are as consistent as possible with the provisions set out in the forthcoming MPA legislation.

Objective 2. To facilitate open and constructive engagement with key Government and non-Government stakeholders that have extensive maritime interests in the Irish Sea (e.g., culture/heritage, defence, fisheries, ORE, transport, recreation), in order to integrate their participation and consider their interests as part of the analysis and mapping processes within the project.

Objective 3. To ensure that any rationales and recommendations for the potential designation of MPAs in the study area, as determined by the work of the reconstituted MPA Advisory Group, will be up to date and in time for active consideration by DHLGH when the MPA legislation comes into force.

Objective 4. To facilitate possible future identification by the Government of viable "go-to-areas" for offshore renewable energy projects in the Irish Sea, in view of any biodiversity/environmental/cultural constraints that are concluded via the project.

4. Study area and project term

4.1 The area of interest for this ecological sensitivity study comprises the western Irish Sea within Ireland's jurisdiction, stretching from Carlingford Lough, Co. Louth to Carnsore Point, Co. Wexford, and also the wider waters and ecosystems within the Irish Sea as a whole.

4.2 The project commenced on 12 December 2022.

The first meeting of the MPA Advisory Group is due to take place on Wednesday 21 December.

All project work is expected to conclude by 30 April 2023*.

(* Provision for an extension to the work may be made in extraordinary and extenuating circumstances)

5. Project operation

5.1 As the competent authority in Ireland with responsibility for implementation of the EU Marine Strategy Framework Directive and the OSPAR Convention, the Department of Housing, Local Government and Heritage (DHLGH, Marine Environment Section) will facilitate and support the work of the group. The Department will also assist UCD with secretariat and administrative support for meetings of the group.

5.2 In order to accommodate engagement and information exchange with a selection of external third parties across the marine sector, other experts, as required, will also be invited to contribute to the project via the presentation of information, data and other scientific/technical material or observations of core value to the study.

5.3 The locations of group meetings will be decided by the Chair in conjunction with meeting participants and the Secretariat. The selection of meeting locations will need to consider the availability of rooms / facilities and participating organisations and seek to minimise the travel burden on meeting participants so that the attendance of group members is maximised.

5.4 On behalf of the advisory group, research support in UCD and the Department's Secretariat will collaborate to

- compile draft minutes and action points from all group meetings and provide these to the Chair;
- coordinate with the Chair so that the circulation for comments/observations of draft minutes to all members of the group takes place at least one week before the next group meeting;
- provide the Chair with the final agreed versions of meeting minutes, recording the agreed decisions along with the names of those present;
- arrange the reimbursement of appropriate travel and subsistence expenses incurred by group members in attending and conducting meetings of the group.

6. Methodology

6.1 Research and constraints/opportunities mapping elements of the sensitivity analysis will be undertaken on the basis of the best available scientific information (e.g. data, literature, publications) and best available technical information (e.g. GIS shapefiles, map products, reference coordinates).

6.2 The expert advisory group will oversee the gathering and compilation of such material from key sources it has identified in the initial phase of the study. These will include Government, scientific, socio-economic and sectoral sources of data and information, in order to facilitate a holistic and comprehensive view of the study area, its resources, and existing opportunities and constraints around area-based conservation, maritime activity or development, for example.

6.3 It is expected that there will be a strong element of data integration and GIS mapping in the study, in order to ensure that area-based considerations can be examined in a detailed but flexible, adaptive and time-efficient manner. This exercise will also need to take account of existing protected or conservation-oriented sites within the study area (e.g. Natura 2000 sites, Reserves, Restricted areas).

6.4 In line with Objective 2, the presentation of evidence, data and other information to the advisory group by a range of key stakeholders will be facilitated as part of the research and mapping processes. This will involve active and open engagement with such stakeholders, both online and in-person, in order to get maximum value from the participation process and exchanges of information.

6.5 The advisory group's considerations around the information gathered, site selection criteria and features warranting protection, conservation objectives, and decision rationales, will need to be comprehensive, defensible, systematic in approach and based on scientific evidence and stakeholder engagement.

Although the advisory group is independent its work will be done in consultation with DHLGH to ensure that the process reflects *inter alia* expert advice to DHLGH contained in the MPA Advisory Group report (2020), international standards and best practice, and provisions being included in the draft MPA legislation. This is in order to ensure a coherent, consistent and coordinated national approach.

7. Deliverables

7.1 This project will result in a detailed final report from the study, presented in an agreed and standardised format.

7.2 This report will contain specific recommendations to DHLGH arising from the study and covering a complete assessment of the western Irish Sea for potential new MPA sites in view of all the information gathered and processed by the expert advisory group.

7.3. Based on its analyses, the study may also give broad indications of which maritime activities should be restricted or prevented in potential MPA sites that are identified via the exercise.

8. Transparency and cooperation

8.1 For the effective functioning of the group and in turn the delivery of its report, its members (a) must be able to communicate openly and truthfully with one another, (b) should be able to exchange information and other material, and (c) should be able to be trusted to hold such communications and interactions as internal during the group's work.

Appendix 1 of TOR

Context to the ecological sensitivity analysis of the Irish Sea

Ireland is currently undergoing several important transitions in maritime activity. Two of these are related *inter alia* to national actions to address the impacts of climate change and of biodiversity loss, respectively.

Firstly, comprehensive legislation that will enable the designation and management of marine protected areas (MPAs) is currently at an advanced stage of development. Planned for enactment in 2023, this MPA Bill will allow for area-based conservation measures in our seas and ocean to be significantly strengthened and expanded. This will facilitate Ireland in meeting its agreed national and international targets and obligations.

In parallel, Ireland is also advancing plans and processes for the development of its offshore renewable energy (ORE) resources as soon as possible underpinned by a national ORE development plan (OREDP II), provisions set out in the Maritime Area Planning Act 2021, and the establishment in 2023 of the Maritime Area Regulatory Authority, for example.

The western Irish Sea is an area that has been identified for potential ORE development in this decade, based on the current state of the industry/technology plus key logistical and operational factors (e.g., seafloor substrate type, water depth, port facilities, electricity grid requirements). At present, several development proposals (i.e., Phase One projects) are earmarked for the region that, if awarded statutory consents, could amount to over 3,500MW (3.5GW) of wind-generated electricity capacity. While necessary to achieve the Government's target of 5GW by 2030, the Phase One wind projects alone will not be sufficient to reach this overall target. Further projects that can be developed by 2030 will also be required (i.e., Phase Two projects).

In light of potentially competing marine interests and space-use priorities for the western Irish Sea within this decade between (a) ORE resource development and (b) area-based conservation of biodiversity and other key environmental/cultural resources, the Marine Environment Section (DHLGH) has identified a concise and authoritative independent review and analysis that could usefully be undertaken in the near term.

Details of this project, its methods and operational parameters, etc are set out in the itemised and numbered paragraphs above.

Appendix 2 of TOR

Members of the MPA Advisory Group and supporting roles, 2022-2023

MPA Advisory Group functional role	Name	Affiliation
Chair of Advisory Group Life & ocean sciences expert	Prof Tasman Crowe	University College Dublin
Life & ocean sciences expert	Prof Louise Allcock	University of Galway
Life & ocean sciences expert	Prof Mark Johnson	University of Galway
Life & ocean sciences expert	Dr Tom Doyle	University College Cork
Life & ocean sciences expert	Dr Oliver Tully	Marine Institute
Life & ocean sciences expert	Dr Cormac Nolan	Marine Institute
Institutional support role	**Name**	**Affiliation**
Research Assistant	Dr Elgar Kamjou	University College Dublin
Research Assistant	Caoimhe Morris	University College Dublin
Research Assistant	Domonique Gillen	University of Galway
Research Assistant	Dr Damien Haberlin	University College Cork
Research Assistant(s)	Dr Danielle Orrell	University College Cork
Scientific & Technical Officer (Conservation/sensitivity assessment)	Dr Patricia Breen	Marine Institute
GIS/Data manager	Andrew Conway	Marine Institute
GIS/Data technician	Kellie Heney	Marine Institute
GIS/Data technician	Denise O’Sullivan	Marine Institute

DHLGH support

The Marine Environment Section of DHLGH will provide active support to UCD and the expert advisory group in all aspects of the study and its operation as appropriate and as requested, through the involvement of at least one member of its technical staff and through administrative support as necessary. This support will include Secretariat, operational and meeting facilitation functions for the advisory group as needed.

Marine Institute support

Work under a Service Level Agreement (SLA) between DHLGH and the Marine Institute will serve an important supporting function and technical resource to call on, given the data handling personnel, data sets and data management processes already underpinned by DHLGH's funding and task-based implementation of the SLA. Additional GIS layers of OREDP II use and importance may also be possible to obtain from DECC/GSI and other providers (e.g., 3rd level institutions, SEAI).

Additional expertise within the Marine Institute is also expected to be called upon, as necessary, by the two advisory group members from the Institute.

Primary contact points

Professor Tasman Crowe (UCD)

Richard Cronin, Oliver Ó Cadhla, Tim O'Higgins (Marine Environment, DHLGH)

Appendix 2
Definition of MPAs and key principles for network expansion

From Box 1 of the MPA Advisory Group (2020) report and reflected in the General Scheme of the MPA Bill 2022.

The following operational definition of an MPA is proposed for MPAs in Ireland.

A geographically defined area of marine character or influence which is protected through legal means for the purpose of conservation of specified species, habitats or ecosystems and their associated ecosystem services and cultural values, and managed with the intention of achieving stated objectives over the long term.

Recommended key principles:

• MPAs should be designated and managed to form a network that is designed to be coherent, representative, connected and resilient and to meet Ireland's commitments under international instruments such as the EU's Marine Strategy Framework Directive, OSPAR Convention, UN CBD and Aichi Targets (particularly Target 11) and the UN Sustainable Development Goals (particularly Goal 14).

• Objectives for MPAs and the MPA network in Ireland may focus on the protection and recovery of:

- Threatened or declining species or habitats
- Important or ecologically significant species or habitats
- Features representative of the range of features present in Irish waters
- Areas of high biodiversity, naturalness, or sensitivity
- Areas contributing to maintenance of ecosystem functioning and ecosystem services including carbon sequestration
- Areas with significant biocultural diversity value

• MPA site objectives may also focus on the prevention of impacts from specified pressures such as artificial light or noise or buffering against the effects of climate change.

• Conservation is taken here to mean maintenance of or restoration to a state that is as close as possible to the expected structure and functioning of the ecosystem given the general physiography and location of the area or as compared to selected reference sites or states. In MPAs designated for biocultural diversity value, conservation of this value would be the primary objective.

• Additional benefits of MPAs may include opportunities for research and environmental education and to create socio-economic added value, provided that these are not in conflict with the MPA site objectives.

- A Systematic Conservation Planning (SCP) approach should be followed for planning, implementation and management of the expanded network, with a provision also for proposal of individual site-based MPAs.

- In designing the network, consideration should be given to interactions with networks designated by other States in the same marine regions.

- Early and sustained stakeholder engagement should be integral to the selection and management processes for MPAs. Engagement should be inclusive and equitable and the process should be designed to ensure that it is transparent, meaningful and facilitating.

- Management measures [referred to as conservation measures in the General Scheme of the MPA Bill 2022] should be established as appropriate for each MPA to achieve its stated conservation objectives and taking account of socio-economic and cultural considerations.

- Management measures should be established as part of the designation process.

- Management of MPAs should be based on the best available evidence and on the precautionary principle.

- Carefully designed monitoring should be used to assess efficacy of the network and inform periodic reviews and adaptations of designations and management measures.

- It is recommended that a national coordinating body should be established with the authority to coordinate planning and implementation, to foster good governance and ensure close collaboration among relevant departments and agencies and synergy with related undertakings such as the National Marine Planning Framework.

- New legislation is needed to establish the necessary framework for governance and management and appropriate resources and funding must be allocated to plan, implement, manage, monitor, and review the MPA network.

Appendix 3
Existing spatial protection of habitats and species in the western Irish Sea (Natura 2000 sites)

Several species and habitats (and their associated marine fauna and flora communities) in the Irish Sea are spatially protected through designation of areas under the Habitats (Special Areas of Conservation; SACs) and Birds Directives (Special Protection Areas; SPAs) respectively. Collectively these sites constitute the Natura 2000 site network in the Irish Sea which is part of the network of such sites in Ireland and Europe. The scope of these Directives is confined to the species and habitats that are listed in the Annexes of the directives. In the Irish Sea the SACs and SPAs are primarily coastal and include qualifying interests such as saltmarsh, estuaries and intertidal marine habitats and shallow water sub-tidal sedimentary habitats and reef. Waterbirds (waders and wildfowl) and seabirds, Harbour Porpoise, Seals, Salmon and Shad are designated in one or more sites.

For each of the species or habitats (and associated marine communities) that are designated within SACs and SPAs specific conservation objectives have been identified by the National Parks and wildlife Service (NPWS). For example, the objective may be to maintain the distribution, range and structure and function of a given habitat or to ensure that populations of species are maintained in a long-term stable condition. More specific objectives and targets are also identified in certain cases that relate to the quality or conservation status of the feature. Given the existing responsibility of NPWS for the features listed under the Birds and Habitats Directives, those features are beyond the scope of the current project.

The degree to which the designation of areas as Natura 2000 sites affects sectoral activities within the Irish Sea is assessed on a case-by-case basis. These sites, therefore, are not easily classified according to International Union for Protection of Natura (IUCN) or other scheme which might indicate the degree of protection. The degree of protection varies according to the likely sensitivity of the features to human activities and to the ecological importance of such areas. For instance, seagrass beds are given strict protection given that they are ecologically important features and can easily be damaged by human activities and pressures such as abrasion and smothering. Some tolerance of change or impact is allowed for in the case of sedimentary habitats which may be less sensitive to a range of activities that may occur in such sites. The degree of protection and the acceptance of risk to species populations is also considered relative to the status and sensitivity of such populations.

Whether an activity can continue to occur in such sites and the degree to which the site is protected is argued in a so-called appropriate assessment of the activity (typically projects or plans) relative to the conservation objectives that are set for the site. NPWS have set out guidelines for appropriate assessments (https://www.npws.ie/protected-sites/guidance-appropriate-assessment-planning-authorities). Essentially, for an activity to continue in a site an absence of significant effects on the qualifying features in the site and on the ecological integrity of the site has to be successfully argued. Furthermore, in the case of species *ex situ* effects should be accounted for. When a species temporarily moves outside of the site the activities that may affect it should be accounted for in the appropriate assessment.

The full list of SACs and SPAs in the western Irish Sea and their qualifying interests are presented in Table A2.1 and Table A2.2. The finer resolution description of marine communities within the main qualifying interest habitats are in Table A2.3.

Table A2.1 The list of SACs in the Irish Sea within 12nm of the coast and their Qualifying Interests (QIs) where n>1 indicates the number of marine community features within the QI that are listed in the Conservation Objectives.

Qualifying interest	Baldoyle Bay	Blackwater Bank	Boyne Coast and Estuary	Bray Head	Buckroney-Brittas Dunes and Fen	Cahore Polders and Dunes	Carlingford Shore	Carnsore Point	Clogher Head	Dundalk Bay	Kilmuckridge-Tinnaberna Sandhills	Kilpatrick Sandhills	Lambay Island	Long Bank	Magherabeg Dunes	Malahide Estuary	North Dublin Bay	Raven Point Nature reserve	Rockabill to Dalkey	Rogerstown Estuary	Slaney River Valley SAC	South Dublin Bay	Wicklow Reef	The Murrough Wetlands
1110 Sandbanks which are slightly covered by sea water all the time		2												1										
1130 Estuary			2							3										4	4			
1140 Mudflats and sandflats not covered by seawater at low tide	2		2					1		3						5	3	2		4	4	2		
1170 Reefs								3					2						2				1	
1210 Annual vegetation of drift lines																		1						
1310 Salicornia and other annuals colonizing mud and sand	1									1						1	1			1				
1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	1						1			1						1	1	1		1				1
1351 Harbour porpoise Phocoena phocoena																			1					
1364 Grey seal (Halichoerus grypus)													1											
1410 Mediterranean salt meadows (Juncetalia maritimi)	1				1					1						1	1			1				
2110 Embryonic shifting dunes					1	1						1			1		1	1						
2120 Shifting dunes along the shoreline with Ammophila arenaria ('white dunes')					1	1					1	1			1	1	1	1		1				
2130 Fixed coastal dunes with herbaceous vegetation ('grey dunes')					1	1					1	1			1	1	1	1		1				

2170 Dunes with Salix repens ssp. argentea (Salicion arenariae)					1													1						
2190 Humid dune slacks					1												1	1						
Alkaline fens [7230]					1																			1
Allis shad (Alosa alosa) [1102]																					1			
Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]																					1			
Annual vegetation of drift lines [1210]					1	1	1					1			1		1							1
Atlantic decalcified fixed dunes (Calluno-Ulicetea) [2150]					1							1			1									
Brook lamprey (Lampetra planeri) [1096]																					1			
European dry heaths [4030]				1					1															
Freshwater pearl mussel (Margaritifera margaritifera) [1029]																					1			
Harbour Seal (Phoca vitulina)													1											
Old sessile oak woods with Ilex and Blechnum in British Isles [91A0]																					1			
Otter (Lutra lutra) [1355]																					1			
Perennial vegetation of stony banks [1220]					1		1			1														1
Petalwort (Petalophyllum ralfsii) [1395]																	1							
Petrifying springs with tufa formation (Cratoneurion) [7220]															1									
River lamprey (Lampetra fluviatilis) [1099]																					1			
Salmon (Salmo salar) [1106]																					1			
Sea lamprey (Petromyzon marinus) [1095]																					1			
Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco				1																				

Brometalia)(*important orchid sites) [6210]																								
Spartina swards (Spartinion maritimae) [1320]																1	1			1				
Twaite shad (Alosa fallax fallax) [1103]																					1			
Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]				1					1				1											
Water courses with Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]																					1			
1410 Mediterranean salt meadows (Juncetalia maritimi)																								1
Calcareous fens with Cladium mariscus and species of the Caricion davallianae [7210]																								1

Table A2.1. Qualifying interests in SPAs in the Irish Sea (1 indicates the species is designated within the site).

Qualifying interest	Baldoyle Bay	Boyne Estuary	Carlinford Lough	Dundalk Bay	Malahide Estuary	North Bull Island	River Nanny estuary and Shore	Rockabill	Rogerstown estuary	South Dublin Bay	South Dublin Bay and River Tolka Estuary	The Raven	Wexford Harbour and Slobs	Cahore Marshes	Dalkey Island	Howth Head Coast	Irelands Eye	Lambay Island	Skerries Islands	The Murrough	Wicklow Head
Little Grebe Tachybaptus ruficollis wintering [A004]													1								
Grey Heron Ardea cinerea wintering [A028]													1								
Bewick's Swan Cygnus columbianus wintering [A037]													1								
Whooper Swan Cygnus cygnus wintering [A038]													1								
Brent Goose Branta bernicla hrota [A046]	1		1	1	1	1			1		1		1						1	1	
Shelduck Tadorna tadorna [A048]	1	1		1	1	1			1				1								
Scaup Aythya marila wintering [A062]													1								
Hen Harrier Circus cyaneus post-breeding/roost [A082]													1								
Coot Fulica atra wintering [A125]													1								
Oystercatcher Haematopus ostralegus [A130]		1		1	1	1	1		1		1		1								
Ringed Plover Charadrius hiaticula [A137]	1			1			1		1		1										
Golden Plover Pluvialis apricaria [A140]	1	1		1	1	1	1				1		1	1							
Grey Plover Pluvialis squatarola [A141]	1	1		1	1	1			1			1	1								
Lapwing Vanellus vanellus [A142]		1		1									1	1							
Knot Calidris canutus [A143]		1		1	1	1	1		1		1		1								

Sanderling Calidris alba [A144]		1				1	1				1	1	1								
Purple Sandpiper Calidris maritima [A148]								1											1		
Black-tailed Godwit Limosa limosa [A156]		1			1	1			1				1								
Bar-tailed Godwit Limosa lapponica [A157]	1			1	1	1					1		1								
Redshank Tringa totanus [A162]		1		1	1	1			1		1		1								
Turnstone Arenaria interpres [A169]		1				1													1		
Little Tern Sterna albifrons [A195]		1											1							1	
Arctic Tern (Sterna paradisaea) [A194]								1			1				1						
Black-headed Gull (Chroicocephalus ridibundus) [A179]				1		1					1		1							1	
Black-tailed Godwit (Limosa limosa) [A156]				1																	
Common Gull (Larus canus) [A182]				1																	
Common Scoter (Melanitta nigra) [A065]				1								1									
Common Tern (Sterna hirundo) [A193]								1			1				1						
Cormorant (Phalacrocorax carbo) [A017]												1	1				1	1	1		
Curlew (Numenius arquata) [A160]				1		1							1								
Dunlin (Calidris alpina) [A149]				1	1	1			1		1		1								
Goldeneye (Bucephala clangula) [A067]					1								1								
Great Crested Grebe (Podiceps cristatus) [A005]				1	1								1								
Greenland White-fronted Goose (Anser albifrons flavirostris) [A395]												1	1	1							
Greylag Goose (Anser anser) [A043]				1					1									1		1	

Herring Gull (Larus argentatus) [A184]				1			1										1	1	1	1	
Lesser Black-backed Gull (Larus fuscus) [A183]													1					1			
Mallard (Anas platyrhynchos) [A053]				1									1								
Pintail (Anas acuta) [A054]				1	1	1							1								
Red-breasted Merganser (Mergus serrator) [A069]				1	1								1								
Red-throated Diver (Gavia stellata) [A001]												1								1	
Roseate Tern (Sterna dougallii) [A192]								1			1				1						
Shoveler (Anas clypeata) [A056]						1			1												
SPA 1140 Mudflats and sandflats not covered by seawater at low tide										5											
Teal (Anas crecca) [A052]				1		1							1							1	
Wetlands & Waterbirds [A999]	1	1	1	1	1	1	1		1		1	1	1	1						1	
Wigeon (Anas penelope) [A050]													1	1						1	
Kittiwake (Rissa tridactyla) [A188]																1	1	1			1
Guillemot (Uria aalge) [A199]																	1	1			
Razorbill (Alca torda) [A200]																	1	1			
Puffin (Fratercula arctica) [A204]																		1			
Shag (Phalacrocorax aristotelis) [A018]																		1	1		
Fulmar (Fulmarus glacialis) [A009]																		1			

Table A2.3. Examples of finer resolution descriptions of marine communities within each qualifying interest within SACs.

Name	Qualifying interests	Marine communities within the qualifying interest within the site
Lambay Island	1170 Reefs	Intertidal reef community complex
Lambay Island	1170 Reefs	Laminaria-dominated community complex
Malahide Estuary	1140 Mudflats and sandflats not covered by seawater at low tide	Fine sand with oligochaetes, amphipods, bivalves and polychaetes community complex
Malahide Estuary	1140 Mudflats and sandflats not covered by seawater at low tide	Estuarine sandy mud with Chironomidae and *Hediste diversicolor* community complex
Malahide Estuary	1140 Mudflats and sandflats not covered by seawater at low tide	Sand to muddy sand with *Peringia ulvae*, *Tubificoides benedii* and Cerastoderma edule community complex
Malahide Estuary	1140 Mudflats and sandflats not covered by seawater at low tide	Zostera-dominated community
Malahide Estuary	1140 Mudflats and sandflats not covered by seawater at low tide	Mytilus-dominated community complex
Dundalk Bay	1130 Estuary	Muddy fine sand community
Dundalk Bay	1130 Estuary	Fine sand community complex
Dundalk Bay	1130 Estuary	Gravel dominated by gravel community
Dundalk Bay	1140 Mudflats and sandflats not covered by seawater at low tide	Muddy fine sand community
Dundalk Bay	1140 Mudflats and sandflats not covered by seawater at low tide	Fine sand community complex

Dundalk Bay	1140 Mudflats and sandflats not covered by seawater at low tide	Gravel dominated by gravel community
Long Bank	1110 Sandbanks which are slightly covered by sea water all the time	Sand with *Nephtys cirrosa* and *Bathyporeia elegans* community complex
Carnsore Point	1140 Mudflats and sandflats not covered by seawater at low tide	Intertidal sand dominated by polychaetes and crustacea community complex
Carnsore Point	1170 Reefs	Sheltered to moderately exposed intertidal reef community complex
Carnsore Point	1170 Reefs	Exposed subtidal reef dominated by a faunal community complex
Carnsore Point	1170 Reefs	Laminaria dominated community complex
Wicklow Reef	1170 Reefs	sub-tidal current swept reef
Blackwater Bank	1110 Sandbanks which are slightly covered by sea water all the time	Sand with *Nephtys cirrosa* and *Bathyporeia elegans* community complex
Blackwater Bank	1110 Sandbanks which are slightly covered by sea water all the time	Cobble with Epifaunal community
Rockabill to Dalkey	1170 Reefs	Intertidal reef community complex
Rockabill to Dalkey	1170 Reefs	Subtidal reef community complex

Appendix 4
Fisheries in the western Irish Sea

1.1. Historical account

A large expansion of the whitefish fishery in the Irish Sea occurred from the early 1960s (Bentley *et al* 2019). This was followed by development of fisheries for Nephrops and industrial fishing for herring in the late 1960s. Herring stocks declined in the 1970s and whitefish landings peaked in the mid 1980s. Steep declines in cod, whiting and sole stocks were evident by the early 1990s. From the mid 1990s shellfish (mainly Nephrops) dominated fish landings. A dramatic but short-lived expansion of haddock stocks occurred in the late 1990s and despite the introduction of a cod recovery plan in the early 2000s whitefish fisheries collapsed and remain low to the present day. The lack of recovery despite reduction or removal of fishing effort and particularly the continued truncated age structure for some whitefish species remains largely unexplained. The scale of the changes is dramatic; for instance landings of finfish peaked at over 150,000 tonnes in the 1970s with a smaller peak of about 70,000 tonnes in the mid 1980s. In recent years landings, which are significantly constrained by total allowable catches, which reflect the very low biomass as assessed by ICES, have been less than 5000 tonnes. During this time landings of benthic invertebrates (crustaceans and molluscs) has increased from almost zero in the early 1960s to over 50,000 tonnes in recent years. The removal of cod, which is a significant predator of Nephrops, may have led to increase in Nephrops stocks and the capacity to support higher levels of fishing mortality and landings than in the past.

The changes to the Irish Sea ecosystem brought about by fishing or a combination of fishing and environmental changes are complex but today the Irish Sea system is different from the system that existed 40 years ago. In addition to large scale declines in finfish biomass some species may have been entirely lost; by the late 1970s Brander (1981) reported that overfishing had already brought skate to the brink of extinction in the Irish Sea and the recovery would not be possible if fishing continued.

1.2 Fishing activity

The main fishing activities in the western Irish Sea are (Table A4.1):

- Bottom trawling for *Nephrops* and mixed species of demersal fish
- Beam trawling for rays and flatfish
- Dredging for scallop
- Dredging for razor clams
- Dredging for cockle (Dundalk Bay only)
- Dredging for mussels
- Potting for whelk and crustaceans
- Pelagic trawling for herring and sprat
- Trammel netting for bait

- Fisheries occur in different areas of the western Irish Sea and reflect the spatial distribution of the target species, which in turn, for shellfish species, reflects the distribution of specific habitats (sediments, current speeds).

- Most fishing effort in the western Irish Sea is by Irish vessels. All vessels from Northern Ireland have access to the baselines while France, Belgium and Netherlands have access to some fisheries to 6nm from the baselines. Access and quota arrangements with the UK are under negotiation following the UK withdrawal from the European Union (Brexit).
- The bottom trawl fishery, targeting *Nephrops*, occurs mainly on mud and sandy mud in the northwest Irish Sea. Gadoid fish and particularly cod and whiting were important target species in this region previously. In this area in the northwest Irish Sea gyre, which developed in summer, retains *Nephrops* larvae and provides regular recruitment to the seabed. The water column in this area is stratified in summer and bottom temperatures remain relatively cool.
- Inshore of the trawl fishery, in the north Irish Sea, and on coarser sediments, there is a small-scale coastal scallop (*Pecten maximus*, *Aequipecten opercularis*) fishery prosecuted by a very limited number of inshore vessels. This fishery also occurs on sand banks and coarse sediments further south to Wicklow. Larger scallop dredgers may also fish these inshore grounds opportunistically.
- Closer inshore again and up to the lower water mark, a dredge fishery for Razor clams (*Ensis siliqua*) occurs on muddy sand and mixed sediments in the area from north Dundalk Bay south to Malahide. Razor clams are also fished in the south Irish Sea from Rosslare Bay north to Curracloe off the east Wexford coast.
- Cockles are fished, using hydraulic dredges, in intertidal sedimentary habitats of Dundalk Bay.
- Lobster (*Homarus gammarus*) are fished with creels along coastal reefs while crab (*Cancer pagurus, Necora puber*) are targeted in various areas both inshore and offshore on coarse sedimentary habitats.
- Small pot fisheries for shrimp (*Palaemon serratus*) may occur in coastal waters north of Dublin.
- In some years, depending on quota availability, there is a pelagic fishery for herring (*Clupea harengus*) off county Down in the western Irish Sea
- In the south Irish Sea, currents are stronger and sediments coarser and the profile of the fishery is different to the north Irish Sea. There is a significant, large vessel, scallop fishery offshore from Wicklow south to Carnsore Pt which overlaps with a beam trawl fishery for rays and mixed demersal fish. Some bottom trawling also occurs here targeting rays and mixed demersal fish.
- Towards the coast there is an extensive and important pot fishery for whelk on the landward and seaward slopes of sandbanks.
- Mussel beds may also be found in relatively small patches at the edge of sand banks and on coarse sediments and rock which are scoured by strong currents. These mussel beds are fished in autumn by large dredging vessels.

Table A4.1 Fishing metiers (species gear combinations), target species, gears and importance of main fisheries in the Irish Sea.

Metier description	Target species	Scientific name	Gears	Static or mobile gear	Scale and importance
Trap – crustacean	Shrimp	*Palaemon serratus*	Shrimp pots	Static	Vessels mostly under 10m in length. The scale of the fishery is small relative to
	Lobster	*Homarus gammarus*	Side and top	Static	

	Crab	*Cancer pagurus*	entrance creels		other Irish coasts but locally important
	Velvet crab	*Necora puber*			
Trap – whelk	Whelk	*Buccinum undatum*	Whelk pots	Static	There are ~50-60 vessels between 8-15m in the fishery fishing from ports from Howth south to Rosslare.
Dredge – benthic	Scallop	*Pecten maximus, Aequipecten opercularis*	Spring loaded scallop dredge	Mobile	Generally, less than 10 inshore vessels involved including vessels from Northern Ireland. Offshore in the south Irish Sea ~10 vessels over 15m have authorisation to fish scallop
	Razor clam	*Ensis siliqua*	Hydraulic dredges	Mobile	Important fishery with 40-70 vessels under 15m.
	Cockle	*Cerastoderma edule*	Hydraulic dredges	Mobile	Important locally for ports of Dundalk and Clogherhead, 28 vessels. Many of these vessels also fish razor clams.
	Mussel	*Mytilus edulis*	Mussel dredge	Mobile	The fishery harvests mussel for relay into aquaculture sites in Wexford Harbour and in Northern Ireland. Vessels are specialised mussel dredgers and have no access to other fisheries
Beam trawl - demersal	Rays	Mixed species	Beam trawl	Mobile	Beam trawl activity.
	Plaice	*Pleuronectes platessa*			
	Sole	*Solea solea*			
Otter trawl – demersal	Plaice	*Pleuronectes platessa*	Bottom Otter trawl	Mobile	The previously large fisheries for cod and whiting in the north Irish Sea are now depleted. Trawlers in the area now rely mainly on *Nephrops*.
	Prawns	*Nephrops norvegicus*			
	Cod	*Gadus morhua*			
	Sole	*Solea solea*			
	Haddock	*Melanogrammus aeglefinus*			

	Whiting	*Merlangius merlangus*			
	Pollack	*Pollachius pollachius*			
	Ray	Mixed species			
Mid-water trawl - pelagic	Herring	*Clupea harengus*	Mid-water trawl, pair trawl	Mobile	Most herring caught in the western Irish Sea is from the Irish Sea stock, which is stable and above all biomass reference points. TAC is predominantly held by the UK. Although the most targeted area for sprat is in the Celtic Sea, vessels both above and below 10m in length catch sprat all along the east coast.
	Sprat	*Sprattus sprattus*			
Trammel net	Various fish		Trammel nets (set nets)	Static	Trammel nets may be used to capture bait for pot fisheries.

1.3 Management of fisheries

1.3.1 Access to fisheries

Access to fisheries is regulated through a fishery licencing system within the constraints of the national capacity (tonnage and kilowatts) limits set for the commercial sea fishing fleet. Access to most stocks is controlled through this primary licence; fishermen who have acquired necessary tonnage and capacity apply to the licencing authority (DAFM) for a fishing licence. A secondary authorization (permit) is required to fish for certain species including cockles (all vessel sizes), scallop (vessels>10m), herring and mussel (mussel is re-laid into aquaculture sites) (Table A4.2).

Other countries have access to fisheries in Irish waters of the Irish Sea as follows:

- Northern Ireland: under a bilateral arrangement with the Republic of Ireland vessels from Northern Ireland can fish all species up to the baselines but not within the internal waters of the Republic of Ireland.
- UK other than Northern Ireland: Access for UK vessels to fisheries in Irish waters of the Irish Sea is currently being negotiated under the trade and co-operation agreement following the UK with drawl from the EU (Brexit).

- Belgium, Netherlands, and France: These countries have access, based on historic activity, to certain fisheries in the 6-12nm zone in Irish waters of the Irish Sea.
- All other members states have access to the 12nm territorial limit in Irish waters of the Irish Sea

1.3.2 Stock assessment and scientific advice

The main commercial species are variously monitored and assessed. Species other than bivalves and crustaceans (excluding *Nephrops*) are assessed internationally through various working groups of the International Council for the Exploration of the Sea (ICES). The quality of the assessments varies from fully analytical age-based assessments to assessments based on trends only to very data poor cases where only landings data may be available (Table 2). The capacity to provide advice on the management of stocks, therefore, also varies. Where biological reference points have been estimated this enables the status of stocks to be reported relative to maximum productivity and relative to status where there is a risk of recruitment collapse. The starting point for all the ICES reference points is B_{lim} or the biomass below which recruitment declines with decreasing spawning stock biomass (SSB). This can be found statistically for some stocks, where B_{lim} is chosen as the break point in the relationship between biomass and recruitment. For other stocks B_{lim} can be taken as the lowest biomass from which a high recruitment has been observed and is used to find the fishing mortality (F_{lim}) that is equivalent to this point. The target fishing mortality F_{msy} (the fishing mortality that maximises sustainable yield) is then calculated from a long-term projection where F_{msy} must also ensure >50% probability of SSB being above B_{lim}. These long-term projections are based on biological parameters, fishery selectivity in the stock assessment and stock-recruitment relationships i.e., life history characteristics that are fundamentally related to species resilience (ICES 2021).

Simpler approaches to modelling are also used, including production methods, which assess the response of populations to harvesting over long periods of time and where there is contrast in the level of fishing (landings) in the time series. These models can provide estimates of stock productivity and the intrinsic rate of increase (r) and capacity for population growth (net reproductive rate divided by the mean generation time) which is a measure of resilience of the population. Fisheries advice, provided from these procedures, act to limit fishing mortality essentially based on the biological characteristics (resilience) of the species.

Species not assessed by ICES and not subject to EU TAC management are assessed nationally by the Marine Institute. Although biological reference points have not been estimated for these stocks there has been an increase in data provision and capacity to develop trends-based assessments in recent years. Scientific surveys are undertaken annually for razor clams, cockles, mussels and from 2023 scallop in the Irish Sea. Indicators are also developed for lobster, crab and scallop which indicate trends.

The most recent MSFD assessment report indicates that in Irish waters overall a total of 34 stocks (18%) have achieved good environmental status (GES), while the environmental status of 99 stocks (60%) is currently unknown. In the case of 44 other stocks (22%), GES has not been achieved (DHLGH 2020)

1.3.3 Management measures

The primary management measure for stocks assessed by ICES and managed at EU level is to limit the total allowable annual catch (TAC) (Table A4.2). This is a direct method of limiting the impact of fishing on the productivity of the stock. Where fishing pressure or annual fishing mortality (F) is effectively managed at stock level, such as in the Irish Sea or part of the Irish Sea, with the objective of maintaining stock productivity, then the productivity of the population is effectively protected from fishing. Some stocks, managed at national level, such as cockle, mussel and razor clam are also managed by TAC or quota which acts to limit outtakes.

1.3.4 The potential role of spatial management

In considering a role for spatial management of commercially exploited species the question is whether such management could result in more effective control of F than the use of TAC alone. For species that are managed by other measures the same question applies; does spatial management provide added benefit to the fishing management measures and effective control of F.

Spatial management in combination with other fishery measures could play a role in some cases as follows.

1. Where there is a high risk that the TAC is not effectively implemented (poor compliance)
2. Where there is unseen mortality of the species, in some phase of their life history, elsewhere such as in another fishery or caused by other pressures that are not controlled and where this vulnerability is spatially defined.

a. However, even hidden, or unseen mortality may implicitly be incorporated into the scientific assessment (of sensitivity) of stocks in that it would be reflected in the apparent stock recruit relationship or in the estimated response to harvesting; the recruitment from a given SSB would be lower than if the unseen mortality did not occur. In such cases the recruitment dynamics of the stock would appear to be less efficient than it would otherwise be, and this would be reflected in the management reference points. Spatial protection could in these cases result in improved recruitment at a given SSB and a change in reference points leading to higher TACs. If that is the objective, then the spatial protection would be defined as an OECM (designed to improve fishing yields); a 'spillover effect' to larger size classes (optimising yield).
b. Where aggregations of juveniles occur and where they also provide an important ecological (rather than future fishery yield) function then spatial protection of these life history stages could be consistent with MPA objectives independently or in combination with fishery objectives.

3. Where fishing operations find it difficult to avoid fish that will not optimise yield due to poor selectivity and aggregation of mixed ages (and sizes) in targeted shoals or where there is a high proportion of juvenile fish in some locations
   a. In these cases, temporary or permanent spatial protection may reduce unwanted mortality of undersized fish and increase yields later in the same location (spillover in time) or elsewhere (a spatial spillover effect). This would be defined as an OECM given that the primary objective may be to improve selectivity and optimise fishery yields.

4. Where fisheries unintentionally catch species for which the TAC is zero or where the catch and retention on board of such species is prohibited and where the survival of discarded fish is low. In the case of species that are endangered and where their populations are extremely low unintentional mortality, caused by fishing, may pose a significant risk. Spatial management in these cases may or may not be suitable. This depends on how such species are distributed in space and time. Other measures to avoid such species may involve changes in fishing gears.

    a. A number of elasmobranch and other fish species fit this category e.g. Angel shark and also species listed in the Habitats Directive such as Twaite Shad.

Where F is unknown or not effectively managed by TAC then there is a strong case for use of other measures to protect stock status. These measures could include minimum landing sizes, fishing gear restrictions or seasonal closures. Spatial management, through temporary or permanent restrictions, may have a role in cases where:

5. Other management measures are absent or ineffective AND
    a. Life history parameters indicate low resilience to exploitation AND
    b. Some life history stages at least are amenable to spatial protection

6. The essential habitat of a commercially exploited species could be considered for spatial protection if the fishery itself or other activities posed a threat to it
    a. Herring spawning on gravel beds. The primary objective is to protect an essential habitat which if damaged could result in reduced productivity and fishery yields. The effect of the fishing activity itself on the essential habitat would need to be assessed for fishing to continue in such areas.

Table A4.2. Stock assessment, status, access arrangements and primary management measures in place for main commercial species in the Irish Sea.

Target species	Stock assessment and monitoring	Stock biomass (status[1])	Access arrangements	Other countries	Primary management measure
Shrimp	None	Unknown	Polyvalent licence	Northern Ireland to baselines[2]	Season closure
Lobster	Indicators based on observers, industry reporting and logbook and landings data	Stable	Polyvalent licence	Northern Ireland to baselines	Minimum conservation reference size, max size, v-notch prohibition
Crab	Indicators based on observers, industry reporting and logbook and landings data	Declining	Polyvalent licence	Northern Ireland to baselines	Minimum conservation reference size
Velvet crab	None	Unknown	Polyvalent licence	Northern Ireland to baselines	Minimum conservation reference size
Whelk	Length based from port sampling time series (preliminary)	Landings stable	Polyvalent licence	Northern Ireland to baselines	Minimum conservation reference size
King scallop	Indicators based on VMS logbook data. Surveys beginning in 2023	Stable	Authorised limited entry vessels >15m. Effort cap (kwdays) for vessels over 15m	Northern Ireland to baselines	Minimum conservation reference size
Queen scallop	None. Surveys beginning in 2023	Unknown	Authorised limited entry vessels >15m.	Northern Ireland to baselines	Minimum conservation reference size

Razor clam	Survey based estimation of biomass	Stable	Specific (bivalve) or polyvalent licence	Northern Ireland to baselines	Weekly quota limits per vessel
Cockle	Survey based estimation of biomass	Biomass recruitment dependent	Authorised limited entry	None	Total allowable catch
Mussel	Survey based estimation of biomass	Biomass highly recruitment dependent	Authorised limited entry	Northern Ireland to baselines	Total allowable catch
Rays mixed species	Landings only. Indicators based on VMS logbook data for some species	Generally unknown	Polyvalent licence	Northern Ireland to baselines Belgium, France, Netherlands to 6nm. Access arrangements for UK, other than Northern Ireland, in the Irish sector of the Irish Sea and the share of quota is being negotiated under the trade and co-operation agreement between UK and EU. Most fishing activity in the 6-12nm zone in the Irish Sea 2013-2021 was Irish.	Generic TAC, some specific catch limits
Sole	Age based assessment	Biomass above reference point (productive).	Polyvalent licence		Total allowable catch
Plaice	Age based assessment	Biomass above reference point (productive).	Polyvalent licence		Total allowable catch
Prawns	Survey based estimate of biomass and length-based assessment	Biomass above reference point (productive)	Polyvalent licence		Total allowable catch ICES area VII. No specific TAC in Irish Sea
Cod	Age based assessment	Biomass **below** reference point (depleted)	Polyvalent licence		Total allowable catch

Sole	Age based assessment	Biomass above reference point (productive)	Polyvalent licence		Total allowable catch
Haddock	Age based assessment	Biomass above reference point (productive)	Polyvalent licence		Total allowable catch
Whiting	Age based assessment	Biomass **below** reference point (depleted)	Polyvalent licence		Total allowable catch
Herring	Age based assessment	Biomass above reference point (productive)	Pelagic or polyvalent licence		Total allowable catch
Sprat	No assessment. Advice based on recent catches (ICES Category 5)	Unknown	Pelagic or polyvalent licence		No total allowable catch

1.4 References

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Appendix 5 Methodologies

Appendix 5a
Methodology for the selection of features

'Features' are the aspects of nature for which MPAs are selected, that are the focus of conservation objectives in MPAs, and which management measures are designed to protect. They are usually species or habitats, but can be other aspects of the environment, such as ecosystem processes, ecosystem services or biocultural features. The full features list for Ireland's national network of MPAs will be developed through a process involving stakeholder engagement under the MPA legislation when it comes into force. Given the time constraints for this project, and the need to establish the focal features at an early stage in the project as they underpin the rest of the work, the advisory group and the wider project team established a practicable, transparent, and defensible process for selecting a list of features for the current project.

Broad criteria were based on the types of features specified in the General Scheme of the MPA Bill 2022 (under Head 7 and in Schedule 3), but only included those types of features that could be definitively characterised without wider consultation and discussion, and which are of specific relevance to the western Irish Sea:

- Threatened or declining species or habitats
- Important species and habitats/biotopes
- Features representative of the range of features in Irish waters
- Areas of high biodiversity, naturalness, or sensitivity
- Areas supporting ecosystem services
- Features with potential for restoration

Some initial consideration was also given to biocultural features, which are also specified in the General Scheme of the MPA Bill 2022 (under Head 7), but it was not considered possible within the time frame to complete the necessary research and consultation for their identification and further consideration.

The criteria established to determine whether to include or exclude each candidate feature from further work in the project are summarized in Figure A5a.1. A long list of candidate features was initially established that either clearly or potentially aligned with one or more of the options in Step 1 on Figure A5a.1.

First the listings of species and habitats under the Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and the Red Lists established under the International Union for the Conservation of Nature (IUCN) were reviewed to identify species and habitats that may occur in the western Irish Sea and have been identified as threatened or declining against internationally agreed criteria. These lists are specified under Head 7 of the General Scheme of the MPA Bill 2022. OSPAR publishes lists of priority species and habitats that are agreed by its member states and intended to be the focus for protection by the OSPAR network of MPAs. IUCN Red Lists are developed through a rigorous framework to determine conservation status at national, regional, or global level, with relevant categories of Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern and Data Deficient. A candidate feature was deemed to merit inclusion on the project's feature list if it was listed by OSPAR or classified under IUCN criteria as Critically Endangered, Endangered, Vulnerable or Near Threatened in Ireland, Europe or Globally.

Consideration was given to including species and habitats that had been identified as high priority by the Government of Wales and the Northern Ireland Environment Agency. However, it was decided that the criteria were not directly applicable to Ireland and as these lists were not specified in the General Scheme of the MPA Bill 2022, wider research and discussion would be necessary to decide on the inclusion of each. Therefore, they were not included in this project, but may merit inclusion in future features lists. The features proposed by stakeholders during the public consultation on the MPA Advisory Group (2020) report on 'Expanding Ireland's network of MPAs' were also considered. Some of these also met the criteria used in this project and so were included, but it was decided that such nominations were not sufficient alone to merit inclusion in the work of this project. Again, they may be reconsidered in developing the full list of features under the MPA legislation.

The ecological experts on the team also proposed species and habitats that could be considered ecologically important. Particular attention was given to species that provide structural habitat for biodiversity, often called ecosystem engineers (e.g., mussel beds) and species that provide an important food source for species listed under Natura, OSPAR or IUCN or are commercially fished (e.g. forage fish, barrel jellyfish).

Given Ireland's legal obligations under the MSFD, the relevant priority habitats listed under that Directive were included. In addition to their legal importance, this grouping also captures the range of habitats representative of the western Irish Sea and in protecting them, protection is also afforded to a range of associated species and ecosystem functions.

Ecosystem services are specified in the General Scheme of the MPA Bill 2022 as comprising provisioning, regulating and cultural ecosystem services (see https://cices.eu/cices-structure/ for details). Of these, cultural ecosystem services were deemed to require considerable additional research and stakeholder engagement to enable consideration. The main provisioning service in the area of interest is the production of fish and shellfish. As indicated below, this was essentially outside our scope, but consideration was given to some features that indirectly support this ecosystem service by promoting productivity and forage fish and protecting early life history stages. Regulating ecosystem services were thus the primary focus, particularly carbon sequestration, due to its potentially important contribution to climate change mitigation and its potential sensitivity to sea-bed disruption.

Finally, features were considered that are now extinct in the western Irish Sea but were historically important and have potential to be restored e.g., oyster beds.

Having established a long list based on any one of the above criteria, the first filter applied to potentially exclude candidate features was to determine whether the feature was already managed or conserved under other policies, directives, or regulations (Step 2 in Figure A5a.1). As described in Section 1 of the report, features explicitly listed on the EU Birds and Habitats Directives are outside the scope of this project. Commercial fish and shellfish individually managed under the CFP were also excluded because they are effectively managed by other means. Nevertheless, some habitats important to fished species, some commercial species that were not deemed to be individually and effectively managed under fisheries regulations and forage fish including juveniles of some commercial species were included.

Consideration was then given to whether the western Irish Sea could be considered a significant part of the range of each feature in Irish waters, if indeed they occurred at all in the western Irish Sea in the past or present (see Step 3 in Figure A5a.1 for further details). If not, they were excluded from the features list.

Finally, an initial determination was made as to whether, based on current knowledge, the feature is potentially amenable to spatial protection (Step 4 in Figure A5a.1). There are a range of approaches to protecting or conserving different features from the range of pressures that may affect them and MPAs are not always the best approach (see MPA Advisory Group, 2020). In this regard, consideration was first given to whether the feature had specific habitat requirements or areas important for specific life history stages (such as spawning or nursery grounds) that could be protected and thereby benefit the species. The distribution and mobility of the features was also reviewed. If they are very widely distributed or highly mobile, it may not be useful to designate areas in which they are protected; they may be better served by being protected wherever they occur, for example. Nevertheless, it may still be considered for many features that protecting a proportion of its range would be of value. As such, at this early stage in considerations for each candidate feature, this criterion was generally applied quite leniently; features were retained if it was considered possible that they would benefit from spatial protection.

For each feature that met the criteria and was included for further consideration in the project, a case report was produced, providing some background information on the feature and the rationale for its inclusion in the project (Appendix 10). Candidate features that were considered by the group but not included were also documented, giving explanations for their exclusion in terms of the above criteria (Appendix 6).

After the process of collating data and information on features that were included, features were divided into three broad groups for their subsequent treatment in the project/report:

A. Sufficient data of sufficient quality for inclusion in conservation prioritization.

B. Sufficient data/information to make some recommendations for spatial protection but not enough for formal conservation prioritization modelling.

C. Not enough data/information to make recommendations about spatial protection at all. For these features, we will recommend that priority is given to generating new data and knowledge to inform the best approach to conservation.

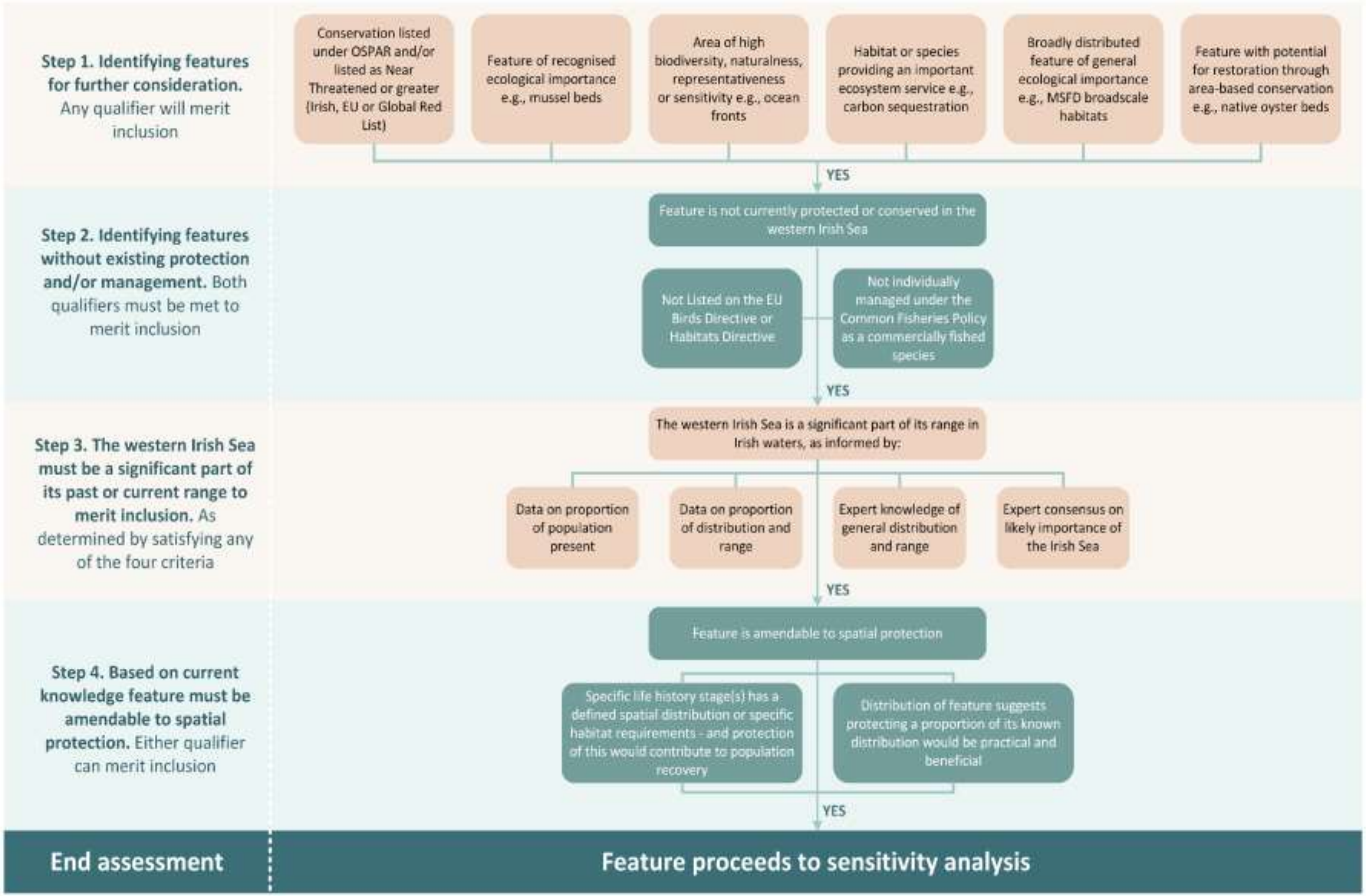

Figure A5a.1 Criteria for inclusion and exclusion of candidate features for consideration for spatial protection the current project

Appendix 5b
Collation and processing of information and data

A structured approach was taken to data discovery, collection, processing and cataloguing in preparation for conservation prioritization. The steps are outlined in Figure A5b.1.1 and complete description is provided below.

1.1. Data discovery

To assemble the best available evidence base for recommendations, a comprehensive data discovery process was undertaken involving exploring a wide range of data collection programmes in state archives as well as those still under ongoing operation (e.g., the DCF and the MSFD).

Data were sourced from state departments, agencies, higher-educational institutes, sectoral bodies, citizen-science initiatives, and pan-European and international bodies, such as the International Council for the Exploration of the Sea (ICES) and the European Marine Observation and Data Network (EMODnet).

One prominent source was Ireland's national data repository, accessible through https://data.gov.ie/. This state archive compiles national, regional, and local datasets, not just from government departments, but also from local authorities, semi-state agencies, and other relevant organisations. An extensive collection of datasets available through the service pertains to ecological and environmental concerns, while others provide crucial insights into population, socioeconomic, cultural, and legal matters. The information, available through Ireland's national data repository, was used in the analysis for this report to gain a comprehensive understanding of the various factors that influence the ecological health of our marine environment.

Data was also sought from experts from more than a dozen agencies, eNGOs, sectoral bodies. This effort involved a combination of email, phone calls, in-person meetings, and video conferences to ensure comprehensive coverage. A complete list of data providers can be found in Appendix 7.

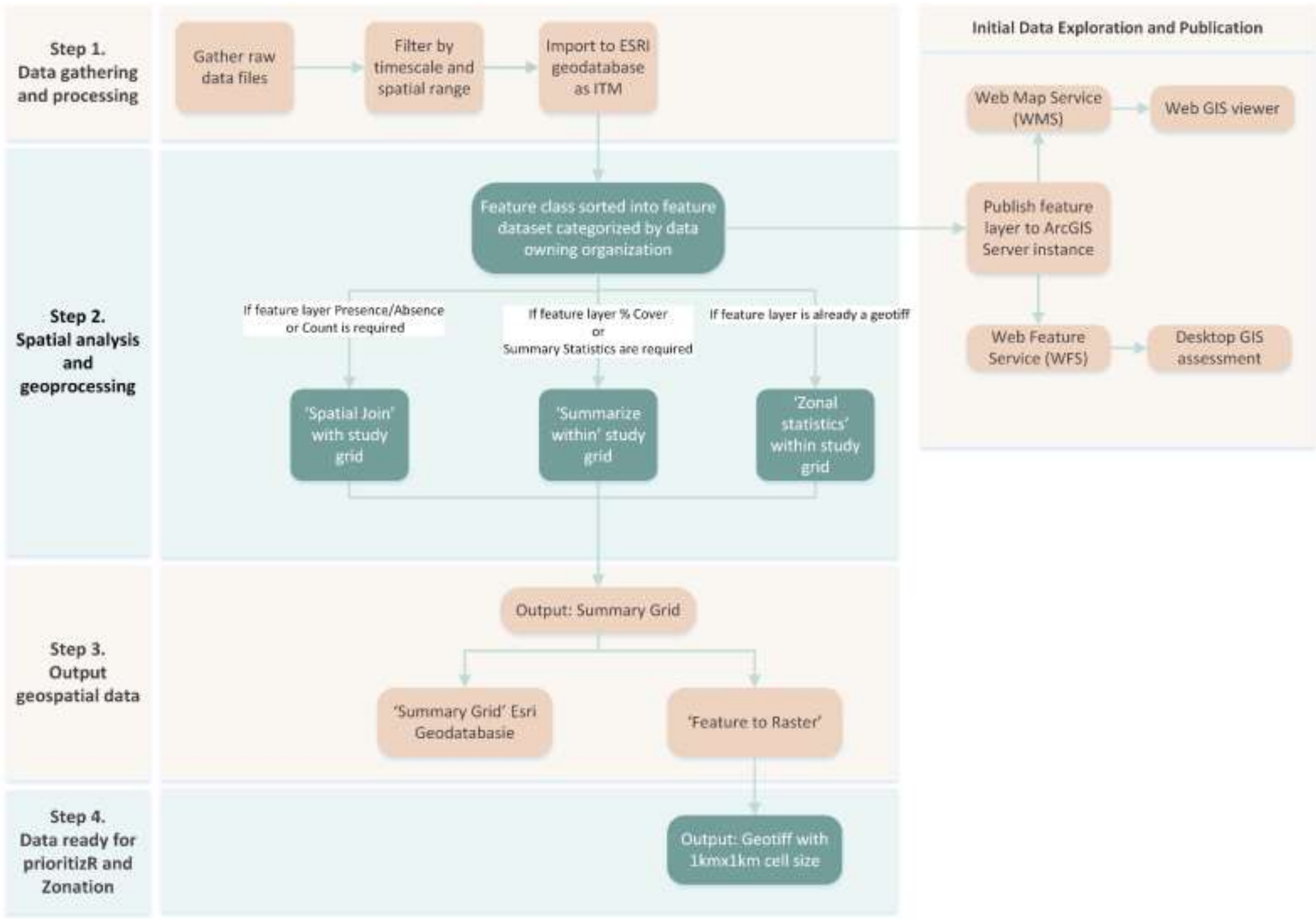

Figure A5b.1.1. Process flow of technical method used to geoprocess data in preparation for use in *prioritizR* and Zonation.

1.2. Data quality assessment and modelling to estimate distributions over larger areas

To assess the accuracy and reliability of the data, a quality filter was applied to each piece of information collected. This allowed for the categorisation of data resulting in a better understanding of the quality and spatial and temporal coverage of the data that was available. This is presented in Table A5b.1.1. A full categorisation of the quality of data collected and used is available in Appendices 7 and 8.

This report utilizes compiled data to estimate the distribution of ecological features in the western Irish Sea. The resulting distributions are then overlaid onto a planning unit grid, which allows for the systematic identification of potential areas that should be considered for spatial protection of these features (see Section # for more details). Among the available datasets, those that provide observations (presence/absence, counts, estimates) for the entire area of interest are the most valuable. Ideally, such observations would be available for every cell in the planning grid, but comprehensive data such as these are not available. As a result, individual datasets provide varying degrees of spatial coverage within the area of interest. For example, extensive datasets like fishing catch and effort can be spatially biased toward areas with higher fish abundance, while scientific survey data may have lower spatial coverage and are designed for specific purposes. Despite these limitations, these datasets can still be used to estimate the distribution of ecological features over larger areas using various modelling methods.

Datasets may also be used individually or in combination to provide modelled estimates of the distribution of an ecological feature. Modelling invariably involves some form of interpolation to predict the distribution of a feature in areas which have not been sampled; that's the purpose of the model. The uncertainty in such estimates depends on the data support (samples) used in the model and how the distribution of the feature may be correlated with other variables used in the model prediction (e.g., a species may be associated with a particular physical habitat). Modelled estimates can potentially provide estimates of the distribution of a feature for the entire area of interest. It is important to note, however, that some uncertainty is inherent in this process and ground-truthing should be used where possible to help reduce uncertainty.

Other data are collected opportunistically (not by design) and could originate from scientific surveys for other features, fishing vessels, citizens, or other observed sources. It may or may not be possible to use these datasets in models and if they stand alone then they provide weaker evidence of the presence, absence or distribution of a species or habitat in the area.

A temporal filter was applied to all data on the basis that data up to 30 years old was acceptable for static species and habitats, while for mobile species, data up to 10 years old could be considered relevant to current distribution in the area of interest. This cut-off was based on expert judgement.

Table A5b.1.1. Data quality categories to assess the datasets provided. Examples are provided in Appendices 7 and 8.

Quality/type	**Description**
High	The ideal dataset for these analyses would be systematically collected without bias, using techniques specific to the feature(s) in question. It would have intensive coverage e.g., on a 1-3 km grid and would include repeated observations over several years.
Modelled from good data	Modelled distribution data (based on modelling of systematic design-based observed data). The modelling process enables interpolation to areas not sampled and therefore has high spatial coverage. Uncertainty depends on the predictive power of the model. Examples include survey data used to model the predicted distribution of species, vessel monitoring system (VMS) data which is extrapolated to a grid and modelled estimates derived from acoustic data ground-truthed with observed samples.
Modelled from moderate data	Modelled distribution data that may have a spatial bias or provide incomplete information on the potential distribution of the feature. Examples are provided in Appendix 7 and include species distributions from fisheries effort and catch data interpolated or raised to a grid.
Good; observed data	Data acquired systematically which covers a large spatial area, but not the entire area of interest, and preferably with repeated measures over a long time series. These data ideally will provide a good spatial representation of the area but the distance between observations is much larger than the distance between planning units. This category also represents data sources which were combined to give a higher spatial coverage of a feature. Examples include observed data acquired from systematic surveys.
Moderate; observed data	Data acquired systematically or opportunistically, is not modelled, and covers only a limited area relative to the potential distribution of the feature. Examples include citizen science data and sea angling data.

Low/ Insufficient for conservation prioritization	Data exist in the area of interest but are older than 10 years (for mobile features) or 30 years (for static features) **OR** anecdotal **OR** spatially imprecise.
N/A	No data available in the area of interest

1.3. Data topic categories

Aligning with the terms of reference, data were then grouped into the following topic categories:

A. Ecological
Understanding the distribution and ecology of the diverse range of marine species and habitats that are ecologically sensitive and require protection is critical for effective management and conservation of the marine environment. Comprehensive data on ecological information, such as species distribution, feeding and spawning areas, and migration routes, is necessary to provide insights into the ecological sensitivity of the Irish Sea and inform the development of spatial management strategies.

B. Sectoral activity
This encompasses activities associated with various industries in the area, such as fishing, shipping, tourism, and energy exploitation. These data are important for assessing the impact of these activities on the environment and identifying areas where these activities may need to be regulated or restricted to protect sensitive ecological features. For more context on the considerations taken for data collected under this category, see Section 2.3.

C. Biocultural diversity
Biocultural diversity refers to the cultural and social values associated with the area's natural resources. This is essential for understanding how people interact with and depend on the ecosystem, and it can inform management decisions that balance ecological and social considerations.

D. Legislative - designated areas

Ireland has a regulatory framework to govern offshore and nearshore activities through protected areas such as SACs and SPAs and other means. These frameworks encompass a variety of industries, ranging for example from aquaculture farms, which are licensed, monitored and enforced by the Department of Agriculture, Food and the Marine (DAFM), to offshore energy projects such as historic fossil-fuel exploration, modern renewable energy infrastructure, and communication and energy cable authorisations, which are supervised by a combination of local authorities, national planning agencies, and the Department of Environment, Climate and Communications (DECC). In addition, there are other areas of strict activity usage originating from military and aviation activities, which are managed by the Irish Navy and the Irish Aviation Authority, respectively. Legislative drivers also exist at the European level which act to place protection on Ireland’s marine resources. Regulation (EU) 2016/2336 has banned bottom trawling at a seafloor depth greater than 800 metres, accounting for 50% of Ireland's maritime area. Datasets in this category include information on designated protected areas, licensed sites, and other legal frameworks that regulate activities in the area.

It should be noted that while these categories provide a useful framework for organising the data collected for this report, they are not mutually exclusive. Many data sources may provide information relevant to multiple categories, and a comprehensive understanding of the ecological sensitivity of the area requires consideration of all relevant data. Additionally, this report focuses only on Ireland's jurisdiction in the Western Irish Sea, and other nearby ecosystems and their interactions were not studied due to time constraints.

1.4. Data cataloguing

All datasets provided and used throughout the study were catalogued to provide traceability, transparency and reproducibility. Much of the data used is freely available online and the publicly accessible links to download the data were recorded where available. Any datasets not openly available online are stored in a centralised place internally within the Marine Institute to allow for the reproducibility of this study (and only this study) and the catalogue contains the location of the file path where the data is stored.

The catalogue includes the following information:

- Data owning organisation
- Metadata record URL
- Data download URL
- Date range for which data is available
- Date range used in the study
- Monitoring Regime under which data was collected
- Location of raw dataset
- Code - link to any code which was used to analyse the data

1.5. Technical processing

The data layers were received in various formats including CSV, shapefiles, GeoTiffs, and SQL server databases. All raw data was stored as received without any editing on a file share. The datasets were then processed by making them spatial and filtering them based on the established feature timescale and spatial range.

The geoprocessing of the candidate spatial data layers started with integrating all the datasets and feature layers into a dedicated ESRI file geodatabase. Each layer was converted into a feature class and sorted into a feature dataset based on the data-owning organization. Upon integration into the dedicated geodatabase, each layer was projected to the IRENET95/ Irish Transverse Mercator coordinate system.

All candidate layers were then published as web map services (WMS) and web feature services (WFS) on an ArcGIS server instance. This allowed for easy dissemination of the candidate layers for assessment within desktop-based GIS applications as well as web-based map viewers.

The high overlap and clustering of data within the candidate layers, coupled with major sparsity in other areas, presents a challenge to getting an unbiased and clear view of the true impact and location of potential high-value areas when observing these layers in their raw format. As such, an alternative approach was developed to determine the full landscape of values more accurately and quantitatively for all marine space within the study area.

To facilitate this comprehensive analysis of the marine space falling within Ireland's Exclusive Economic Zone (EEZ) in the Irish Sea, a 1x1 km2 grid layer was created and clipped to the EEZ boundary. This resulted in a grid layer comprising 11,034 individual cells, each with a maximum area of 1x1 square km2, that encapsulated all marine space within the study area (Figure A5b.1.2)

Using a gridded approach to generate a model output value offers significant advantages, particularly concerning scale. The addition or removal of layers is a simple calculation amendment, and layers can be masked out or weighted based on their relative importance compared to other candidate layers. The model also allows for equation complexity to grow alongside the complexity of layer input, resulting in a flexible and adaptable system that consistently produces a user-friendly output. Ultimately, this approach aids understanding and decision-making by providing a familiar and informative product.

To generate GeoTiffs for use in conservation prioritization modelling, each candidate feature layer was integrated into the 1km x 1km study grid. The initial by-product of this integration resulted in a summary vector grid output for each individual candidate layer. The attribute table of this vector grid contains one row for each grid cell within the grid layer, with a corresponding summary value relating to the feature layer it belongs to. The first step of this process required the creation of a second ESRI file geodatabase in which to hold these summary vector grids, with the resulting grids organised and categorised by data owning organisation.

The method of vector summary grid creation depended primarily upon how each feature layer was to be represented in the modelling process, and secondarily on the format of the layer being summarised. For vector layers where a presence/absence or count representation was required, a spatial join between the feature layer and the 1km x 1km grid was conducted in ArcGIS. For vector layers where a percentage cover or summary statistic (mean, max, or sum) was required, the ‘summarise within’ tool was used in ArcGIS Pro. For data received as raster layers, or where the data were already in the GeoTiff format, the Zonal Statistics tool was used in QGIS.

Regardless of the method in which a data layer was ingested into the summary grid format, the method of transforming this summary grid into a GeoTiff was consistent. The ‘Feature to

Raster' tool within ArcGIS was used to transform each vector summary grid into a GeoTiff with a 1km x 1km cell size.

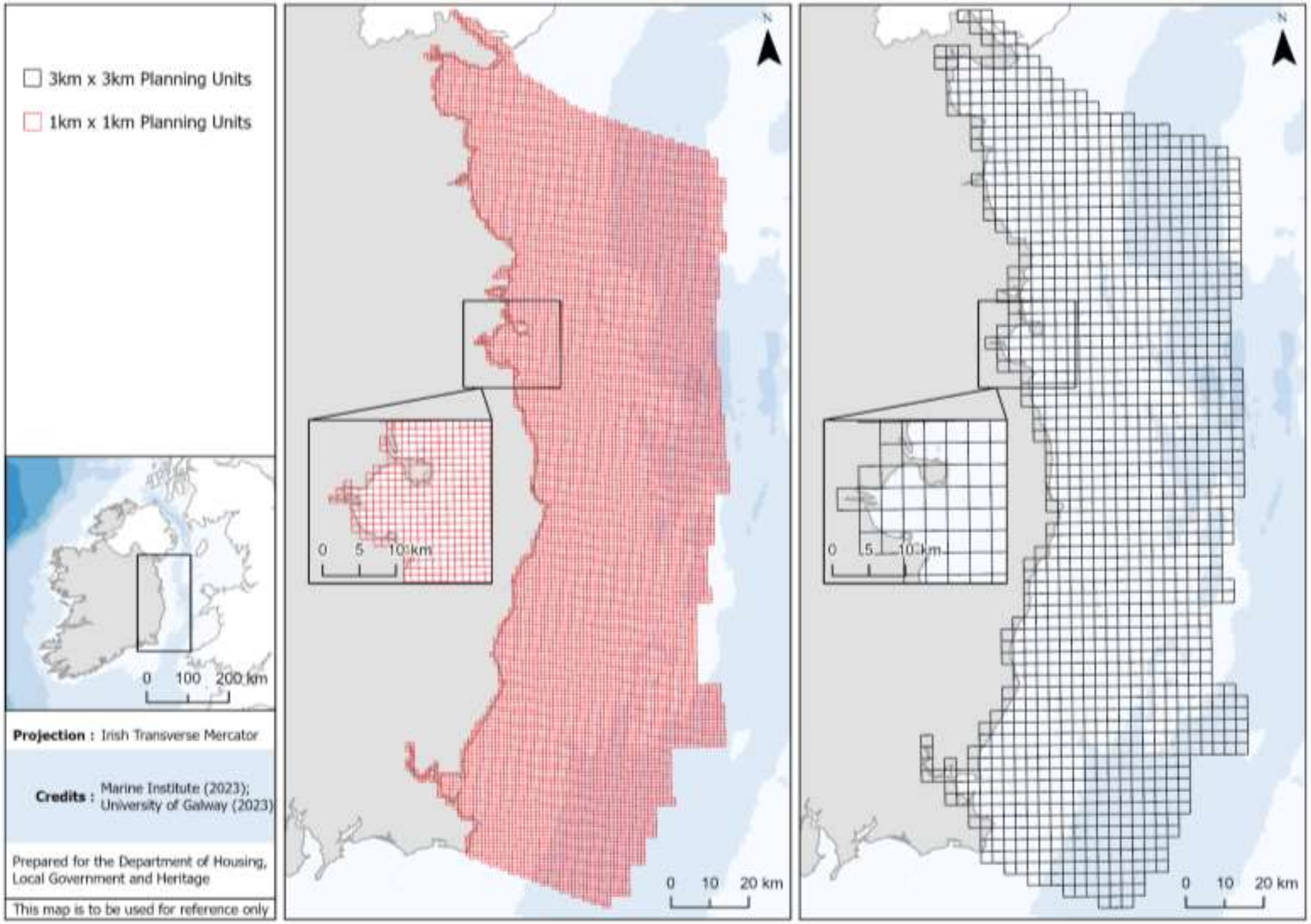

Figure A5b.1.2. Planning unit grid layers, 1 km^2 (left) and 3 km^2 (right).

1.6. Best available evidence and combining data sources

In many cases, features had just one or two available sources of data and the decision of which source to use for conservation prioritization was simple. For other features however, particularly those relating to fisheries, there were many and varied sources of data available. In such situations, the choice of which dataset to use for conservation prioritization was non-trivial as each had different strengths and limitations. Ideally, all the available evidence for each feature would be included in the analysis but combining and re-scaling data from disparate sources is complex. The following section elaborates on these points, outlines the approach taken, including its pros and cons, provides a worked example, and suggests improvements for future work.

Principle of using all available evidence

The quality of output from conservation prioritization modelling is directly linked to the quality of the data input. Ideally therefore all available data that meet a minimum standard should be included. In theory programs like Zonation and *prioritizR* (Hanson et al. 2023) can accept multiple data layers for a given feature but in practice this would require careful consideration of how to set spatial targets for multiple data sources within the one feature. As an example, an elasmobranch species would likely have data available from commercial catches reported from linked logbooks and VMS, discard data from a fisheries observer program, fishery-independent data from a scientific bottom trawl survey, catch and release records from shore anglers, tagging data from a subset of the local angling vessels, location of stranded egg cases from a citizen science program, and possibly local knowledge of juvenile or nursery areas. All these sources are relevant, but they vary widely in their coverage, sampling intensity, spatial accuracy, level of detail, sampling design and interpretability. Using these data separately in conservation prioritization can be problematic as it would involve setting different spatial targets for different datasets related to the same species. For instance, a different spatial target would need to be set for areas where the species is caught in surveys vs. those where it is caught by anglers. To avoid such difficult target setting, a single best data layer could be chosen, or all the layers could be combined into one.

Combining data sources

Combining data sources as disparate as a bottom trawl survey and egg case observations, for example, is difficult but not impossible. The survey has a systematic design, scattered coverage over the whole area of interest, is repeated regularly, and identifies the exact location of the species in question (above a certain size). Citizen science reports of stranded egg cases, while definitely useful, differ in that they are opportunistic, limited to the suitable coastline, and do not pinpoint the exact source i.e., they can be used to prove presence in a general area but not absence.

The simplest way to combine data sources would be a grid of presence/absence, i.e., ‘downgrade’ all sources to presence/absence and use the positive detections (presence) in relation to the conservation prioritization planning grid. Using this method would ensure all data sources are included in conservation prioritization but it would disregard the inherent differences in data quality and result in the loss of key information from data-rich layers such as the density or catch per unit effort. Anything more nuanced would require complicated rescaling between the data layers and would be time-consuming even for the relatively comparable fisheries datasets obtained from different methods or gears. Nevertheless, this has been achieved in other studies. Dedman et al. (2015) used boosted regression trees to combine bottom trawl survey data with environmental variables such as depth, temperature, salinity, and substrate to model hotspots of four ray species in the Irish Sea. The results aligned with stakeholder knowledge. The raster layers were made available to and used in the current conservation prioritization work but performing a similar exercise for other species was not feasible in the timeframe available to the project.

Approach used

Modelled layers were used for the four above-mentioned elasmobranch species. For a limited number of fish species, two data layers were joined using the presence/absence method described above. However, given the time available for the current study, the approach used for most features with multiple viable sources of data was to choose a single most appropriate layer, i.e. the best available evidence. The choice was based on coverage, time-series, spatial accuracy, sampling design, sampling intensity, and expert judgement. The advantages of this approach are that only the highest quality data layer is included and no ‘downgrading’ is required. The disadvantages are that some usable data are excluded and that the chosen dataset may not cover the whole life cycle of the species. For example, commercial fisheries generally target mature fish so logbook-reported catch data would better represent the distribution of adults than juveniles. For this reason, two different data sources for adults and juveniles have been included for certain species, where possible.

The data chosen for each feature for conservation prioritization is outlined in Appendix 8. In some cases, it was not immediately apparent which single data source was the most appropriate to use. Take for instance the commercially fished species that had both survey data (International Bottom Trawl Survey IBTS) and commercial catch data (VMS/logbook) available. The survey has a random stratified design, a long time series, coverage over the whole area of interest, high spatial accuracy, and independence from the distribution of fishing effort. On the other hand, the number of survey hauls each year is relatively limited and sparsely distributed. The VMS/logbook data have far denser coverage than the IBTS data, with fleets of fishing vessels reporting their catch at the end of each trip and their position every two hours during every day at sea. Although it derives from directed fisheries, the catch data for each species are not just from the areas targeted for that species, but also from incidental catches in other areas targeted for other species. So, the bias in the sampling is mitigated to some degree. Also, the VMS/logbook data are not just catch data but are catch per unit effort. As such, there is less concern about the bias towards only protecting the areas that are heavily fished when using VMS/logbook data in conservation prioritization. For this reason, VMS/logbook catch data were chosen as the best available evidence for certain commercially fished species. This decision leads to fewer blank spots on the species distribution map and greatly reduces the amount of interpolation needed.

The choice of dataset for juvenile and forage fish was different. Since the standard trawl used in the IBTS is more selective to smaller fish than the typical commercial trawl, the survey data was deemed more representative of the spatial distribution of juvenile and forage fish. To address the issue of the relatively large distances between survey hauls in some areas, the density was interpolated to fill in the blank areas (i.e., the catch per unit effort was kriged, see case report 23 for more details). The results were checked for consistency with other datasets (commercial catch), other surveys (AFBI acoustic survey) and similar studies (e.g., Ellis et al. 2012).

Species Distribution Models

Species distribution models (SDMs) are "numerical tools that combine observations of species occurrence or abundance with environmental estimates. They are used to gain ecological and evolutionary insights and to predict distributions across landscapes, sometimes requiring extrapolation in space and time" (Elith & Leathwick, 2009). For future studies, SDMs could be used to combine various sources of data and to bridge the gap between where a species has been observed recently and where it could inhabit in theory given the habitat and environmental conditions.

Data sources not used in the current study but could be used in the designation process

Data used in an ecological sensitivity analysis of a large area like the western Irish Sea should ideally be systematically collected without bias, using techniques specific to the feature(s) in question, have intensive coverage, and include repeated observations over a number of years, i.e. high data quality as specified in Table 2.51. It should also have a large spatial footprint, covering the majority of the whole area or the distribution of an individual feature. Through the course of the current study and the stakeholder engagement process, more focused datasets have been put forward that could be extremely useful for the next steps in the process. For example, detailed fishing tracks and catch composition could be provided by the fishing industry at a much finer resolution than the 2-hourly VMS. This could be used at the designation stage when fine-scale data is required to inform exact boundaries and measures. Other examples arising include:

- ORE industry originated ecological datasets from site investigation *etc*.
- Data from the upcoming grid auction
- Future research projects in the area

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Appendix 5c
Stakeholder engagement methodology

Stakeholder engagement is widely recognised as an important part of the decision-making process for MPAs (Day, 2017; Gruby et al., 2016) and is anticipated to be a key feature of Ireland's MPA process under the new MPA legislation. Evaluating the outcomes and analysing different methods can help identify the crucial aspects to consider in designing a process of stakeholder engagement, which can be grouped into three categories: defining the process, defining the methods of participation, and defining the inputs of participation.

Given the constraints of the current project, it was not possible to undertake as extensive a process of stakeholder engagement as would be envisaged under the forthcoming legislation. Nevertheless, in this reduced process, the same rationale influenced the decisions made regarding defining and conducting the stakeholder engagement process. Four steps have been core to this process (Figure A5c.1): (i) inform, (ii) involve, (iii) engage, and (iv) final level of inform [dissemination]. Each of these steps is discussed in detail below.

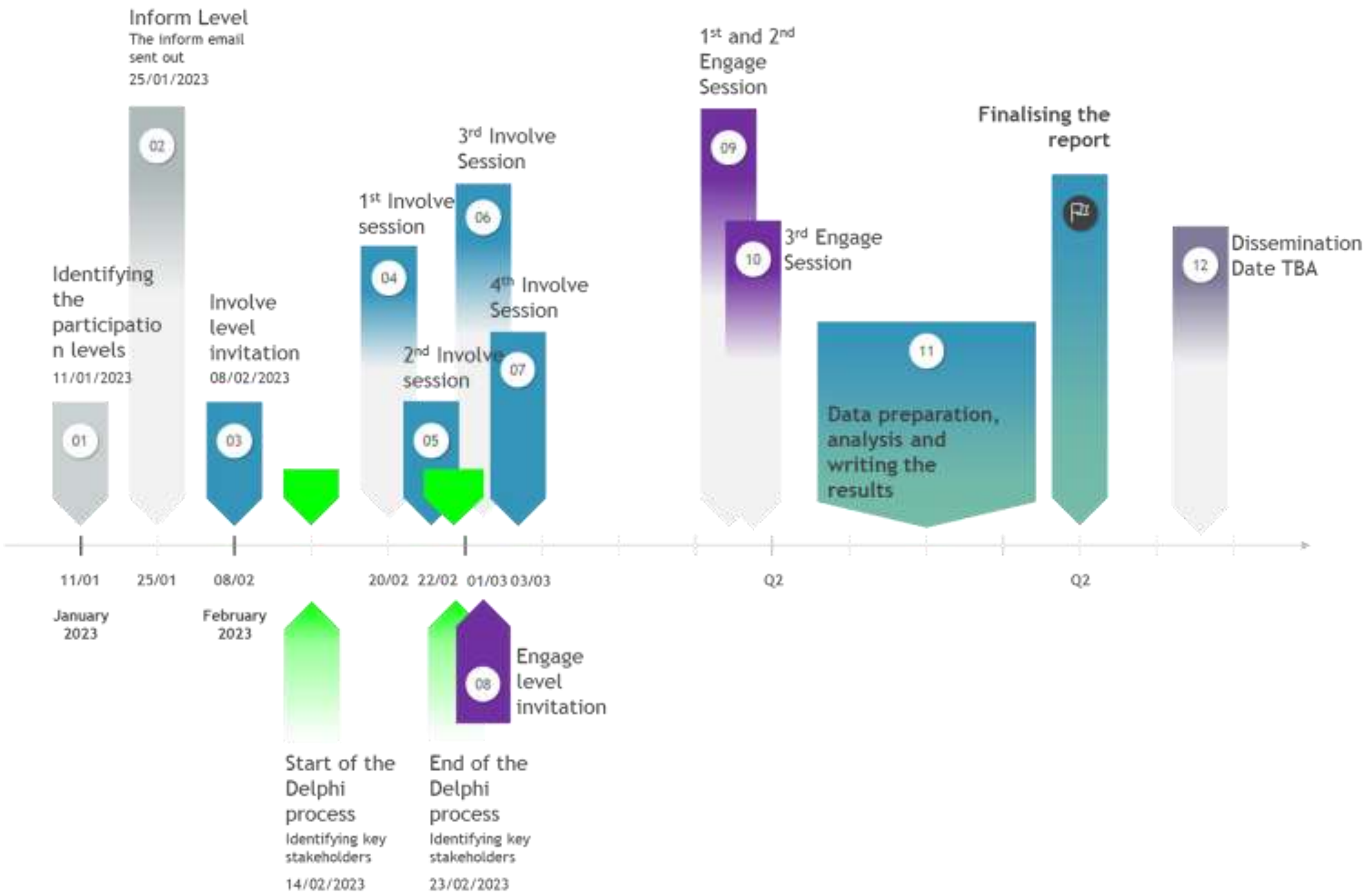

Figure A5c1 - Overview and timeline of the stakeholder engagement process.

The data collected during the Involve and Engage sessions were analysed using thematic analysis to identify the main themes that emerged from the multiple stakeholders who participated in these sessions. Identifying the main themes that emerged from the data, provided insights into the perspectives, experiences, and opinions of the stakeholders who participated. Thematic analysis is a widely used method and involves identifying patterns in qualitative data and grouping them together based on their shared characteristics.

First step of engagement: Inform (Level 1)

The purpose of this level of engagement is to raise awareness about the ongoing project. The informative level provides balanced and objective information to help stakeholders better understand the project. Informing stakeholders about the project's objectives and their respective responsibilities is the crucial first step in encouraging engagement. This fosters trust and prevents misunderstandings among the multiple stakeholder groups, decision-makers, and experts involved. However, the emphasis is often placed on a one-way flow of information - from officials and/or experts to citizens - with no channel provided for feedback or means of raising concerns. Recognizing the significance of delivering informative messages along with a feedback mechanism, an inform process was specifically designed for this project. This process included identifying stakeholders, providing a feedback channel, and developing the content of the message.

Identifying stakeholders

The current project initially relied on existing list of identified stakeholders, which was obtained during the expert advisory analysis of the "Expanding Ireland's Marine Protected Area Network" report in 2019-2020, and the follow up work by the Department of Housing, Local Government and Heritage between 2020 to 2022. The contact points were then updated, and the list was expanded by adding new stakeholder groups, so that the initial information email could be sent to a wider range of stakeholders. On **January 25th, 2023**, the stakeholder participation phase of the project began with the distribution of the information email (Figure A5c.1) to all stakeholders identified for the marine environment of the Irish Sea. This email was sent to a total of **183 contact points** across **109 *stakeholder groups***, including NGOs, industry representatives (such as those in fisheries and energy), government agencies, and recreation sectors (Table A5c.1)

Table A5c.1. Full list of organisations initially informed about the current project.

Pillar	Sector	Organisation
Environment	Irish Environmental NGOs	Irish Environmental Network & Environmental Pillar Coastwatch Birdwatch Ireland An Taisce Native Oyster Reef Restoration Ireland Irish Whale and Dolphin Group Irish Wildlife Trust Purse Search Ireland/Marine Dimensions Sustainable Water Network Change by Degrees

		Friends of the Irish Environment Seas at Risk Fair Seas
Public Sector	Government	Department of The Taoiseach
Public Sector	Foreign Affairs	Department of Foreign Affairs
Public Sector	Built & Natural Heritage	The Heritage Council
Public Sector	The Heritage Council	An Bord Pleanála
Public Sector	Planning & Water	Department of Housing, Local Govt and Heritage European Parliament PECH committee
Public Sector	Renewable Energy	Sustainable Energy Authority of Ireland (SEAI)
Public Sector	Food	Bord Bia Food Safety Authority of Ireland
Public Sector	Nature conservation & biodiversity	National Parks and Wildlife Service - NPWS
Public Sector	Local Government	County and City Management Association Dublin Bay Biosphere Partnership (c/o Dublin City Council) Kerry County Council Dublin City Council Wexford County Council Waterford Council Cork County Council Donegal County Council Mayo County Council Galway City Leitrim County Council Sligo County Council Meath County Council Galway County Council Limerick County Council Clare County Council Louth County Council Fingal County Council Dún Laoghaire-Rathdown County Council
Public Sector	Gaeltacht development & community support	Údarás na Gaeltachta
Public Sector	Marine Research & Innovation	Marine Institute
Public Sector	Sea Fisheries & Aquaculture	Bord Iascaigh Mhara Sea Fisheries Protection Agency Department of Agriculture, Food and the Marine
Public Sector	Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media	DCHG Islands Team (leading new Interdepartmental Committee on Island Development)

Public Sector	Coastal and island heritage & culture	Office of Public Works
Public Sector	Nautical Survey	Department of Transport, Tourism & Sport
Public Sector	Irish Coast Guard	Department of Transport, Tourism & Sport
Public Sector	Environment	Department of Communications, Climate Action & Environment
Public Sector	Defence	Department of Defence, Aviation & Maritime Unit
Public Sector	Fisheries protection/enforcement	Irish Naval Service
Public Sector	Environmental Protection	Environmental Protection Agency
Public Sector	Maritime navigation	Commissioners of Irish Lights
Economic / Industrial	Business/Employers	Irish Business and Employers Confederation
Economic / Industrial	Ports/Shipping	Irish Ports Association
Economic / Industrial	Maritime development	Irish Maritime Development Office
Economic / Industrial	Marine Leisure / Marina Operators	Irish Marine Federation
Economic / Industrial	Electricity – Grid development	EirGrid
Economic / Industrial	Energy – Petroleum	Irish Offshore Operators Association
Economic / Industrial	Energy – Renewables	Marine Renewables Industry Association National Offshore Wind Association of Ireland Irish Wind Energy Association
Economic / Industrial	Fisheries – inshore - vessels under 12m	National Inshore Fishermen's Association
Economic / Industrial	Fisheries – inshore - vessels over 12m	National Inshore Fishermen's Forum
Economic / Industrial	Regional Inshore Fisheries Forums	North North West West South West South East North East
Economic / Industrial	Fisheries - Islands	Irish Islands Marine Resources Organisation
Economic / Industrial	Fisheries – Sea Fishing	Killybegs Fishermen’s Organisation Irish South and West Fish Producers

		Organisation Irish South and East Fish Producers Organisation North Western Waters Advisory Committee Irish Fish Processors and Exporters Association Irish Fish Producers Organisation Clogherhead Co-op
Economic / Industrial	Sea angling	Inland Fisheries Ireland Sea Angling Ireland Irish Charter Skipper Association Irish Federation of Sea Anglers
Economic / Industrial	Aquaculture	Irish Farmers Association Aquaculture Section Irish Native Oyster Fisheries Forum
Economic / Industrial	Tourism & Sport	Irish Tourism Industry Confederation Federation of Irish Sport Irish Sailing Association Irish Underwater Council Seasearch Ireland Irish Association for Adventure Tourism Irish Surfing Association
Economic / Industrial	Seaweed Harvesting	Coiste Chearta Cladaí Chonamara
Economic / Industrial	Seaweed Processing	*Ascophyllum nodosum* Processors Group
Economic / Industrial	Island Communities	Comhdháil Oileáin na hÉireann/ Irish Islands Federation
Social & Economic development	Sustainable Development	National Economic and Social Council
Social & Economic development	Enterprise and Innovation	Enterprise Ireland
Public Sector	Public Participation Network	Dublin City PPN Dun Laoghaire Rathdowne PPN Fingal PPN Louth PPN Meath PPN South Dublin County PPN Wexford PPN

Feedback channel

To transfer the informing process to an interactive level of participation, an online platform was utilized to collect feedback and potential questions. The platform of choice for this purpose was Google Forms, which was made available to stakeholders for accessing and providing their valuable feedback and queries. The decision on how to respond to the feedback and questions was primarily based on the volume of interactions received. If a high volume of responses was received, a Frequently Asked Questions (FAQ) list would have been provided. However, given that only a few responses were received, individual responses were sent directly to the stakeholders.

Developing the content of the message

The informing message was drafted with care by consulting experts from the MPA Advisory Group to ensure that it covered key aspects, including:

• Clearly stating the objective of the project, titled "Ecological Sensitivity Analysis to Identify Potential MPAs in the Irish Sea"

• Differentiating the current project from the legislation process of the MPAs

• Providing an understanding of the limitations of the project

• Offering a feedback channel via a link to the provided Google Form

See Figure A5c.2 for more details.

Dear Sir/Madam,

As a stakeholder in the marine environment of the Irish Sea, I am contacting you on behalf of an independent expert advisory group on marine protected areas (MPAs) recently established by the Minister for Housing, Local Government and Heritage. The group, for which I am the Chair, comprises a subset of relevant scientific experts from the MPA advisory group whose 2020 report provided recommendations on expanding Ireland's MPA network and underwent a public consultation process in 2021.

The objective of the project

the limitations of the project

We have been asked to undertake an ecological sensitivity analysis of the western Irish Sea in order to identify where potential MPAs may be merited in the region. This is intended to inform future maritime management decisions in the region as relevant, including the spatial planning of sectoral activity, particularly relating to Offshore Renewable Energy (ORE). Our report will be based on sensitivity analyses and conservation prioritization procedures for selected features of recognised value. The scientific evidence base for our conclusions will be fully transparent. The final report is due at the end of April and will be made publicly available. Although we will consult with a few key stakeholders, comprehensive engagement will not be possible within this time frame.

Differentiating the current project from the

Please note that the independent analytical work of our group will be an initial scientific and ecological screening exercise, and it will not lead directly to the selection and legal designation of MPAs. In the latter context, the General Scheme of the Marine Protected Areas Bill is currently before the Oireachtas and work has begun on drafting the Bill. It is hoped that legislation will come into force later this year. When that happens, a full MPA identification and designation process will be undertaken based on the provisions of the legislation. Under the General Scheme of the Bill, that process is designed to involve a comprehensive programme of public and stakeholder engagement and participation in the selection, design and delivery of Ireland's MPAs.

Offering a feedback

If you have any general questions on the work of this group, please post them via this link before 13 Feb. The answers to frequently asked questions will be circulated within two weeks of this date. We will run a wide dissemination event at the end of this Irish Sea project, to which you and numerous other stakeholders will be invited.

Figure A5c2 Content of the inform message sent to stakeholders

Second step of engagement: Involve (Level 2)

The involve level of participation provides an opportunity to stakeholders to share information, data, ideas and concerns. Due to time constraints and the primarily scientific objectives of the project, it was neither possible nor central to involve all stakeholders and the public. However, the team decided to discuss the project with key stakeholders in the government and agencies to address concerns and incorporate aspirations into the project while asking for related data and information.

Therefore, the involve level was designed to first facilitate open and constructive engagement with key Government and agencies stakeholders that have extensive maritime interests in the Irish Sea in order to integrate their participation and consider their interests as part of the processes within the project, and second, to exchange information and data for evidence-based decisions for potential MPA blocks.

Designing the involve level of stakeholder participation included several key steps, such as identifying all relevant stakeholders and carefully designing the process and structure of each session to ensure active engagement. These steps are discussed in the following sections.

Identifying stakeholders

For this particular level of participation, the team had made a strategic decision to engage with government and agency groups. The main goal behind this decision is to exchange crucial data and information with relevant stakeholders. However, it is important to note that non-governmental stakeholders were not included in this level of participation. This decision was made based on various factors, such as the nature of the project, the level of data sensitivity involved, and the specific expertise required. It is worth noting that while non-governmental stakeholders were not included at this level of participation, they had opportunities to engage with the project at other levels.

To identify the relevant stakeholders within the government and agency groups, the team conducted a comprehensive analysis of the initial list of stakeholders that were identified during the inform level. To ensure that we engaged with the most relevant stakeholders, we carefully considered each group's mandate, area of expertise, and relevance to the project. Through this process, we were able to identify over **130 points of contact** across **22 groups** (Table A5c.2).

Table A5c.2 . List of government departments and agencies included in the Involve step.

Departments	Agencies
Department of Tourism, Culture, Arts, Gaeltacht, Sport and Media	The Heritage Council
Department of Rural and Community Development	An Bord Pleanála
Department of Environment, Climate and Communications	Sustainable Energy Authority of Ireland

Department of Defence	Bord Bia
Department of Agriculture, Food and the Marine	Office of Public Works
Department of Housing, Local Govt and Heritage	An Bord Iascaigh Mhara
Department of Foreign Affairs	Sea Fisheries Protection Authority
Department of the Taoiseach	Inland Fisheries Ireland
Department of Transport	Environmental Protection Agency
	National Parks & Wildlife Service
	Marine Institute
	Commissioners of Irish Lights

Design of the process

The "involve sessions" were designed in the format of a focus group to allow the team to present the aim, methods, and potential outcomes of the ecological sensitivity analysis project, and to provide opportunities for participants to discuss, raise questions, and provide feedback. A PowerPoint presentation was prepared for these sessions to provide an overview of the project. The duration of each Involve Session was an hour and a half, which was divided into three parts. Firstly, there was a 10–20-minute introduction where participants from both stakeholder groups and the team would introduce themselves. Secondly, there was a 20–25-minute presentation where the chair of the MPA advisory group presented the prepared presentation. The presentation began with an introduction to the team and an outline of the project objectives, emphasizing the distinction between this project and the full MPA selection process. The spatial boundaries of the project were discussed, along with the methodology and steps for completion of the work. Key terms such as "ecological sensitivity analysis" and "conservation prioritization" were explained. The presentation also explained stakeholder participation in the project and illustrated potential outcomes. The presentation concluded by emphasizing the importance of stakeholder engagement in achieving project objectives.

Following the presentation, the remaining session was intended to foster mutual discussion among participants for 45-60 minutes. This provided an opportunity for all participants to share their unique perspectives, concerns, ideas, and recommendations related to the project. It also allowed participants to ask questions, clarify any doubts, and engage in productive dialogue with other stakeholders. This interactive approach aimed to facilitate a deeper understanding of the work and encourage constructive collaboration among the participants.

Table A5c.3. Summary of the four involve sessions

Session Number	One	Two	Three	Four
Participants' groups	A representative from DECC A representative from DHLGH	DHLGH DAFM BIM DECC	IFI Heritage Council	DHLGH EPA DoT An Bord Pleanála DECC Fingal Co.Co CIL
Members of the team	Tasman Crowe (Chair), Elgar Kamjou (UCD), Andrew Conway (MI), Kellie Heney (MI), Oliver Ó Cadhla (DHLGH)	Tasman Crowe (Chair), Elgar Kamjou (UCD), Danielle Orell (UCC), Patricia Breen, Andrew Conway, Kellie Heney (MI), Oliver Ó Cadhla (DHLGH)	Tasman Crowe (Chair), Elgar Kamjou (UCD), Andrew Conway (MI), Kellie Heney (MI), Oliver Ó Cadhla (DHLGH)	Tasman Crowe (Chair), Elgar Kamjou (UCD), Cormac Nolan, Patricia Breen, Andrew Conway, Kellie Heney (MI), Oliver Ó Cadhla (DHLGH)
Overall Number of Participants	7	21	8	16

The team designed four Involve Sessions after considering the potential number of participants, the contacted groups, and the project timeline (Table A5c.3). Two of these sessions were held in person while the other two were conducted remotely through Zoom. The goal of this approach was to provide participants with both face-to-face meetings and the flexibility to participate remotely, based on their individual preferences and needs. Each session had a maximum of 15 participants.

The two in-person sessions were held at a central location in Dublin, which was easily accessible for all participants. The team ensured that the venue was well-equipped with all the necessary resources, including projectors, and whiteboards. Arrangements for refreshments were in place to ensure that participants could stay energized and focused throughout the sessions. For the remote sessions, the team selected Zoom as it is a reliable and user-friendly online platform that could accommodate a large number of participants. They conducted several tests and trials to ensure that the platform was working smoothly and that all participants could access the sessions without any technical difficulties.

During the planning stage, the team invested significant effort into selecting the most suitable dates and times for each Involve Session. However, due to the demanding timeline of the project, it was not feasible to provide the desired four-week gap between the invitation and the first session. Nonetheless, the team was committed to ensuring a minimum of two weeks between the two events.

On February 8th, 2023, the team sent out the invitation link to all stakeholders identified for the Involve sessions. In addition to the invitation link, a Doodle poll link was provided to take into account the availability of participants. The team used the responses received through the poll to allocate participants to each Involve Session, which were subsequently recorded in Table A5c.4 and A5c.5.

Table. A5c.4. Time, date and type of each involve session

Session Number	**One**	**Two**	**Three**	**Four**
Date	Feb 20	Feb 22	March 1	March 3
Type	In-Person	Zoom	In-person	Zoom
Time	10:30 – 12:00	3:00 – 4:30	11:00 – 12:30	2:00 – 3:30

Initially 35 participants responded to the Doodle Poll out of which 25 in total participated in Involve Sessions, see table below.

Table A5c.5 Detail list of participants in four involve sessions

	February 2023				March 2023			
	Mon 20		Wed 22		Wed 1		Fri 3	
	10:30 AM - 12:00 PM	Attendance	03:00 PM - 04:30 PM	Attendance	11:00 AM - 12:30 PM	Attendance	02:00 PM - 03:30 PM	Attendance
Commissioners of Irish Lights							YES	YES
Decc			YES	YES				
BIM			YES	YES				
BIM			YES	YES				
BIM				YES				
BIM				YES				
BIM				YES			YES	No
BIM			YES	YES			YES	No
BIM			YES	YES			YES	No
Inland Fisheries Ireland					YES	YES		
DAFM			IF NEED BE	No			IF NEED BE	No
DHLGH			IF NEED BE	No			YES	YES
DAFM			YES	YES				
BIM			YES	YES				
Fingal Co co							YES	YES
Heritage Council					YES	YES		
EPA							YES	YES
Dfa							YES	No
DECC							YES	No
DAFM			YES	No				
DoT							YES	No
Inland Fisheries Ireland					YES	YES		
DoT							YES	YES
DHLGH			YES	YES				
DECC			YES	YES				
DHLGH	YES	YES						
DECC					YES	No		
DECC	YES	YES					YES	YES
DECC			YES	YES				
Heritage Council	YES	No	YES	No				
Pleanala								YES
DECC	YES							
Taoiseach					YES	No	YES	No
Inland Fisheries Ireland					YES	No		
DAFM			YES	YES				
Defence								
EPA							YES	No

Third step of engagement: Engage (Level 3)

The aim of this level of participation was to listen to and acknowledge the responses and concerns of non-governmental stakeholders so that they could be taken into account in preparing the report. As discussed earlier, meaningful engagement with all identified stakeholders was not possible due to project constraints. However, the team decided to engage with key stakeholders at this level. Note that all stakeholders, regardless of being identified as key stakeholders or not, were contacted at the inform level and will also be contacted for the later level of participation called 'dissemination'. This level of participation involved several steps, including identifying key stakeholders and designing a process, which will be explained below.

Identifying key stakeholders

In stakeholder engagement, selecting key stakeholders from a long list of stakeholders is an important step in the process. To ensure a systematic and inclusive approach, the team employed the Delphi Method, a decision-making tool commonly used in policy development and complex decision-making. It is a structured process that involves gathering a panel of experts and engaging them in several rounds of anonymous questioning to make decisions or solve complex problems. The method allows for honest and unbiased input from experts while minimizing biases that may arise in live discussions. The Delphi process typically includes multiple rounds, with facilitators reviewing and sorting through the answers after each round, identifying common themes, and circulating the results for further input and adjustment by the experts.

The application of the Delphi method requires several steps. The first step is to identify experts with different backgrounds. The size of the Delphi panel can vary, but it is usually between four to twelve experts. For this project, nine experts were identified, six of whom were part of the advisory group, and three were external experts. The next step was to prepare and distribute the materials, which included the goal of the study, ethical procedural guidelines, instructions, timeframe, and deadline. The materials were distributed to the experts and the first round started by February 21st. Out of the nine experts, five participated in the Delphi process. The final decision was made by February 23rd through a live Delphi process.

The experts were asked to evaluate a list of stakeholders based on five predefined criteria. These criteria were used as a framework to identify the stakeholders who might be impacted the most by this project, their direct interest in the western Irish Sea, their potential to provide an important perspective at this stage, the need to engage with them to build trust for MPA designation in the near future, and overall identification as a key stakeholder in the project.

The experts were provided with a list of stakeholders and a brief description of each stakeholder as Delphi material. The experts were then asked to answer each of the five questions using a predefined numeric scale. The first round of the Delphi process resulted in the identification of 21 groups of stakeholders as key stakeholders. Additionally, there was a consensus among experts in excluding 26 of the stakeholders for the current level of participation. However, the team was uncertain about 20 other stakeholders.

In the second round of the Delphi process, the experts revisited both the uncertain and excluded groups. As a result, 16 more stakeholders were identified as key stakeholders, bringing the total number of key stakeholders to 37 groups. This iterative process was continued until a consensus was reached among the experts and a final list of groups of key stakeholders for this project was identified (Table A5c.6).

Table A5c.6 List of identified key stakeholders through the Delphi Process

Type	Organisation	Type	Organisation
Consultant	Native Oyster Reef Restoration Ireland (NORRI)	Energy	Irish Wind Energy Association (WEI) – Renewable
Consultant	Purse Search Ireland/Marine Dimensions	Energy	EirGrid – Electricity grid development
Economy / Industry	Regional Inshore Fisheries Forums – South East	Energy	Irish Offshore Operators Association (IOOA) – Energy petroleum
Economy / Industry	Regional Inshore Fisheries Forums – North East	Local Authorities	Dublin Bay Biosphere Partnership (c/o Dublin City Council)
Economy / Industry	Irish South and East Fish Producers Organisation (IS&EFPO) – Sea fishing	Local Authorities	County and City Management Association (CCMA)
Economy / Industry	National Inshore Fisherman's Forum	NGO	Irish Environmental NGOs - Environmental pillar
Economy / Industry	Irish Fish Producers Organisation (IFPO) – Sea fishing	NGO	Birdwatch
Economy / Industry	Inland Fisheries Ireland (IFi) – Sea angling	NGO	Irish Whale and Dolphin Group
Economy / Industry	Clogherhead Co-op	NGO	Irish Wildlife Trust
Economy / Industry	Irish Fish Processors and Exporters Association (IFPEA)	NGO	Fair Seas
Economy / Industry	Irish Maritime Development Office (IMDO)	NGO	Sustainable Water Network (SWAN)
Economy / Industry	Irish Marine Federation (IMF) – Marine Leisure / Marina Operators	NGO	Coastwatch
Economy / Industry	Killybegs Fishermen’s Organisation (KFO) – Sea fishing	NGO	An Taisce
Economy /	Sea Angling Ireland	Sports and	Irish Charter Skipper

Industry		tourism	Association – Sea angling
Economy / Industry	Irish Farmers' Association (IFA) – Aquaculture Committee	Sports and tourism	Irish Federation of Sea Anglers (IFSA)
Economy / Industry	Irish South and West Fish Producers Organisation (IS&WFPO) – Sea fishing	Sports and tourism	Seasearch Ireland
Energy	Marine Renewables Industry Association (MRIA) – Renewable	Sports and tourism	Federation of Irish Sport (FIS)
Energy	National Offshore Wind Association of Ireland (NOW Ireland) – Renewable	Sports and tourism	Irish Sailing Association

Designed process

The engage level was structured as a focus group, with the aim of presenting the ecological sensitivity analysis project's purpose, methods, and potential outcomes to key stakeholders. This provided an opportunity for key stakeholders to discuss their concerns, raise questions and provide feedback. The sessions, like the involve level sessions, began with a brief introduction, followed by a presentation and discussion.

To ensure effective communication and clear objectives for each session, these sessions were led by a facilitator. The session began with a discussion of the purpose and agenda by the facilitator, followed by 20-30 minutes of introduction where participants from both stakeholder groups and the team would introduce themselves and indicated what would make the session 'good' for them.

Following the introduction, the chair of the expert advisory group delivered a brief presentation using PowerPoint slides. The presentation introduced the team, highlighted the importance of the project, discussed the project's drivers, objectives, key points to remember, spatial boundaries, and the process involved. Special attention was given to explaining scientific terminologies such as "ecological sensitivity analysis" and "prioritization", and the stakeholders' participation process was also discussed. The presentation was designed to last 20-30 minutes.

The remainder of the session, which lasted 60-90 minutes, was led by the facilitator. Specific questions were posed to the stakeholders to better understand their vision for Ireland's marine environment and the Irish Sea within it, what they liked about the project, their concerns about the project, and how they could help the team now and in the future. Comments and feedback from stakeholders were also welcomed during the discussion time.

The team carefully considered the potential number of participants, the contacted groups, and the project timeline while designing the engage sessions. They ensured that all sessions were held in person with a maximum of 20 participants at a central location in Dublin. The venue was well-equipped with projectors and whiteboards, and arrangements for refreshments were in place to keep the participants energized and focused.

The team put in significant effort to select the most suitable dates and times for each engage session and ensured a minimum of three weeks between the invitation and the first session. On March 2nd, 2023, the team sent out the invitation link to all stakeholders, along with a Doodle poll link to consider their availability. Using the responses received through the poll, the team allocated participants to each Engage Session and recorded them in Table A5c.7 and Table A5c.8. The goal was to provide participants with face-to-face meeting opportunities and engage them in the project effectively. Careful consideration was given to assigning participants to each session to ensure gender balance and a diverse representation from various groups, including fisheries, local authorities, the energy sector, and NGOs.

Table. A5c.7. Summary of the four engage sessions

Session Number	**One**	**Two**	**Three**
Participants' groups	Sea Angling Ireland (SAI) Regional Inshore Fisheries Forums – South East (RIFF)	Fingal County Council (F. CoCo) Native Oyster Restoration, (NORI) Coastwatch (CW) Wind Energy Ireland (WEI) Irish Wildlife Trust (IWT) Irish Marine Federation (IMF) Irish South and East Fish Producers Organisation (ISEPO) Irish Farmers' Association (IFA)	Killybegs Fishermens' Organisation (KFO) Dublin County Council (D. CoCo) Irish Fish Producers Organisation (IFPO) An Taisce (AT) Fairseas (FS) Inland Fisheries Ireland (IFI) EirGrid (EG)
Members of the team	Tasman Crowe (Chair) Elgar Kamjou (UCD) Macdara Molloy (UCD) Oliver Tully (MI) Andrew Conway (MI) Patricia breen (MI) Kellie Heney (MI) Denise O'Sullivan (MI) Oliver Ó Cadhla (DHLGH)	Tasman Crowe (Chair) Elgar Kamjou (UCD) Macdara Molloy (UCD) Oliver Tully (MI) Andrew Conway (MI) Patricia breen (MI) Kellie Heney (MI) Denise O'Sullivan (MI) Oliver Ó Cadhla (DHLGH)	Tasman Crowe (Chair) Elgar Kamjou (UCD) Andrew Conway (MI) Cormac Nolan (MI) Denise O'Sullivan (MI) Oliver Ó Cadhla (DHLGH)
Facilitator	Padraig Ó Máille	Padraig Ó Máille	Padraig Ó Máille
Overall Number of Participants	12	19	14

Out of 37 groups, 26 responded to the invitation email. Out of which 18 attended to the meetings, see table below for more details.

Table A5c.8 Detail list of participants in four engage sessions

	March 2023					
	Thu 23				Fri 24	
	10:30 AM - 12:30 PM	Attendance	02:00 PM - 04:00 PM	Attendance	10:30 AM - 12:30 PM	Attendance
Wind Energy Ireland (WEI)			YES	YES		
EirGrid (EG)					YES	YES
Fisheries Ireland (FI)					YES	YES
Irish South and East Fish Producers Organisation (ISEPO)			YES	YES		
Clogherhead Co-op	YES	No				
Native Oyster Reef Restoration Ireland (NORRI)	YES	No				
CoastWatch (CW)			YES	YES		
Birds Watch Ireland (BWI)					YES	No
Dublin County Council (D. CoCo)					YES	YES
Killybegs Fishermens' Organisation (KFO)					YES	YES
Sea Angling Ireland (SAI)	YES	YES				
Irish Offshore Operators Association (IOOA) - Energy petroleum					YES	No
Regional Inshore Fisheries Forums - South East (RIFF)	YES	YES				
Irish Farmers' Association (IFA)			YES	YES		
Fairseas (FS)			YES	No		
An Taisce (AT)	YES	No			YES	YES
Irish Marine Federation (IMF)			YES	YES		
Native Oyster Reef Restoration Ireland (NORRI)			YES	YES		
Irish Environmental NGOs - Environmental pillar (IEN)					YES	No
Fingal County Council (F. CoCo)			YES	YES		
dlr County Council (F. CoCo)					YES	No
Irish Wildlife Trust (IWT)			YES	YES		
Irish Whale and Dolphin Group (IWDG)					YES	No
EirGrid (EG)	YES	No				
Fairseas (FS)	YES	No			YES	YES
Irish Fish Producers Organisation (IFPO)	YES	No			YES	YES

Fourth step of engagement: Dissemination (Level 4)

As previously discussed, the team plans to share the outcomes of the project with all relevant stakeholders through an online webinar as well as through the report itself. The specifics of the session are still being finalized. Nonetheless, the event will be open to all stakeholders and individuals who have an interest in this subject.

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Appendix 5d
Sensitivity analysis methodology

1.1. What is sensitivity analysis?

Ecological sensitivity analysis is a methodology used to determine the degree to which a species, habitat or other feature is affected by specific pressures resulting from human activities. Sensitivity is determined by the capacity of the feature to remain unchanged under the influence of the pressure (termed resistance) and, if changed, the amount of time needed for a full recovery once the activity has stopped (termed resilience). See Table A5d.1 for definitions. A feature that is easily damaged has low resistance and if it takes a long time to recover, has low resilience. Ultimately, if a feature is not sensitive to the pressures associated with an activity, that activity is not incompatible with conservation of that feature; if there is a high degree of sensitivity of a feature to an activity in an area designated for it, management measures are needed to prevent damage by that activity to that feature.

The sensitivity assessment process involves a systematic review of the literature for each feature (see Section 1.3 below, Step 1). Best available evidence is compiled relating to the influence on the feature of each pressure exerted by each relevant activity above the pressure benchmark (Tyler-Walters et al. 2018; Table A5d.2). The process also includes an assessment of the quality of the evidence on which the derived sensitivity scores are based (Section 1.3 below, Step 6).

Table A5d.1 Definition of sensitivity and associated terms (directly from Tillin et al., 2010; Tyler-Walters et al., 2018).

Term	Definition	Sources
Sensitivity	The likelihood of change when a pressure is applied to a feature and is a function of the ability of the feature to tolerate or resist change (resistance) and its ability to recover from impact (resilience).	Tillin et al. (2010), Tillin & Hull (2003), Tillin & Tyler-Walters (2014 a & b)
Resistance	The degree to which a feature can absorb disturbance or stress without changing character	Holling (1973)
Resilience	The ability of a system to recover from disturbance or stress	Holling (1973)
Vulnerability	Vulnerability is a measure of the degree of exposure of a feature to a pressure to which it is sensitive.	Based on Hiscock (1996), Oakwood Environmental Ltd (2002)
Pressure	The mechanism through which an activity affects any part of the ecosystem'. The nature of the pressure is determined by activity, type, intensity and distribution.	Robinson et al. (2008)
Pressure benchmark	The standard descriptor of the pressure is defined in terms of the magnitude, extent, duration, and frequency of the effect. Benchmarks may be quantitative or qualitative	Tyler-Walters et al. (2001)
Impact	The effects (or consequences) of pressure on a component.	Robinson et al. (2008)
Exposure	The action of pressure on a feature, concerning the extent, magnitude and duration of the	Robinson et al. (2008)

	pressure.	

1.2. Selection of focal sectors of activity and associated pressures

Here, this analysis was used to determine the environmental sensitivity to the three sectors most relevant to the current study with its focus on ORE in the western Irish Sea: commercial fishing, shipping, and ORE itself. These sectors include a range of specific activities which impose one or more pressures on the marine environment. For example, the fishing sector engages in benthic trawling which causes abrasion across the sea floor, and this pressure can vary in intensity and spatial distribution. The 'impact' of this pressure can be the removal of species (or multiple species) and habitat change or loss. A pressure can be physical, chemical or biological, and different pressures can have similar impacts. For instance, fixed bottom turbine construction in ORE will include some abrasion during site preparation and cable laying activities.

A standard list of anthropogenic pressures as set out under OSPAR and refined by Robinson et al. (2008) was adapted for use in this report. From this comprehensive list, some pressures were removed owing to their limited relevance to the commercial fishing, shipping or ORE sectors. The first step in this sensitivity process involved the production of a pressure-sector matrix, summarising which pressures associated with each focal sector of activity (Table A5d.2a).

Table A5d.2a. A matrix of pressures associated with sectors (ORE, fishing, and shipping) and sub-sector activities (different types of fishing or aspects of ORE activity or infrastructure). All pressures potentially associated with each sector/sub-sector are indicated. It is recognised that not all pressures are applied by all forms of each sector. This would be taken into account in the MPA process itself, through more detailed analysis and stakeholder engagement (and see Section 4 for discussion).

Pressures		Sector and sub-sector activity							
Classification	**Pressure type**	**ORE construction**	**ORE operation (cables)**	**ORE operation (turbines)**	**Fishing: bottom trawling**	**Fishing: dredge and beam trawling**	**Fishing: pelagic trawling**	**Fishing: static gear**	**Shipping**
Hydrological	**Water flow changes**			x					
Chemical	**Transition elements & organo-metal contamination**	x		x	x	x	x	x	x
	Hydrocarbon & PAH contamination	x		x	x	x	x	x	x
	Synthetic compound contamination	x		x	x	x	x	x	x
	Introduction of other substances			x	x	x	x	x	x
	De-oxygenation		x						
Physical	**Physical loss (to land or freshwater habitat)**	x							
	Physical change (to another seabed type)	x	x	x	x	x			
	Physical change (to another sediment type)	x	x	x	x	x			

	Habitat structure change-removal of substratum (extraction)	x	x	x					
	Abrasion/disturbance of substratum surface or seabed	x			x	x	x	x	
	Penetration or disturbance of substratum subsurface	x				x			
	Changes in suspended solids (water clarity)	x	x	x	x	x	x	x	
	Smothering and siltation changes (light)	x							
	Smothering and siltation changes (heavy)	x							
	Electromagnetic energy		x	x					
	Underwater noise	x	x	x	x	x	x	x	x
	Barrier to species movement		x	x				x	
	Death or injury by collision	x		x	x	x	x	x	x
Biological	**Introduction or**	x	x	x	x	x	x		x

	spread of invasive non-indigenous species								
	Removal of target species				x	x	x	x	
	Removal of non-target species				x	x	x	x	

Table A5d.2b. Explanatory notes for the sectors and sub-sector activities in Table A5d.1.2a. ORE refers to offshore renewable energy, and in this context, this report only relates to monopile offshore wind turbines.

Sector	Description of sector and clarification of pressures
ORE construction	Construction of offshore wind turbines and activities related to this including dredging, aggregate extraction, seabed levelling, laying subsea cables, monopile insertion, and turbine installation.
ORE operation (cables)	Offshore wind turbine cabling includes array cables that link each wind turbine, cables that link the wind turbine to offshore electrical platforms, interconnector cables that can also link offshore electrical platforms, and the cable corridor of offshore export cables connecting and transferring power from the offshore platform to land. Cables can require repair and re-burial.
ORE operation (turbines)	Operation of offshore wind turbines, including routine inspections, cleaning, and repairs that likely occur a few times a year.
Fishing: bottom trawling	Fishing activity using mobile bottom-contacting gears causing surface abrasion of the seabed (i.e. physical disturbance or abrasion of the substratum surface in sedimentary or rocky habitats) including bottom otter trawls and demersal seines. See ICES (2021) for full description of surface abrasion swept area ratio calculation.
Fishing: dredge and beam trawling	Fishing activity using mobile bottom-contacting gears causing sub-surface abrasion to the seabed, including scallop dredging and beam trawling. Some elements of bottom otter trawls are included also, see ICES (2021) for full description of subsurface abrasion swept area ratio calculation.
Fishing: pelagic trawling	Fishing activity using mobile pelagic gears including pelagic mid-water trawls, pair trawls, purse seines etc.
Fishing: static gear	Fishing activity using static fishing gears including gill nets, trammel nets, lines, and pots.
Shipping	Includes shipping in industrial sectors such as oil and gas and container shipping (as in Crowe et al. 2011)

1.3. The Marine Evidenced-based Sensitivity Assessment Protocol

The Marine Evidence-based Sensitivity Assessment (MaRESA) methodology was developed by the Marine Life Information Network (MarLIN) group based at the Marine Biological Association of the United Kingdom. The MaRESA methodology provides a transparent, repeatable systematic exercise to identify, compile and assess the best available scientific evidence to assess the sensitivity of a feature to pressures. Central to the MaRESA approach is providing an audit trail to evidence each assessment, which makes it replicable, with the potential for an update when new evidence is available.

The MaRESA protocol involves eight steps (full details in Tyler-Walters et al. 2018):

Step 1. Conduct a systematic search of the literature to identify available evidence. A Rapid Evidence Assessment (REA) approach is used to identify a list of keywords and search terms to identify the ecology of a feature and its key elements. The review is time limited (1-2 days) and identified from literature search engines including, but not limited to, the National Marine Biological Library catalogue, Aquatic Science and Fisheries Abstracts, Web of Science, Science Direct and Google Scholar. A preliminary review of available literature can be used to identify key sources of evidence via consultation with experts, review of existing sensitivity assessments, and identifying existing lists of characterising species for the selected habitats.

Step 2. Define the key elements of a feature (e.g., key characterising species of a habitat, or the life history of a given species). Where the assessed feature is a single species, that species is assessed. This species is assumed to be in the middle of its environmental range, i.e., not at the limit of its range and so particularly vulnerable to natural environmental change. The sensitivity of a habitat (biotope) is derived from assessing the sensitivity of its representative species (i.e., key structural, functional, or characteristic species), alongside the physical, hydrographic or chemical nature of the habitat.

Step 3. Assess the resistance of the selected feature against the MaRESA pressure benchmark (see Table A5d.3). Resistance is assessed for each pressure on a species (or key elements of the feature in the case of a biotope) using evidence identified during the systematic literature review.

Table A5d.3. Assessment scale for resistance to a defined intensity of pressure (Tyler-Walters et al. 2018).

Resistance	Description
None	Key functional, structural, characterising species severely decline and/or the physicochemical parameters are also affected e.g. removal of habitats causing a change in habitat type. A severe decline/reduction relates to the loss of 75% of the extent, density or abundance of the selected species or habitat component e.g. loss of 75% substratum (where this can be sensibly applied).
Low	Significant mortality of key and characterising species with some effects on the physical or chemical character of the habitat. Significant decline/reduction relates to the loss of 25-75% of the extent, density, or abundance of the selected species or habitat component e.g. loss of 25-75% of the substratum

Medium	Some mortality of the species without change to habitats. This loss relates to <25% of the species or habitat component
High	No significant effects on the physical or chemical character of the habitat and no effect on population viability of key/characterising species but may affect feeding, respiration and/or reproduction rates

Step 4. Assess the resilience of the feature based on its ecology. Resilience describes the recovery time of a feature once the pressure is removed or stopped, and the conditions resume those experienced before the impact (see Table A5d.4).

Table A5d.4. Assessment scale for the resilience of a feature (from Tyler-Walters et al. 2018).

Resilience	Description
Very low	Negligible or prolonged recovery possible; at least 25 years to recover structure and function
Low	Full recovery within 10-25 years
Medium	Full recovery within 2-10 years
High	Full recovery within 2 years

Step 5. Determine the overall sensitivity of a feature. Sensitivity is derived from the resistance and resilience scores (Table A5d.5).

Table A5d.5. Overall sensitivity assessment (from Tyler-Walters et al. 2018).

	Resistance			
Resilience	**None**	**Low**	**Medium**	**High**
Very low	High	High	Medium	Low
Low	High	High	Medium	Low
Medium	Medium	Medium	Medium	Low
High	Medium	Low	Low	Not sensitive

In cases where a sensitivity assessment is not possible, categories are assigned including:

- Not relevant: describes interactions that are either unlikely to occur or do not occur
- No evidence: there is insufficient evidence to assess the sensitivity of the specific feature/pressure combination, no suitable proxy is available and expert judgement alone does not enable an assessment to be made with any confidence.
- Not assessed: available evidence is very limited, poorly understood or absent.

Step 6. Characterise confidence in the evidence base used to make the assessment. The evidence for resistance and resilience of a feature to a given pressure is assessed in relation to three aspects (i) the quality of evidence, (ii) the degree to which the evidence applies to the assessment, and (iii) the degree of concordance (agreement) between the evidence sources (Table A5d.6). Several de facto criteria for identifying confidence are made. For example, in cases where expert judgement is used to assess the resistance or recovery of a feature then the quality of supporting evidence is classified as ‘Low’ and the degree of concordance is listed as ‘Not relevant’. Equally, the degree of concordance is listed as ‘Not relevant’ when the assessment is made using a single source. To identify the overall sensitivity assessment confidence score, the resistance and resilience scores are combined (Table A5d.7).

Table A5d.6. Confidence assessment categories for evidence, directly adopted from the MaRESA guidelines (Tyler-Walters et al. 2018)

Confidence level	Quality of evidence	Applicability of evidence	Degree of concordance
High	Based on peer reviewed papers (observational or experimental) or grey literature reports by established agencies on the feature (habitat, its component species, or species of interest)	Assessment based on the same pressures acting on the same type of feature (habitat, its component species, or species of interest) to an Irish context (from Ireland, UK, or similar latitudes in northern Europe)	Agree on the direction and magnitude (of impact or recovery)
Medium	Based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features	Assessment based on similar pressures on the feature (habitat, its component species, or species of interest) in other areas	Agree on direction but not magnitude (of impact or recovery)
Low	Based on expert judgement	Assessment based on proxies for pressures e.g. natural disturbance events	Do not agree on direction or magnitude (of impact or recovery)

Table A5d.7. Confidence assessment scoring for assessing sensitivity assessments. Directly adopted from Tyler-Walters et al. (2018).

	Resistance confidence score		
Resilience confidence score	**Low**	**Medium**	**High**
Low	Low	Low	Low
Medium	Low	Medium	Medium
High	Low	Medium	High

MaRESA does not provide a protocol for combining mixed scores for the three aspects of confidence - quality, applicability and concordance in arriving at the confidence scores indicated in the above Tables, e.g. in cases where quality is Medium (M), applicability is Low (L) and concordance is High (H). As such, we determined that: (a) if the majority of the scores was Low (e.g. LLL, LLM, LLH), then the overall confidence score should be Low, (b) if the majority of the scores was Medium or just one was Low (e.g. LMM, LMH, LHH, MMM, MMH), then the overall confidence score should be Medium and (c) if the majority of the scores was high (e.g. MHH, HHH), then the overall confidence score should be High. Where the concordance score was Not relevant (NR, ie only one piece of evidence, see above) it was treated as Low in these evaluations.

When combining confidence scores for pressures to determine confidence in assessments for sectors (presented in Table 3.4.1 of the main report), confidence was taken to be that of the pressure that defined the sensitivity of the sector; if there were several pressures with the same sensitivity, the confidence category was based on the highest level of confidence from among them.

A statement of confidence based on the above is provided in conjunction with all statements about sensitivity levels or resistance or resilience levels in the Case Reports (Appendix 10) and in the text of the report.

Step 7. Document the evidence used and considerations around its application. This documentation is both accurate and thorough so that the basis of each assessment is transparent, repeatable and can be updated in light of new evidence.

Step 8. Quality assurance and peer review. Sensitivity assessments and their respective evidence bases are subject to internal quality assurance and peer review.

1.4. Use of existing sensitivity analyses – MarLIN and FeAST

Before the adoption of the MaRESA approach, sensitivity assessments were conducted by MarLIN (Hiscock et al., 1999; Tyler-Walters 1999, 2001 & 2005). The original MarLIN assessments evaluated the effects of human activity on marine species and habitats and provided sensitivity assessments for a range of biotopes in the European Nature Information System (EUNIS) and British and Irish habitat classifications (V15.03). These initial assessments were a steppingstone for further works, including the MarLIN sensitivity assessment that provided a matrix to enable a feature's sensitivity to be identified in relation to different sectors and associated pressures (Tillin et al., 2010, MB0102 project). The MB0102 project introduced new pressure benchmarks, refining the MarLIN approach, and was subsequently adopted as the MaRESA approach.

Where MaRESA assessments were not available for a feature, the original MarLIN sensitivity assessments provided the assessment for the species or habitat. In such cases, these older assessments summarise evidence/confidence as a single category from very low, low, medium, high or not relevant[1]. This evidence scoring does not define the quality of evidence, applicability of evidence and degree of concordance (agreement) between studies as in newer MarLIN assessments (see Section A5d.1.3).

In cases where there were no MarLIN assessments, Feature Activity Sensitivity Tool (FeAST) assessments were used for this project. The FeAST online tool[2] focuses on a Marine Protected Area feature (habitat or species) approach and allows users to explore sensitivity assessments for Scotland's Priority Marine Features. The tool was developed through the FeAST working group, which includes NatureScot, the Joint Nature Conservation Committee (JNCC), Marine Scotland, Marine Scotland Science and the Scottish Environment Protection Agency. This tool follows a modified MaRESA approach, with features, activities, pressure definitions and pressure-sector linkages adapted to reflect Scottish activities and features and MSFD requirements. FeAST assessments have been adapted to reflect new information and differences in some of the pressure definitions and benchmarks.

1.5. Procedure for new sensitivity analyses where required

In cases where there were no available assessments (MarESA, MarLIN or FeAST) for a feature, a systematic review of peer-reviewed literature was conducted using ISI Web of Science. This review followed the Rapid Evidence Assessment (REA) approach proposed by MaRESA. Resultant abstracts were screened for relevance i.e., the paper had direct links to any of the listed sectors, or mentioned one or more pressures. Search terms incorporated sectoral pressures identified in the refined sector-pressure matrix (Table 2a). All search terms are listed in Appendix 11. This evidence was used to complete a set of tables for each identified feature, summarising its sensitivity to each sector-pressure. Each feature-pressure combination was assessed, unless those that were 'Not relevant' i.e., there is no direct interaction between the pressure and the feature.

In line with the MaRESA protocol, the quality, quantity and concordance of evidence were recorded for each sensitivity assessment (see Section 1.3 above). Quality assurance and peer review were not possible in this project due to time constraints.

Habitats, species assemblages and grouped features

Sensitivity analyses for individual species or features were conducted as prescribed by MaRESA. Determining the sensitivity of broadscale habitats or groups of species was more complex due to the large number of papers, the varying responses, and the complex

[1] Further details on MarLIN evidence ranking: https://www.marlin.ac.uk/glossarydefinition/evidenceranking
[2] The FeAST online tool: http://www.marine.scotland.gov.uk/FEAST/Index.aspx

interactions that emerge when combining multiple species into one assessment. For example, the ecologically important suite of forage fish species, while simple in concept, produced approximately 28,000 papers when a list of possible species was included in the literature search terms. Excluding the individual species names in the search terms and using instead terms like “juvenile fish” and “forage fish" still produced approximately 4,000 results. Similar complex sensitivity assessments were encountered for the broadscale MSFD habitat types and the frontal systems. Exactly how these searches and assessments were dealt with are detailed in the relevant case reports (see Appendices). In brief, the MaRESA rapid evidence assessment approach was required, notably limiting the literature search and screening process to two days in such cases. Sensitivity scores for each pressure for habitats, species assemblages, and grouped features were based on the resistance/resilience of the most sensitive species. For example, sprat are unlikely to be sensitive to disturbances of the substrate whereas sandeel residing in the sand would be. Therefore “forage fish” as a whole are considered sensitive to substrate disturbance.

MSFD Broadscale Habitats

A sensitivity analysis of the broadscale habitats would be an extremely large and time-consuming body of work. Given the time pressure for this report, a series of steps were taken to compile a sensitivity analysis for the 13 broadscale habitats present in the Irish Sea. Infralittoral and Circalittoral Rock and Biogenic Reefs were omitted from this report as these habitats are either not found in the Irish Sea or are protected under the HD.

Circalittoral and Offshore Circalittoral:
Coarse Sediments; Mixed Sediments; Mud; Sand
To obtain a sensitivity analysis for the habitats listed above, a series of steps was followed. The JNCC report ‘Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities’ (Tilin & Tyler-Walters, 2014) was used to obtain sensitivity scores of sixteen ecological groups to a number of the pressures outlined in Table A5d.2a. Phase 1 of the report ‘Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken’ identified 16 ecological groups composed of 96 species that were selected as characterising species for the 33 biotopes. Phase 2, ‘Literature review and sensitivity assessments for ecological groups for circalittoral and offshore circalittoral Level 5 biotopes’ modified the Tillin et al. (2010) sensitivity assessment methodology and compiled an extensive literature review to gain an understanding of the effects of pressures from human activities. Characterising species highlighted in the JNCC report were used to identify important ecological groups for each biotope. To compile the sensitivity scores for the groups into one overall sensitivity analysis sheet for each biotope the highest score across all ecological groups with characterising species associated were transferred into one sheet.

Infralittoral: Coarse Sediments; Mixed Sediments; Mud; Sand
Infralittoral habitats were not covered under the JNCC report mentioned above. To obtain sensitivity scores for these biotopes, a biological comparative table from JNCC was used to obtain a list of species associated with each biotope. The list of species was then grouped based on the ecological groups established as part of Phase 1 for the JNCC report mentioned

above (Tilin & Tyler-Walters, 2014). The sensitivity scores for each group were then taken from the Phase 2 report as stated above. Characterising species listed on the JNCC website were used to identify the important ecological groups for each biotope. An overall sensitivity sheet was compiled by taking the highest score across all ecological groups with characterising species associated with it. Chemical pressure scores were obtained as detailed above via sensitivity analyses of characterising species on Marlin.

Some pressures listed in Table A5d.2a were not assessed as part of the JNCC report used here. These pressures include transition elements & organo-metal contamination; hydrocarbon & Polycyclic Aromatic Hydrocarbons (PAH) contamination; synthetic compound contamination; introduction of other substances; Smothering and siltation changes (light); Underwater noise; Barrier to species movement; Death or injury by collision. To obtain sensitivity scores for some of these pressures, characterising species listed for each biotope were searched for on Marlin. Where sensitivity analysis had been carried out, the highest scores across the list of characterising species were transferred into the overall sensitivity analysis sheet. Pressures covered by these analyses were transition elements & organo-metal contamination (referred to as heavy metal contamination in Marlin sensitivity assessments); hydrocarbon & PAH contamination (hydrocarbon contamination); synthetic compound contamination (synthetic compound contamination) and underwater noise (noise). Barrier to species movement and Death or injury by collision are scored as not relevant to benthic species/habitat.

Carbon sequestration

An expert was consulted to compile the sensitivity analysis table for the pressures relevant to carbon sequestration. Carbon is sequestered in muddy sediments and a physical change to the seabed or sediment would result in the release of carbon from the seafloor. In addition, disruption of the seafloor would allow sequestered carbon to be released into the water column. On that basis, a resistance score of **None** was assigned to the pressures of *Physical change (to another seabed type), Physical change (to another sediment type), Habitat structure change-removal of substratum (extraction), Abrasion/disturbance of substratum surface or seabed and Penetration or disturbance of substratum subsurface.* Unfortunately, there is insufficient evidence in the context of the Irish Sea on the ability of the carbon to return to the seafloor once the pressure has been stopped. This has resulted in the Resilience and Sensitivity scores for the pressures mentioned above being listed as **No Evidence**. Given the shallow depth and turbulent nature of the Irish Sea, however, it is possible that carbon disturbed from the seafloor could be lost to the atmosphere, contributing to climate change. As such, a precautionary approach is recommended, and spatial protection should be considered.

Thermohaline frontal systems

Thermohaline fronts are oceanographic features which occur along the boundary of water masses with different physical characteristics, i.e., temperature and salinity. There are two seasonal frontal systems in the Irish Sea which were considered for the features list due to their ecological importance and the richness of associated biodiversity (see Case Report 39 in

Appendix 10). It was decided to include only the Western Irish Sea Front because the Celtic Sea Front overlaps only marginally with the area of interest. Fronts are regions of enhanced primary productivity and convergent current flows which can aggregate zooplankton and other small species which support larger mobile predator species. A general concern based on other frontal systems would be for seabirds and marine mammals, which are not within the scope of this particular project, however, many fish species including basking sharks, are known to aggregate, forage and possibly migrate along other frontal systems.

There is an argument for completing a sensitivity analysis for key associated biota - equivalent to the approach taken here for the MSFD priority habitats. However, there is limited data on associations with these specific fronts in the Irish Sea and this was deemed inappropriate. In addition, there is no existing sensitivity assessment of frontal systems which might have been adopted here. Because the presence and character of the front, and its ecological influence, are driven by physical forces, the assessment of the fronts here was based on a review of evidence demonstrating a potential impact on the physical nature of the front itself.

Vessels and wind turbine foundations create a wake as water flows around them, and the wake creates turbulence and vertical mixing in the water column. In theory, if this induced turbulence is large enough, it may alter normal oceanographic regimes, possibly impacting the front. In practice, this is difficult to measure, with limited research on ship wakes and research on turbine foundation wakes at an early stage. The majority of research on wind farm wakes involves hydrodynamic models, although more recent work includes some in situ measurements as well. In brief, the research indicates that wind farms can impact local oceanographic processes, at a large spatial extent (>60 km), however, the magnitude of the impact is less than interannual variation. There is no evidence to indicate any negative impact on the formation and character of frontal systems as a result of wind farms (see Case Report 39 in Appendix 10 for additional detail). Therefore, with respect to the pressure, ‘water flow changes’, fronts were assessed as **not sensitive**. All the other pressures were assessed as **not relevant** as they would not impact on the physical character of the front.

It is important to note that the quality, applicability and concordance of the evidence available on this topic is low. Changes to the fronts have the potential to alter noise transmission in the Irish Sea, and in the case of the Celtic Sea Front, should it be considered in future, alter primary productivity, both of which merit further research and consideration. In the meantime, a precautionary approach is advised.

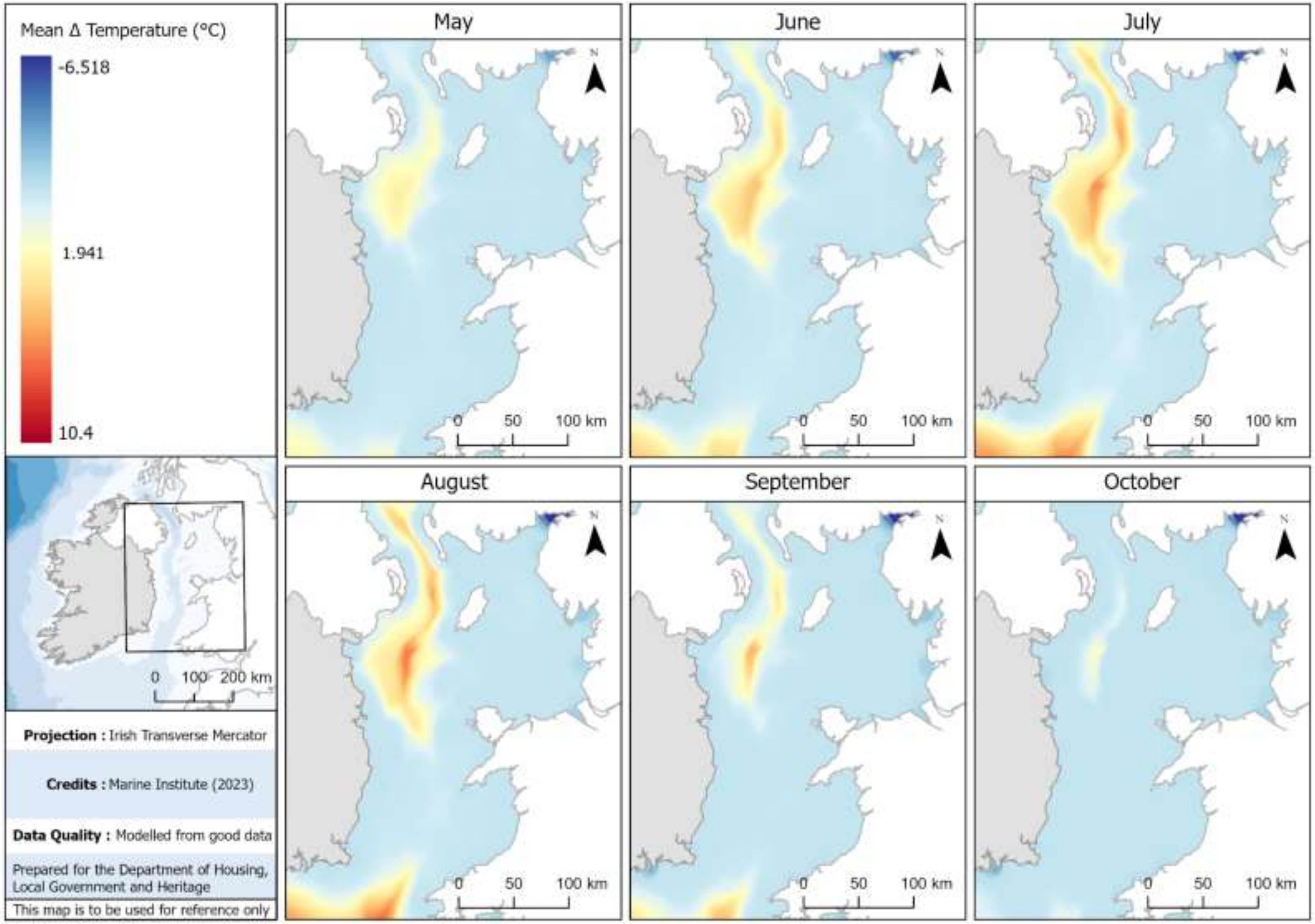

Figure A5d.1.2. Thermohaline frontal systems in the western Irish Sea, May-October.

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Appendix 5e
Conservation Prioritization methodology

Locations can be identified for conservation purposes using different criteria, including reasons of ecological, cultural or aesthetic importance. Locations can also be evaluated by integrating or layering ecological data to obtain a conservation value per area. This sort of analysis is repeatable and can identify locations where investments in conservation are likely to be resource efficient. The approach of integrating spatial data to inform and support decisions is generically referred to as **conservation prioritization**, and can form part of the wider process of systematic conservation planning.

A number of software tools exist to carry out a conservation prioritization. The simplest basic prioritization is probably to compare the species richness between locations, with the most biodiverse locations being candidates for protection. Many options exist to extend this basic accounting, for example subsetting for species of particular value, or placing greater value on traits like rarity. Zonation is an example of software designed to carry out this sort of ranking, with options for varying the importance given to different features of interest.

The next level of complexity after a ranking of locations is to consider how these are related to human activity. There may be trade-offs where conservation actions could still target important sites while reducing the impact that would result from excluding human activities. Further levels of complexity include considering the size, shape and spacing of the prioritized areas identified. As decisions on the aims of different prioritizations often produce separate solutions, it is common for these alternatives to be used to inform stakeholders before conservation decisions are made i.e. decision support.

There is overlap in what different conservation prioritization tools can do, but also some differences in key processes. Zonation was used in this report for ranking locations, including weighting by feature sensitivity to different sectors. The *R* package *prioritizr* was used to identify coherent areas suitable for designation, using information on the trade-offs with different human activities. The size and shape of potential protected areas were also examined in *prioritizr*, with decisions made to avoid reserves that are too small or too irregular in shape for management to be effective. A key difference between the algorithms is that Zonation produces a priority ranking, whereas *prioritizr* is based on finding a solution to the problem of capturing a certain proportion of each conservation feature in a network of protected areas.

Prioritizing locations with Zonation

Identifying areas of conservation importance involves mapping the distribution of the selected features, where spatial data exist to do this. Priority areas are likely to be where a rare feature in the region occurs, in addition to areas where several features co-occur (sometimes called hotspots, Myers et al., 2000). The Zonation programme (see box) can process spatial information to summarise the information across overlapping features, highlighting locations that have a higher overall conservation priority (Lehtomäki & Moilanen, 2013, Moilanen et al., 2022). The main output from Zonation is a map that ranks locations in a region by conservation importance.

What does Zonation do?
The Zonation programme generates a priority ranking of locations based on the proportion of conservation features that are found at each location. Locations are equal-sized subdivisions of the region of interest, generally a map of square ‘cells’ or pixels. An initial ranking is generated by adding the proportion of the separate features in each cell, with the largest sum of proportions indicating the most valuable location. This initial ranking does not take account of how the value of cells might change if the least valuable cell were lost (for example to development). Zonation therefore iterates through the ranking, re-evaluating relative cell values to reflect any changes in cell importance as the lowest ranked cells are removed.

The result of a Zonation run is a ranking of locations with higher values for the cells of highest conservation priority. Figure A5e.1 illustrates three conservation features on a 5 x 5 grid, where brighter colours indicate more of the feature is present. Zonation captures the gradients in features 1 and 2, at the same time as emphasising the importance of the four cells where feature 3 is at high density.

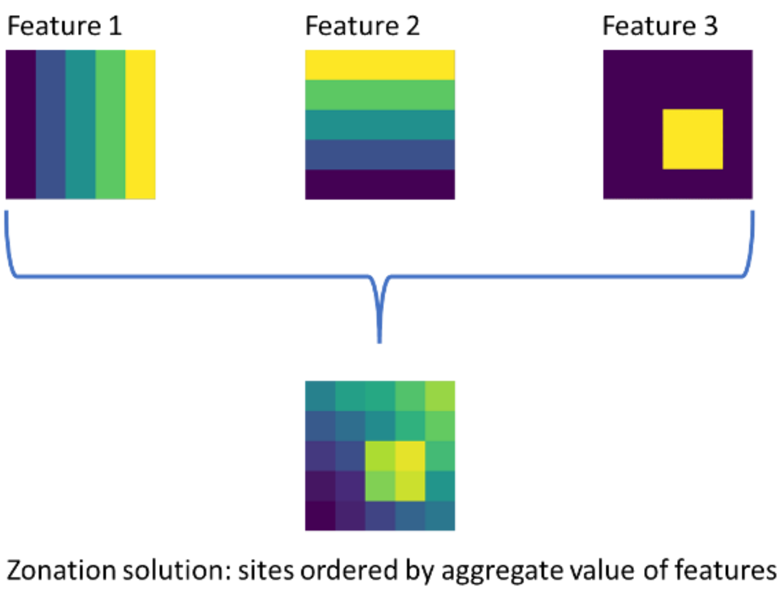


Figure A5e.1 Schematic representation of Zonation cell ranking

The value of different features can be weighted in Zonation; for example, to emphasise particularly important or sensitive species.

Following the identification of features of importance (Section 3.1, Appendix 5a) and a screening of data coverage and quality (Section 3.2, Appendix 5b), 33 layers remained for Zonation analysis (see ‘Data files used in conservation prioritization’). These layers included benthic habitat classes, the location of the western Irish Sea front and distributions for fish, including threatened rays and bony fish. Maps were made using a 1 km^2 resolution as this minimises the extrapolation of point records. This resolution for presentation of Zonation output differs from the priortizr analyses, where different considerations apply (see relevant section). A further set of six features where data were available, but questions remained about the coverage, were included in an additional Zonation analysis. This additional analysis tested whether the additional, lower confidence, data could identify any further areas of potential conservation importance. All rankings used the CAZ2 algorithm in Zonation 5. Trials with other ranking options suggested that the final maps did not vary significantly when using alternative algorithms in the Zonation programme.

Zonation analyses can be modified in a number of ways, including adjusting the importance of different features for the ranking. Sensitivity information was summarized for each feature to different pressures and then related to different sectors (shipping, fishing and ORE) using a sector-pressure matrix that reflects the mechanisms by which sectors interact with the ecosystem. The sensitivity of different features was integrated into Zonation using a weighting of high sensitivity = 3, medium sensitivity = 2, low sensitivity = 1 and 0 for not sensitive, not relevant or not evaluated. In most cases (80%), mapped features had medium or high sensitivity to the sectors. The resulting Zonation maps emphasize areas that are particularly sensitive to the sector used for defining feature weights. As such, the weighted Zonation mapping can identify areas of high conservation value and indicate which sectors would conflict with the conservation objectives in those areas and so should be excluded from them or carefully managed within them as appropriate.

The Zonation rankings in this report are not constrained by potential optimizations that may be made in a marine planning process, such as design of manageable reserve shapes and trade-offs with sectoral activity. These issues are explored in the *prioritizr* analyses.

Prioritizing locations with *prioritizr*

Several methods and software used for conservation prioritization aim to recommend MPA networks which meet conservation objectives whilst reducing costs to marine sectors. In that sense the solutions are optimised to achieve the conservation objectives with minimum encroachment on sectoral activity. In conservation prioritization, overlaps with sectoral activity are known as opportunity costs, or simply 'cost'. In this context, cost is not financial cost. Software optimise MPA network solutions to minimise disruption of sectoral activities while meeting the conservation objectives. The analysis is therefore one of conservation-sector trade-offs with 'cost' reflecting use in the technical literature rather than a direct economic cost or a statement reflecting policy or social values. Where possible, we avoid using the term cost, because although technically correct, it can introduce confusion if readers are not familiar with the language of conservation prioritization.

Finding an optimum trade-off between conservation objectives, sector trade-offs and protected area size is a complex task. *prioritizr* (Hanson et al. 2023) is an *R* package that uses mixed integer linear programming (MILP) to solve conservation planning problems. Similar to *Marxan* (Ball et al. 2009), it produces planning solutions in response to planning objectives, but can be faster and more exact as a result of using MILP rather than heuristics or simulated annealing. In part, we favoured it over *Marxan* due to the ability to write and save *R* scripts, ensuring automation and transparency of process.

What does *prioritizr* do?

The *prioritizr* programme generates an MPA network solution containing set proportions of features of conservation interest while minimizing the selection of cells important to sectoral activities. Hence networks generated in *prioritizr* meet conservation objectives and consider the needs of stakeholders. Figure A5e.2 illustrates the same features as Figure A5e.1 and an area important to sector A (marked in blue). *prioritizr* optimises the MPA to capture set proportions of the three features while minimising reserve overlap with the activities of sector A.

Figure A5e.2 Schematic representation of *prioritizr* reserve selection

prioritizr was implemented in a consistent way throughout, including multiple features as raster layers and a single sectoral activity raster layer, all gridded to a 3 km x 3 km grid. Hereafter the term 'planning unit' is used to refer to any 3 km x 3 km grid cell. The grid scale was selected as a compromise based on likely usefulness to policy makers after generating test solutions. We considered two other grid sizes and found 1 km x 1 km led to MPA network solutions with highly irregular boundaries that would be complex to monitor and implement, while MPA networks generated from 5 km x 5 km cells required a greater overall extent to meet their conservation targets and therefore were less favourable to sectoral activities that may be affected by the MPA network solution.

Conservation planning objectives were set to minimize the overlap with sectoral activities (i.e., cost - see below) while ensuring all targets were met (see Rodrigues et al. 2000), and boundary penalties were implemented such that spatially clumped solutions were favoured based on the overall boundary length of the proposed reserves. Constraining the boundary length with a boundary penalty forces a solution that favours the selection of adjacent cells. For example, four discrete planning units of grid size 3 km have an overall boundary length of 3 x 4 x 4 km = 48 km, whereas a square 'clump' of four adjacent grid cells has a boundary length of 4 x 6 km = 24 km such that the latter is favoured when a boundary penalty is applied. Neighbour constraints were also added that required all selected planning units in the solution to have at least two neighbouring grid cells also selected in the solution. This tends to lead to the selection of larger areas of contiguous grid cells in the MPA network solution and less irregular boundary shapes, both of which contribute to a more realistic MPA network. Targets were set for each feature to specify the minimum proportion of that feature to be in the MPA network solution.

Sectoral activity layers were generated for each of six sectors: ORE, shipping, and four fishing sectors: pelagic trawling, fishing with static gear fishing, fishing by bottom trawling, and fishing by dredge and beam trawling (see Table A5d.1.2b). The ORE sectoral activity layer was generated by overlaying polygons representing wind farm foreshore licence applications on our planning unit grid and generating percent cover for each planning unit. For the shipping sectoral activity layer, we combined six raster layers of vessel density (cargo, military and law enforcement, passenger, service, tanker, tug and towing) from EMODnet into a single raster containing the summed density across the six layers. The pelagic fishing sectoral activity layer was formed from a layer of VMS effort of pelagic trawls & seines. The bottom trawling sectoral activity layer was generated from VMS data indicating surface swept area ratio for vessels greater than 12 m length. The dredge and beam trawling sector layer was generated from VMS data from vessels over 12 m length indicating subsurface swept area combined with 5-years of VMS data from the north Irish Sea razor clam fleet showing hydraulic dredge effort. The fishing with static gear sector layer was generated from VMS data from vessels over 12 m length indicating static gear effort combined with a layer of polygons indicating pot-fishing activity from the under fleet of vessels less than 12 m length. In each case, these sector layers were intended to provide an indication of the relative value of each planning unit to the sector based on information readily available to the team. All sector layers were rescaled such that the maximum value of the sector was 1000 units. In the case of the fishing by dredge and beam trawling and static gear sector layers, the activities of the fleet of vessels over 12 m and the fleet under 12 m were both assigned 500 units, so that both parts of these sectors were valued equally. *prioritizr* will attempt to minimize the overlap of the MPA network solution with sectoral activities and therefore avoid planning units where a protected area could potentially affect sectoral activities. For most conservation prioritization solutions, a combined sectoral layer was used that summed the sectoral layers of all six sectors such that there were 6000 units spread across the layer. This meant that all sectors were valued equally.

For all analyses a set of preliminary solutions (‘prelims’) were generated using a very wide range (several orders of magnitude) of boundary penalties, followed by nine solutions using a narrow range of boundary penalties bounded by the two best prelims. This manual process allows the boundary penalty to be adjusted for each scenario such that reserves within the resulting MPA network are of a suitable quantity and size. The ‘best solution’ was selected based on minimizing the number of reserve clumps, the number of very small reserves, and the overall network boundary length, while minimizing the overlap of the MPA network solution with sectoral activities (i.e minimizing the solution ‘cost’ to use the term commonly applied in conservation prioritization).

It must be stressed that conservation prioritization software does not provide a single ‘right’ answer, but rather provides options to policy makers based on stated conservation objectives. We therefore ran multiple analyses, varying targets and included features, that aimed to illustrate possible implications of a range of potential policy objectives for the design of the MPA network.

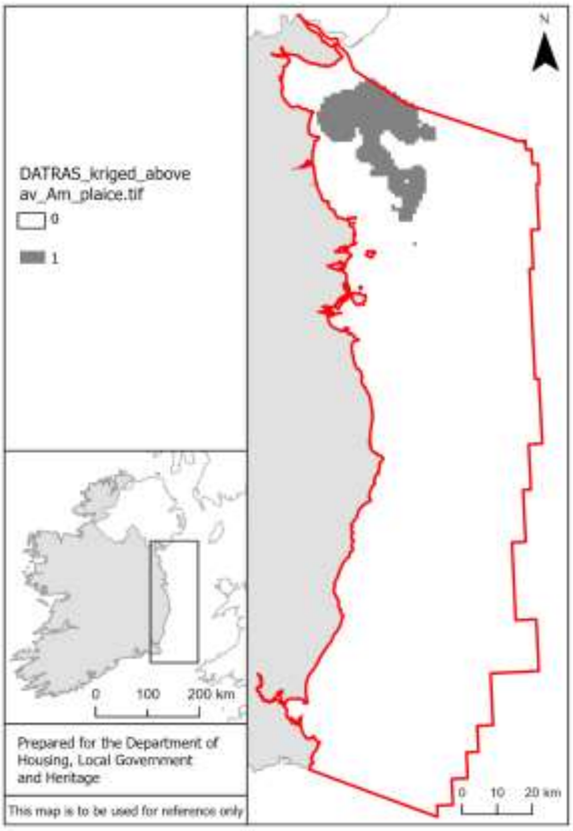
Data files used for features included in conservation prioritization

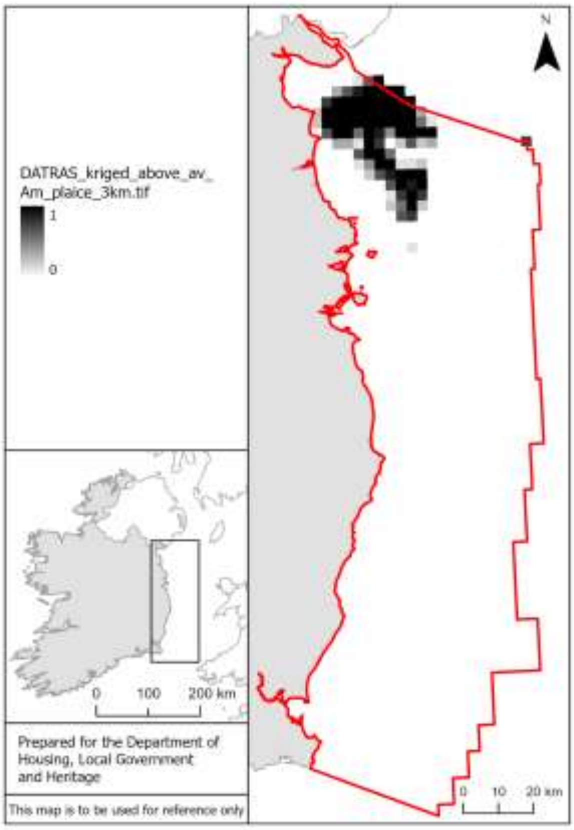
Following the feature selection process and consideration of data quality and coverage (Table 3.1.1 main report), raster layers were prepared for processing with conservation prioritization software.

Rasterised data layers were compiled at a 1 km x 1 km grid scale for Zonation (see Figure A5b.2), and subsequently aggregated to a 3 km x 3 km grid scale for *prioritizr*. Where modifications were made to the data sources compiled (See Appendix 8 for list of data sources), for example to combine data sources, or to convert to presence/absence, details are provided below.

1. American Plaice

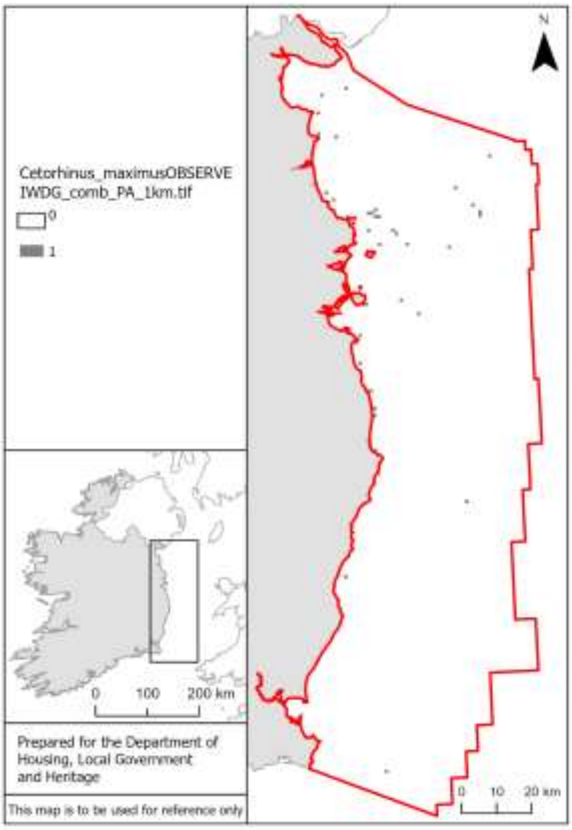
Catch per unit effort data from DATRAS trawls were pooled across 2015-2022 to produce a map of favoured locations (areas of relatively high expected catch). To combine years with different overall catch levels, data were standardised to mean zero by subtracting the annual mean from each measurement and dividing by the standard deviation of the relevant year. Data were interpolated between DATRAS sampling stations using kriging based on the best fitting variogram. A lack of spatial dependence between measurements was considered as an alternative model, but variogram fits demonstrated that spatial dependence was a better model, and that interpolation was justified. Areas of above average (>0) catch were assumed to represent the favoured habitat of American plaice and used in conservation prioritization.

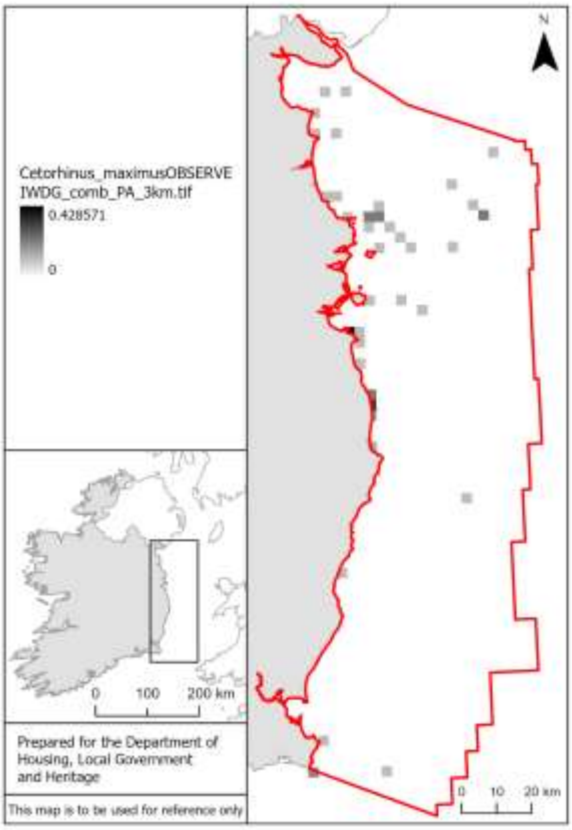




3. Basking Shark

IWDG data indicated basking shark presence within 38 cells of the 1 km x 1 km planning unit grid layer. The University College of Cork's ObSERVE aerial survey Programme 2015-2016 indicated basking shark presence in six grid cells. From these data, a combined presence/absence raster was generated.



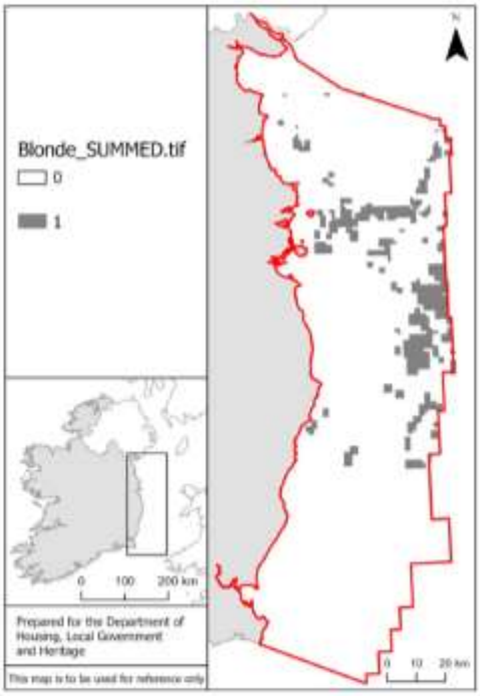


4a, 6a, 13a, 15a. Adult rays (Blonde, Cuckoo, Spotted, Thornback).

VMS and logbook data were converted to a high confidence presence map from the original VMS logbook raster where ‘presence’ was represented by the quartile of cells with the highest catch per unit effort value in each of the beam trawl data and otter trawl data layers. Dedman models were converted to a high confidence presence map whereby ‘presence’ was represented by areas that were in the top 50% of Dedman’s (2015) predicted abundance categories. Conversion to presence/absence was required to combine two datasets with differing units, and to avoid marking areas of low **predicted** abundance in the modelled data as known presence. The methodology of restricting the number of cells marked as ‘presence’ prevents areas of low known and predicted abundance being targeted for conservation by *prioritizr*.

4b, 6b, 13b. Juvenile rays (Blonde, Cuckoo, Spotted).

Dedman models were converted to a high confidence presence map whereby ‘presence’ was represented by areas that were in the top 50% of Dedman’s (2015) predicted abundance categories. This was necessary to avoid marking areas of low **predicted** abundance in the modelled data as presence.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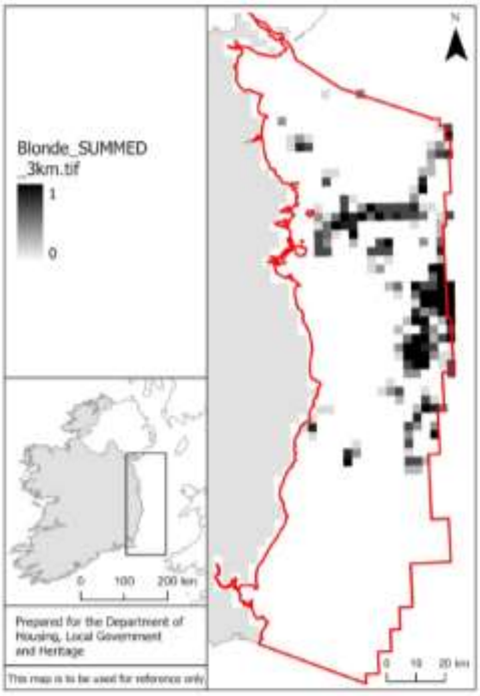
0
1
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
0 10 20 km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Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
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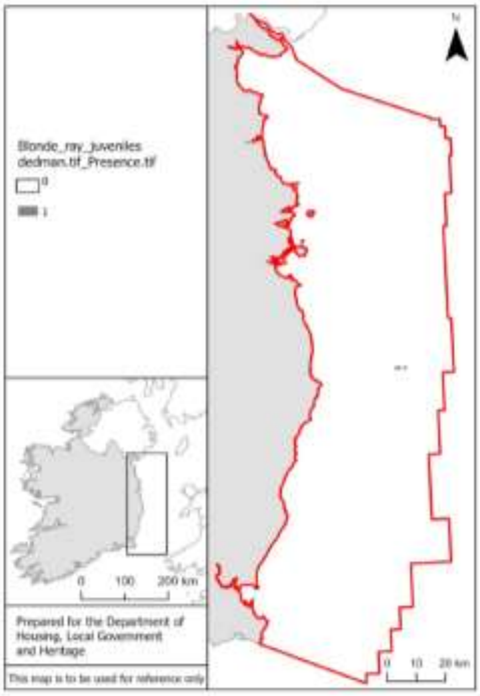
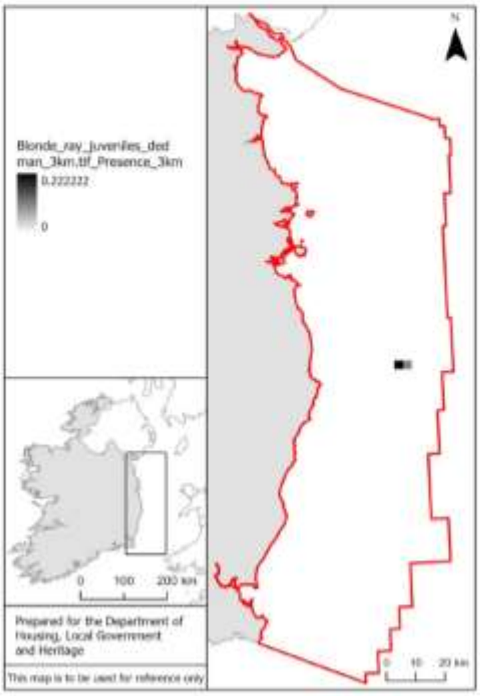

Blonde_ray_juveniles dedman.tif_Presence.tif
0
1
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
0 10 20 km


Blonde_ray_juveniles_ded man_3km.tif_Presence_3km
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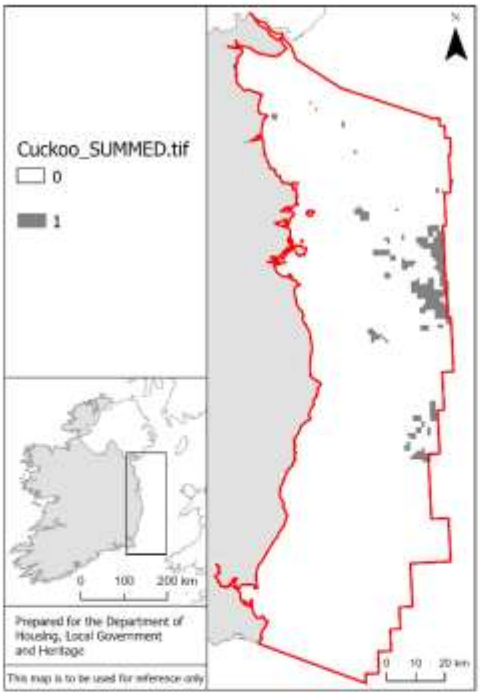
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
0 10 20 km


Cuckoo_SUMMED.tif
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200 km
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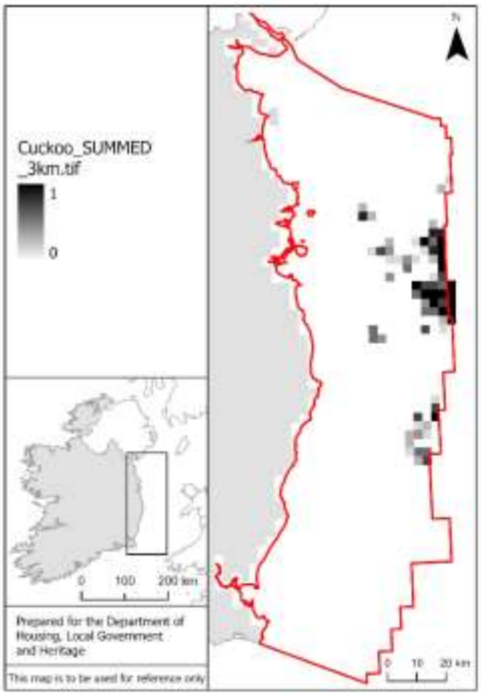
20 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only


Cuckoo_SUMMED _3km.tif
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200 km
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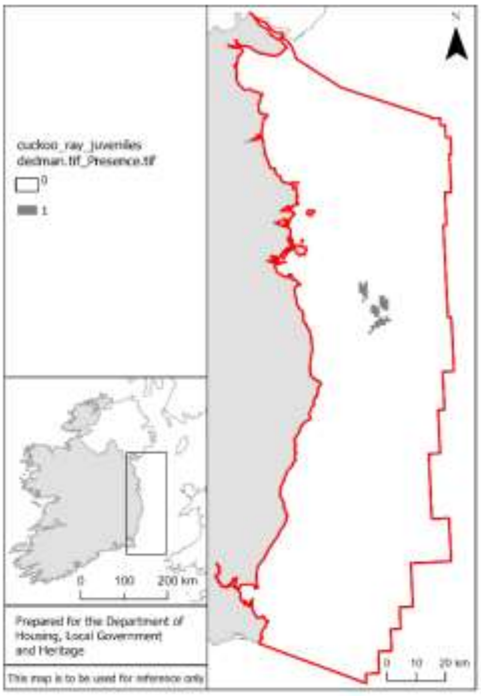
20 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only


cuckoo_ray_juveniles dedman.tif_Presence.tif
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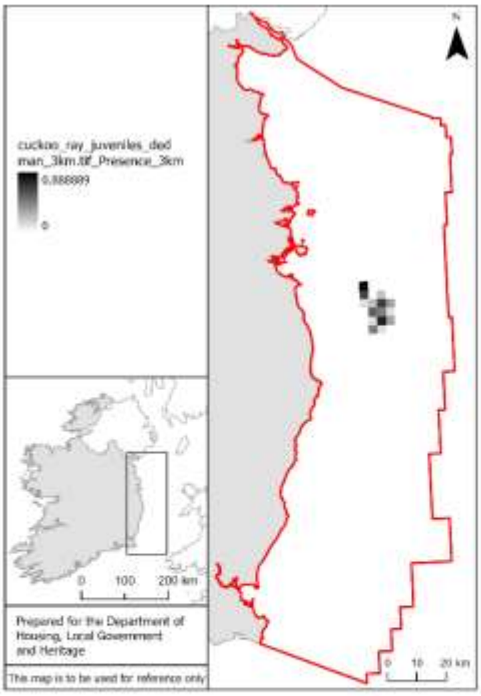
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only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N
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200 km
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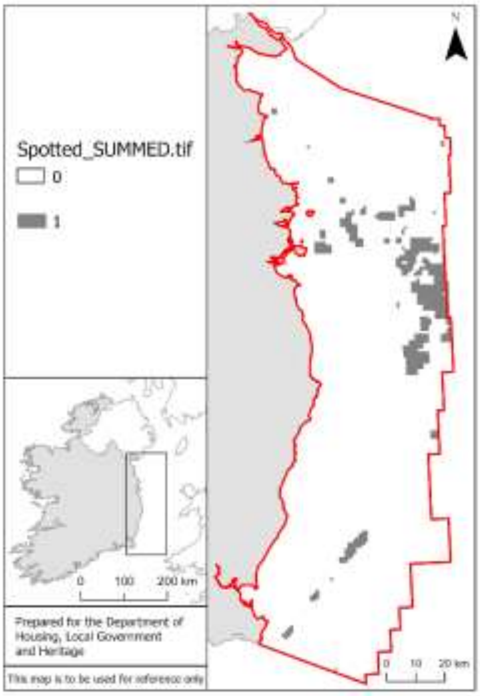
10
20 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only


Spotted_SUMMED.tif
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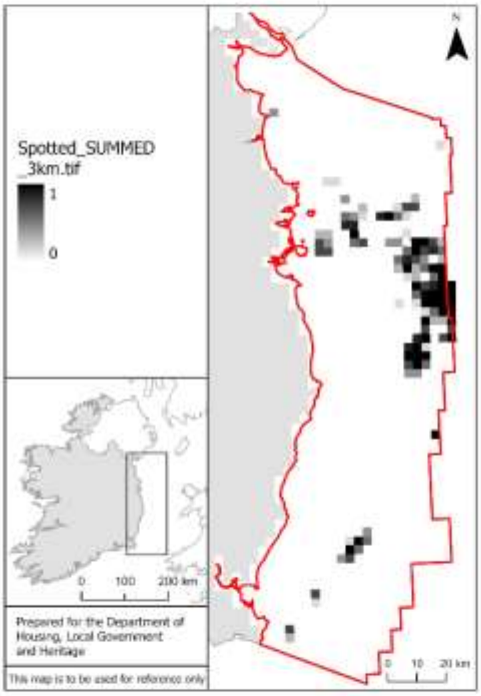
1
N
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
0 10 20 km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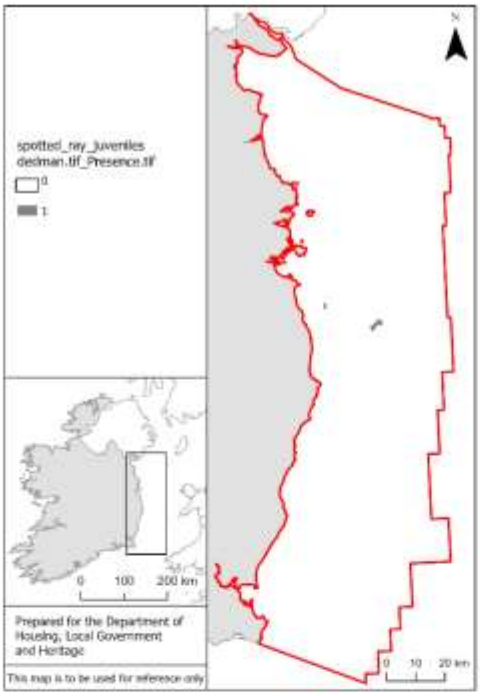
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
0 10 20 km


spotted_ray_juveniles dedman.tif_Presence.tif
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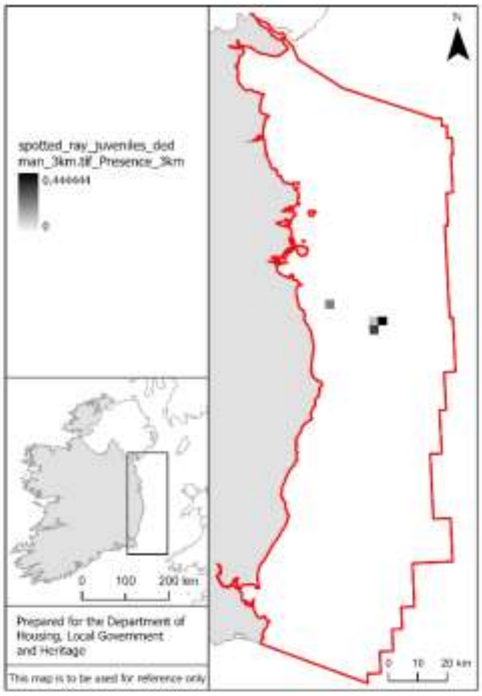
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
0 10 20 km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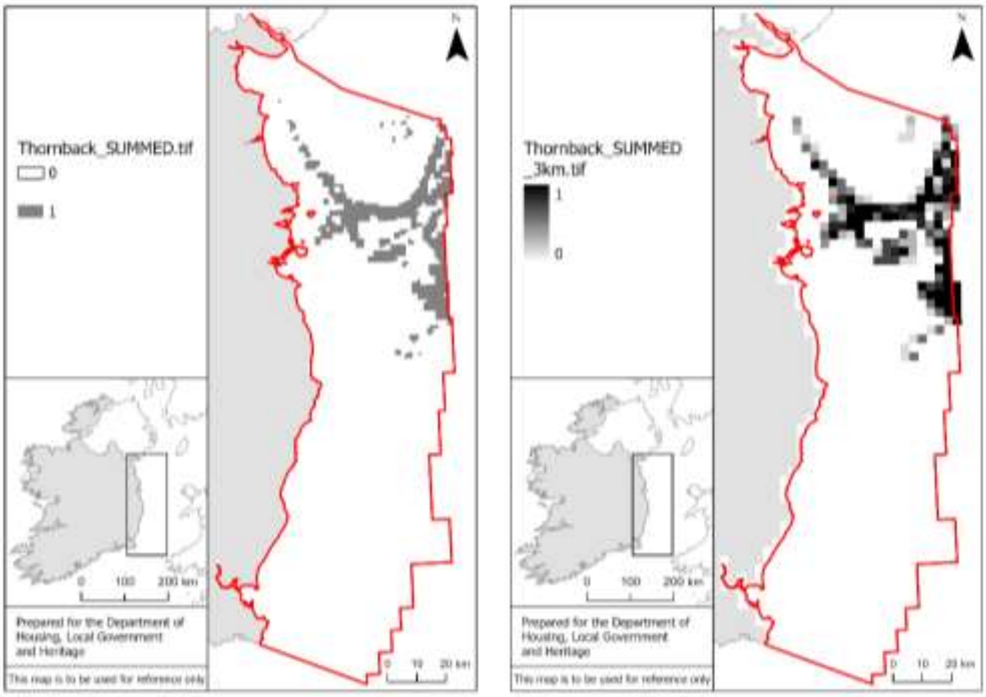
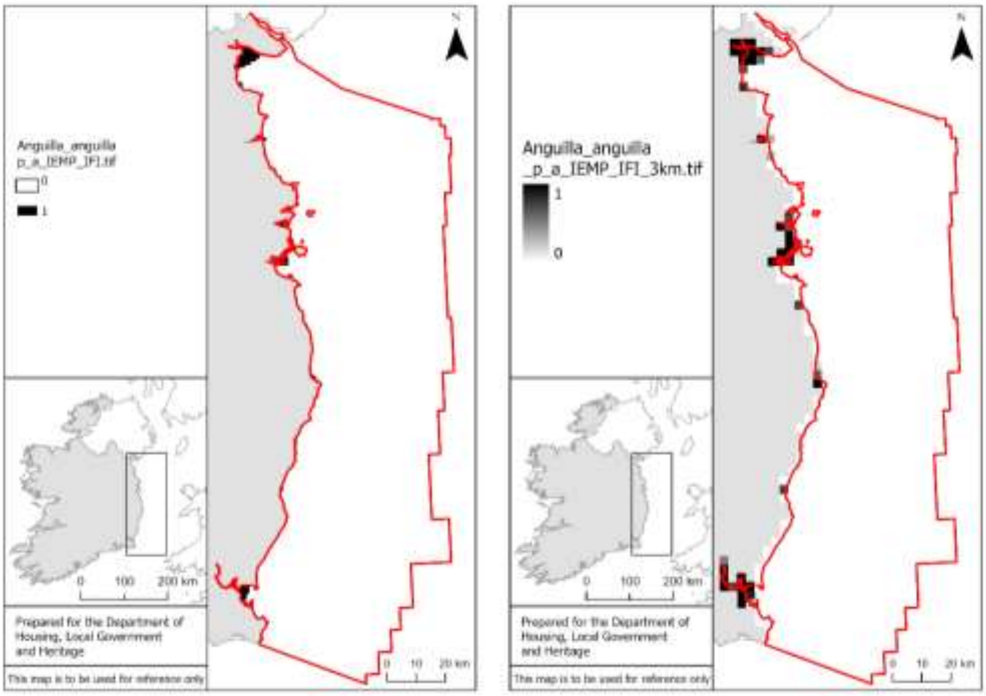
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
0 10 20 km



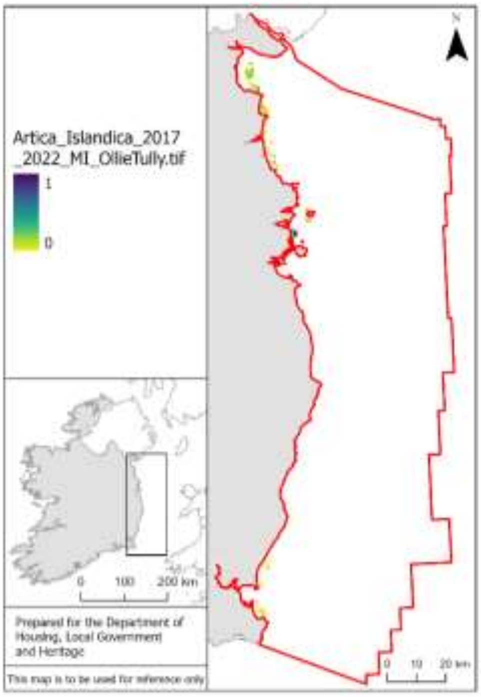
9. European Eel

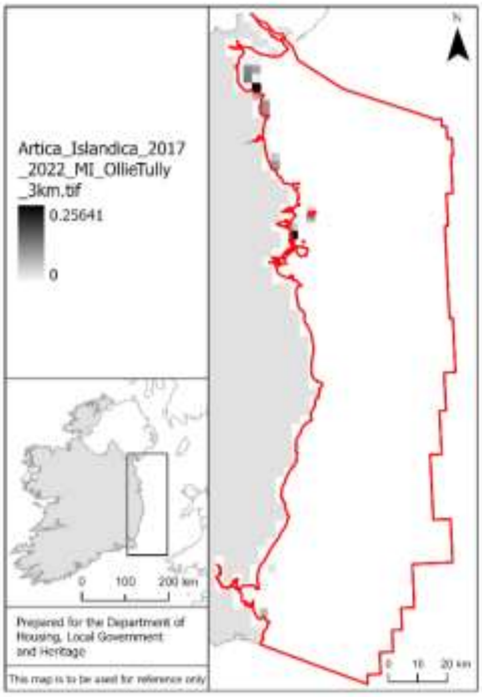
Data layer used unmodified.



10. Icelandic cyprine (ocean quahog)

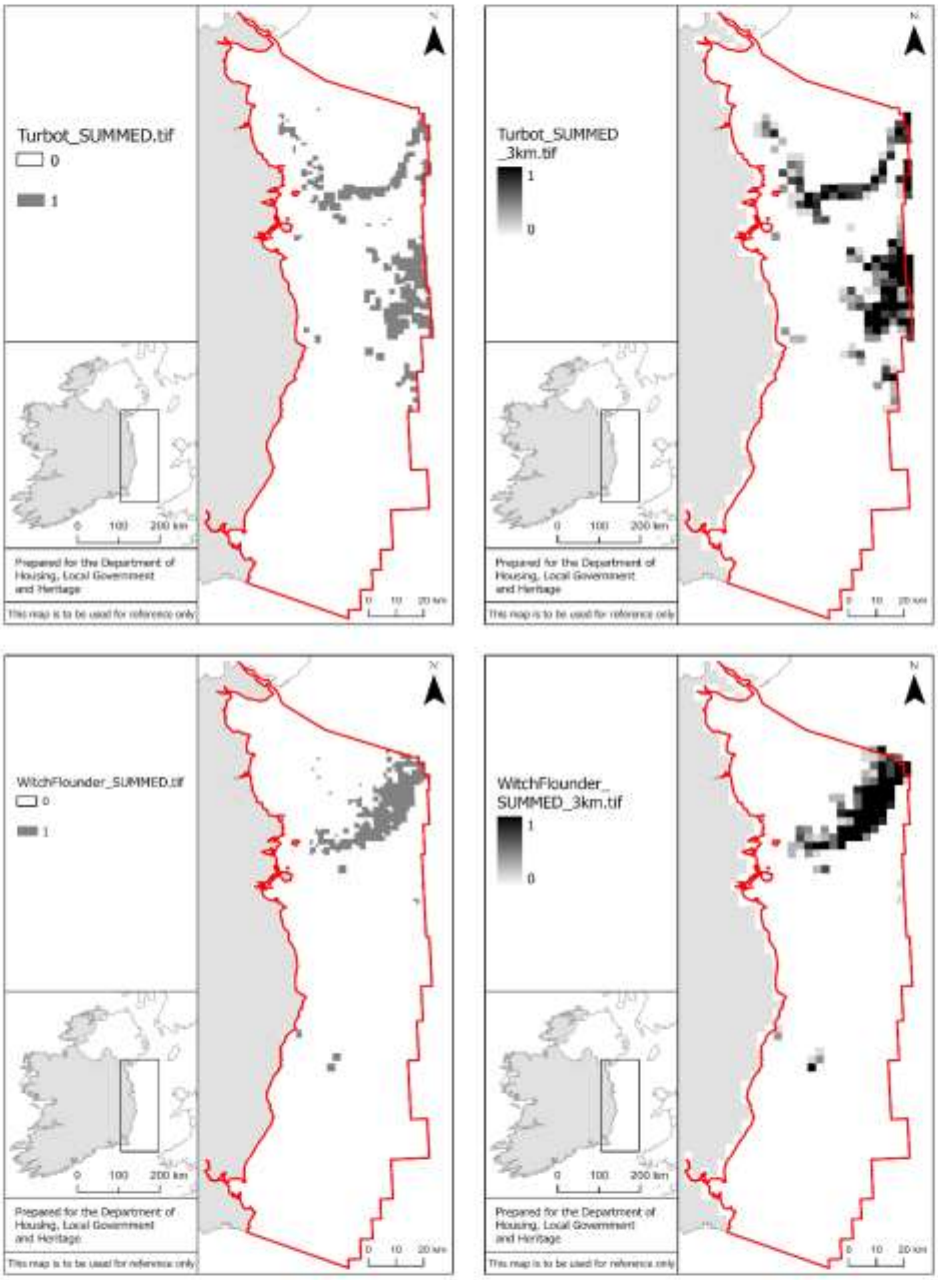
Data layer used unmodified.



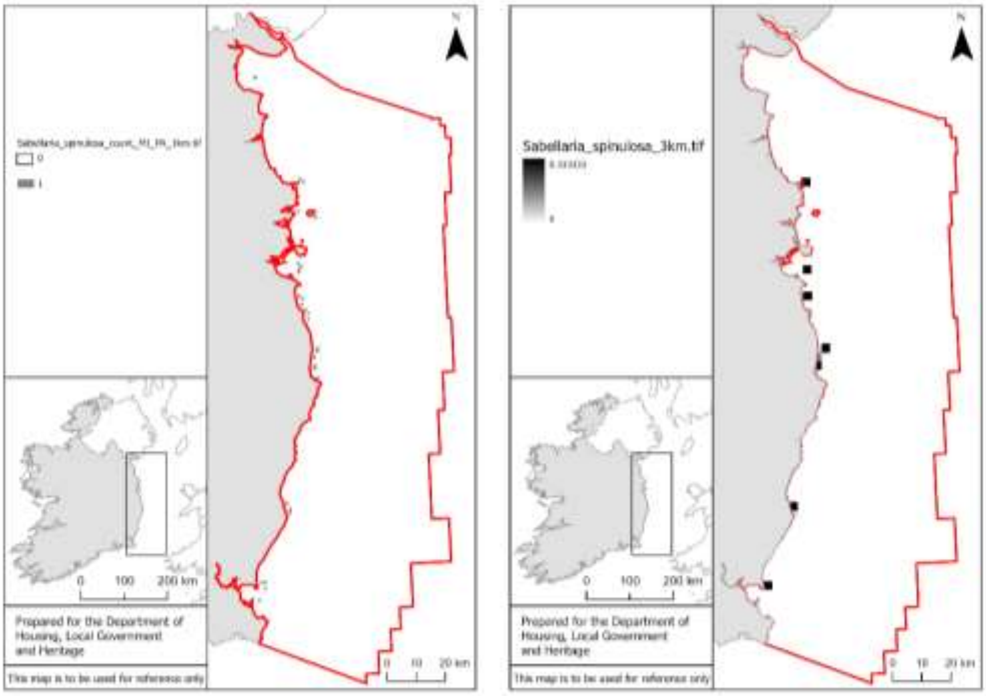


17, 18. Turbot and Witch flounder

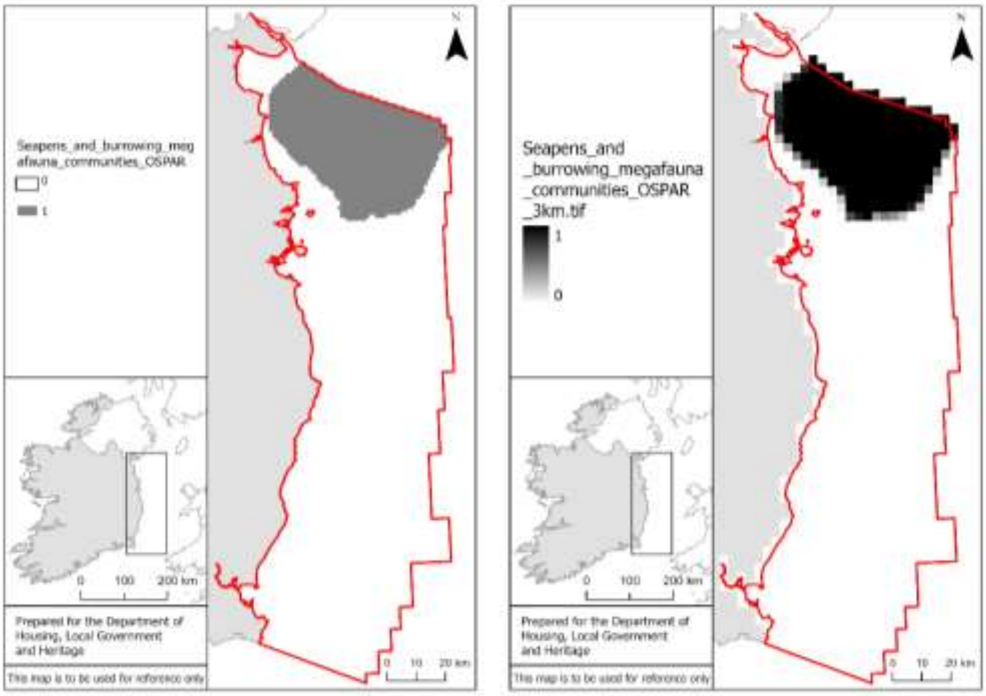
VMS and logbook data were converted to a high confidence presence map from the original VMS logbook rasters where ‘presence’ was represented by the quartile of cells with the highest catch per unit effort value in each of the beam trawl data and otter trawl data layers.



19. Ross worm reefs
Marine Institute WFD benthic data indicating Ross worm counts within 29 cells of the 1 km x 1 km planning unit grid layer were converted to a layer of presence/absence.

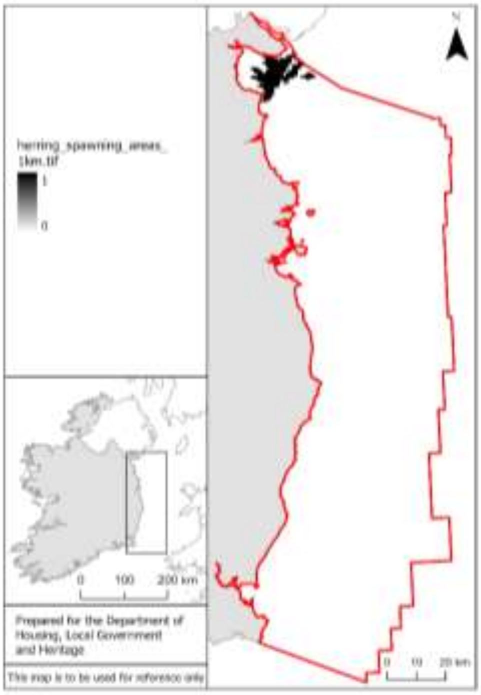


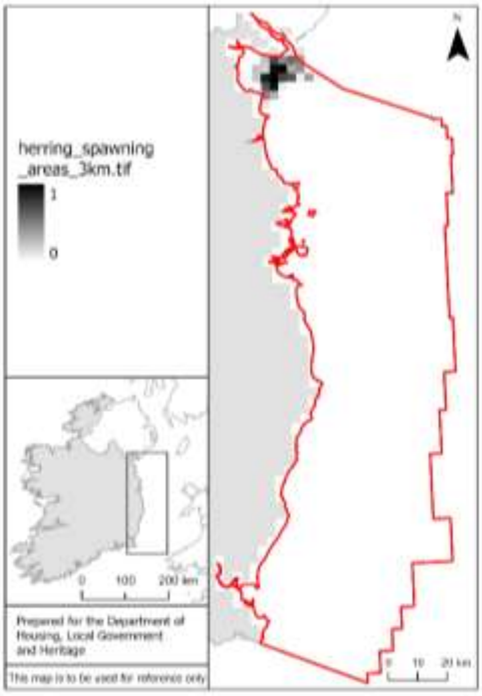
20. Sea pen and burrowing megafauna communities
Data layer used unmodified.



22. Herring spawning grounds/areas/beds

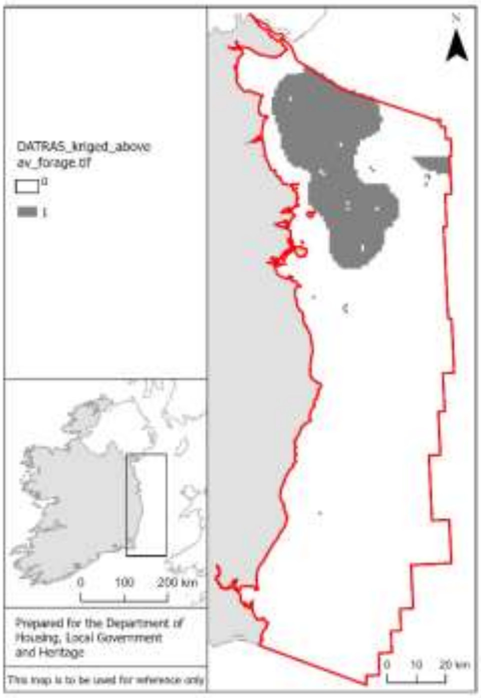
Data layer used unmodified.

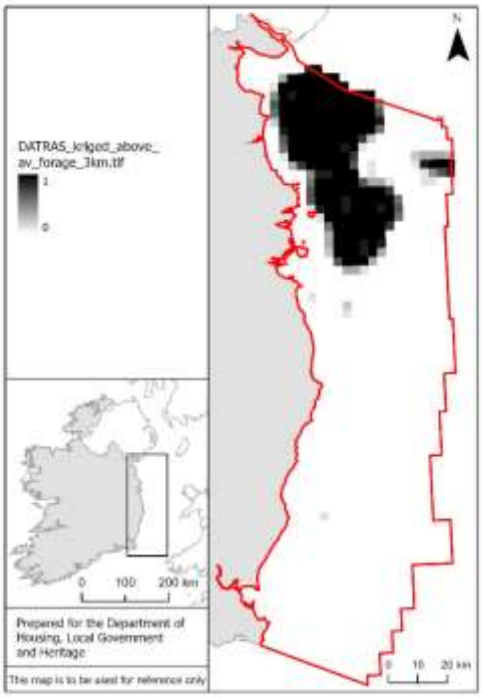




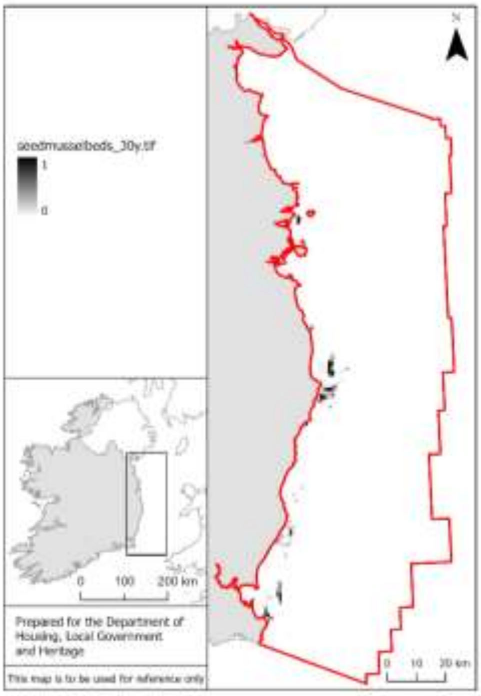
23. Forage/juvenile fish

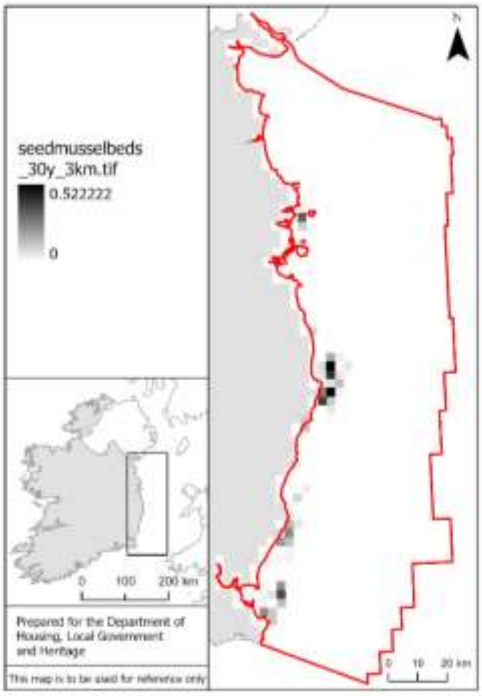
Catch per unit effort in the DATRAS data for each species of forage fish considered were transformed by subtracting the mean for each year (2015-2022) and dividing by the relevant standard deviation. Layers were then pooled over all species to produce an aggregated dataset of average forage fish catch per station (mean 0). Forage fish catch was interpolated using kriging based on the best-fitting variogram. Areas of above-average aggregate catch (>0) were assumed to be the most important locations for conserving forage fish populations and used in conservation prioritization as a single binary layer.



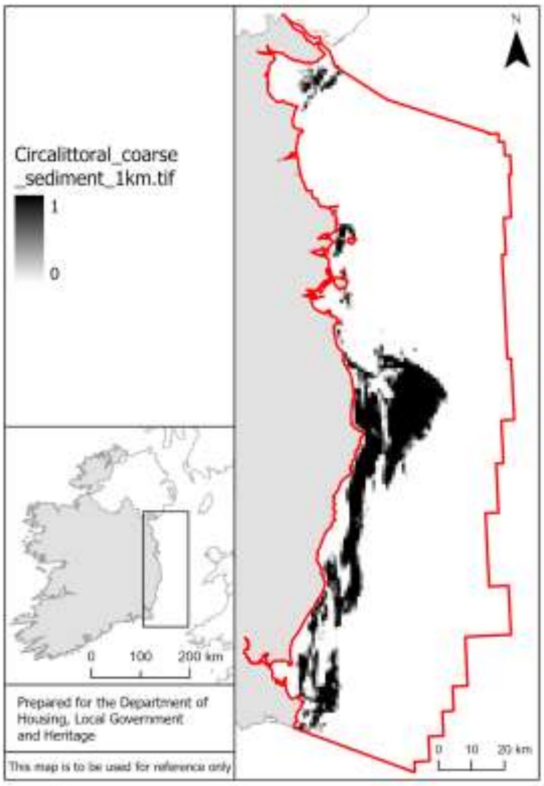


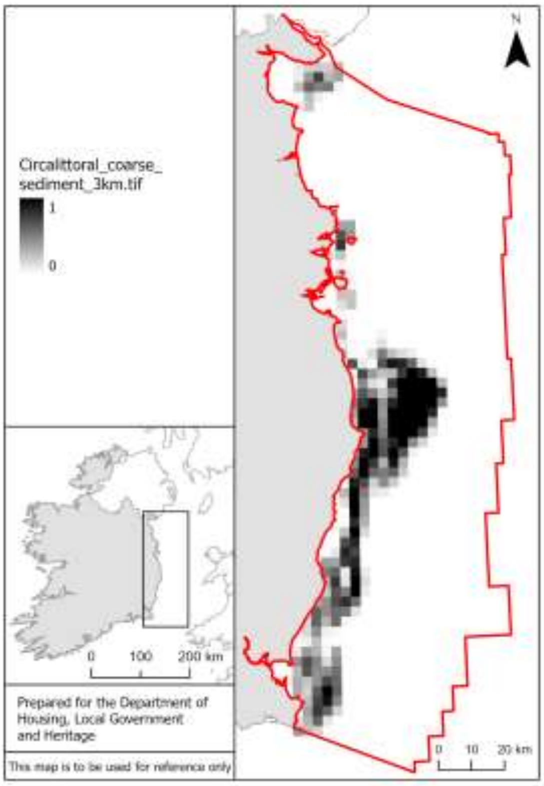
24. Subtidal mussel beds
Data layer used unmodified.

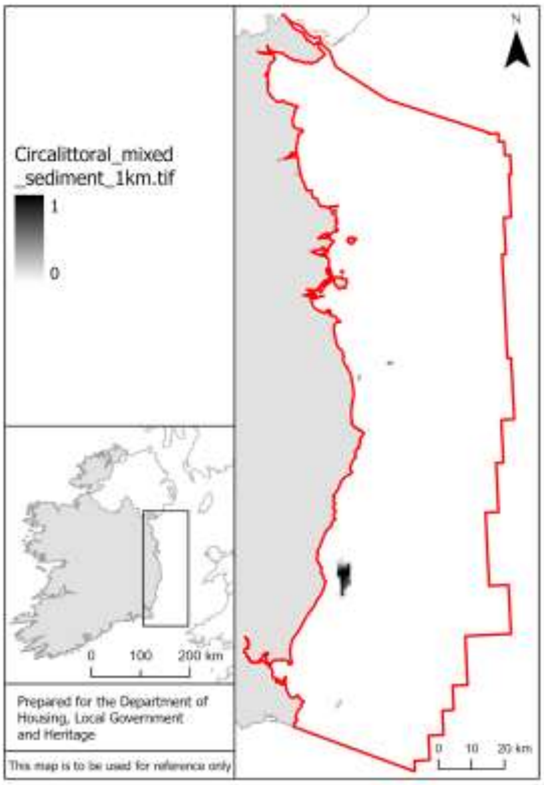


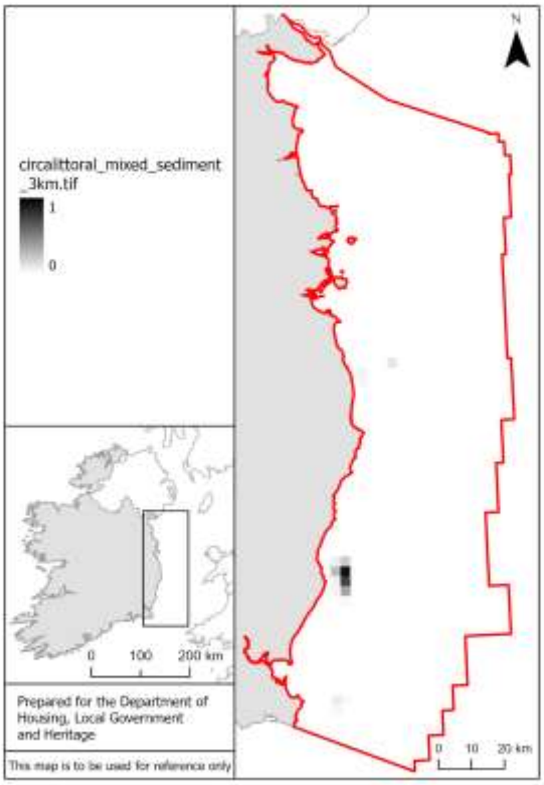


25-37. MSFD habitats
Data layers used unmodified. 13 layers starting with either infralittoral, circalittoral or Offshore_circalittoral. Basemap is figure 2.1.1 in the main report.






Circalittoral_mixed_sediment_1km.tif
1
0
0
100
200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
0
10
20 km


circalittoral_mixed_sediment_3km.tif
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Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
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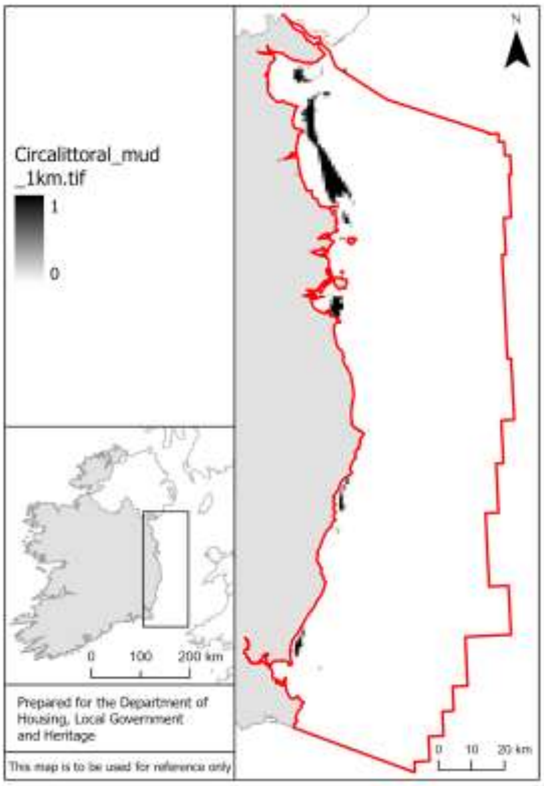
20 km


Circalittoral_mud_1km.tif
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Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
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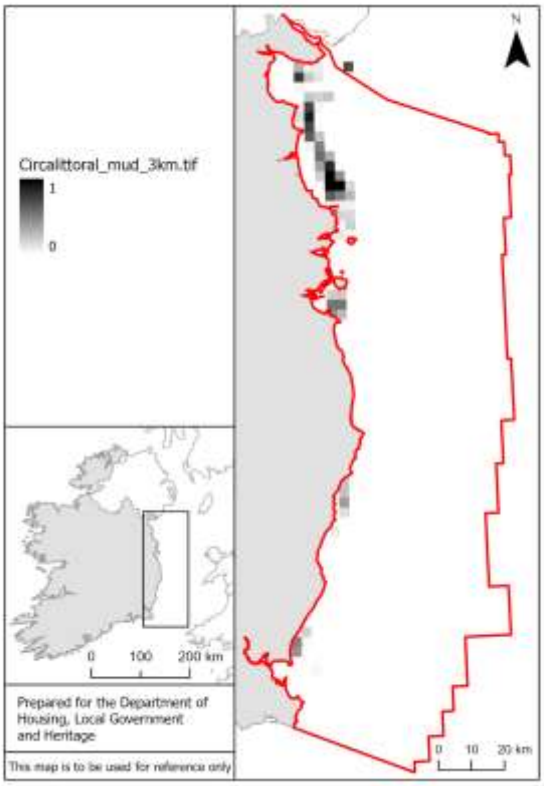
10
20 km


Circalittoral_mud_3km.tif
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100
200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
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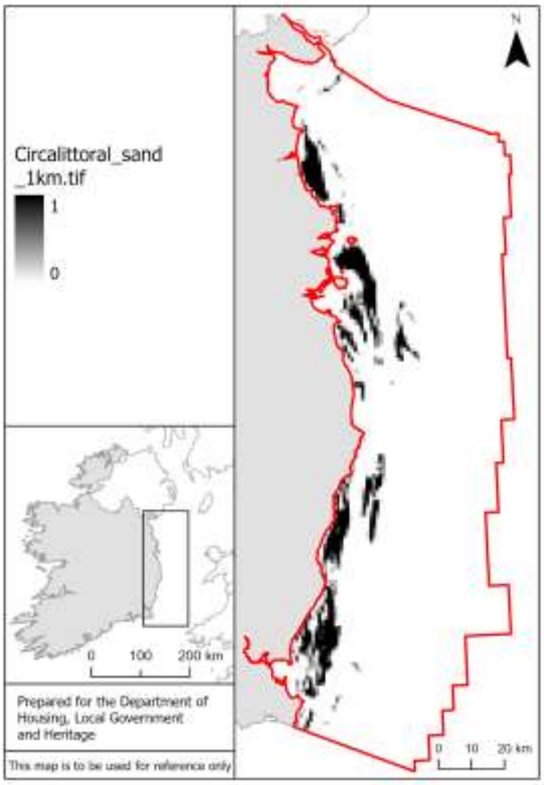
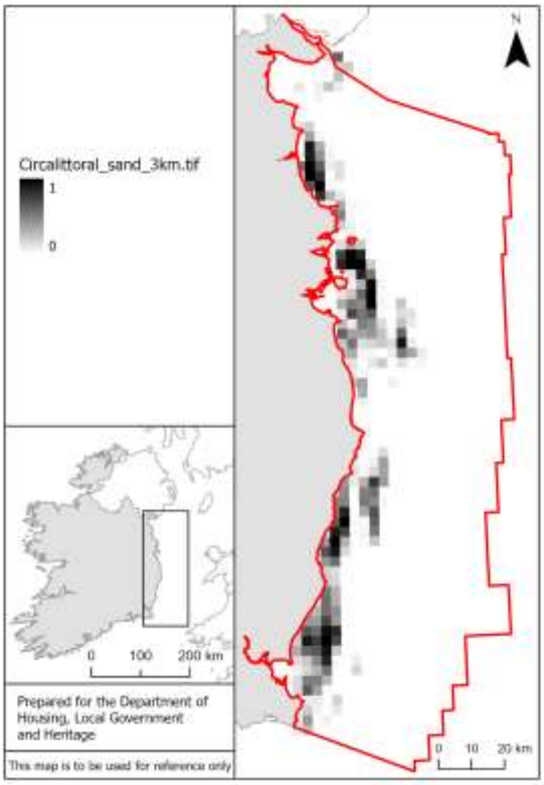
20 km


Circalittoral_sand
_1km.tif
1
0
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
0 10 20 km


Circalittoral_sand_3km.tif
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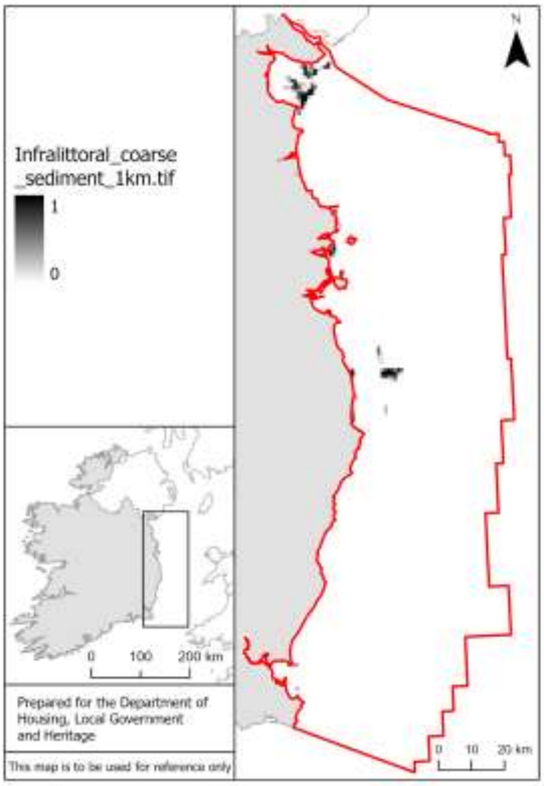
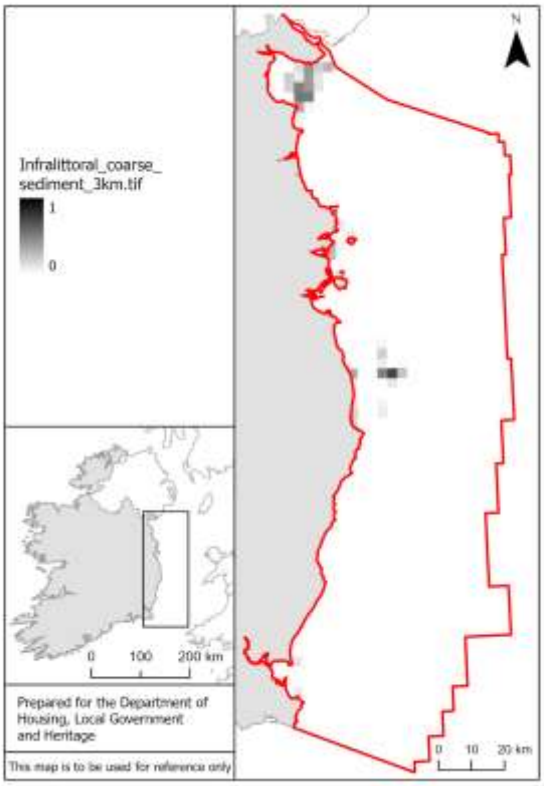
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
0 10 20 km


Infralittoral_coarse
_sediment_1km.tif
1
0
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
0 10 20 km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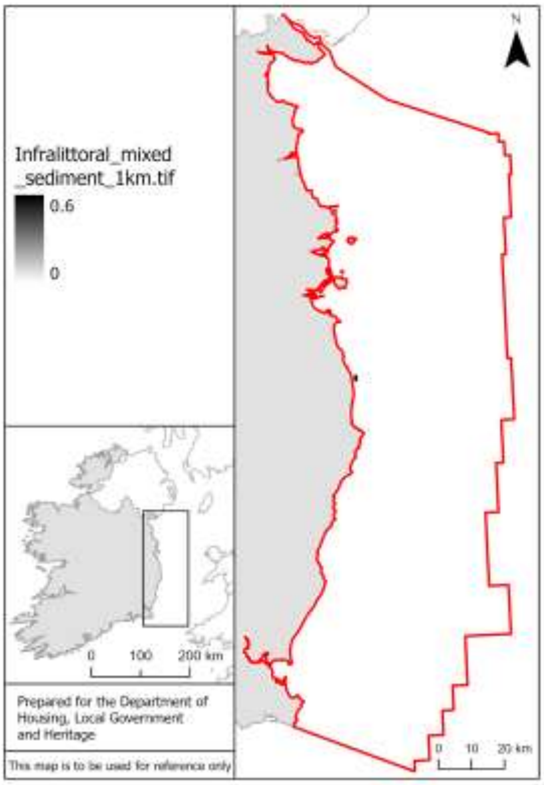
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
0 10 20 km


Infralittoral_mixed
_sediment_1km.tif
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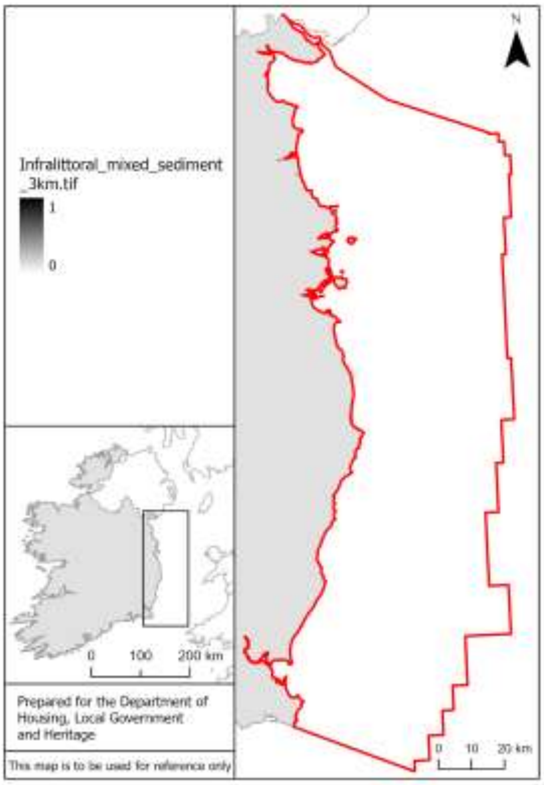
100
200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
0
10
20 km


Infralittoral_mixed_sediment
_3km.tif
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200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
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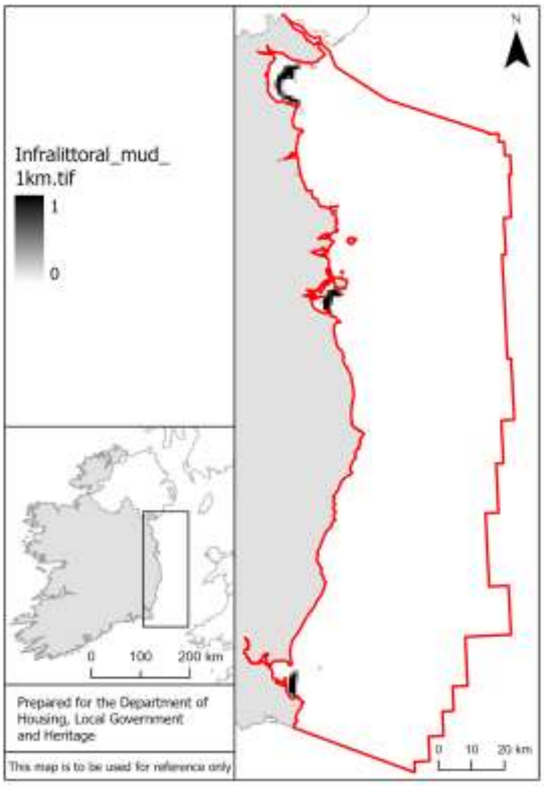
20 km


Infralittoral_mud_
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200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
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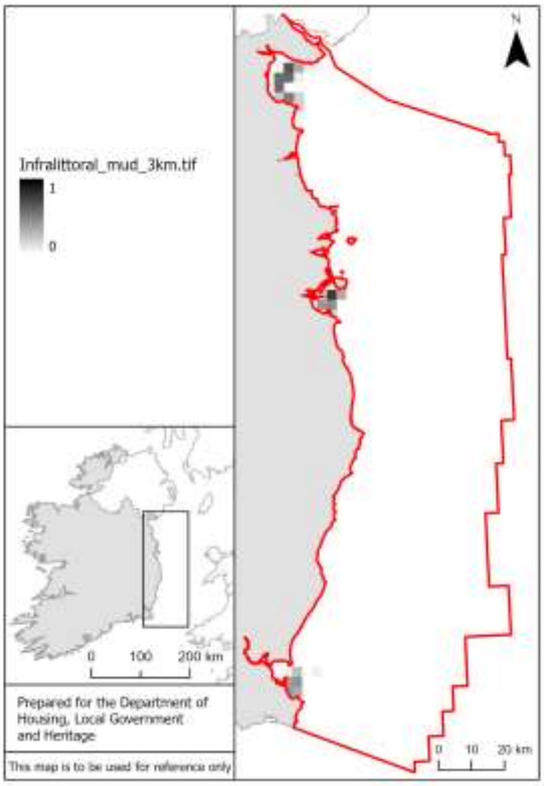
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Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
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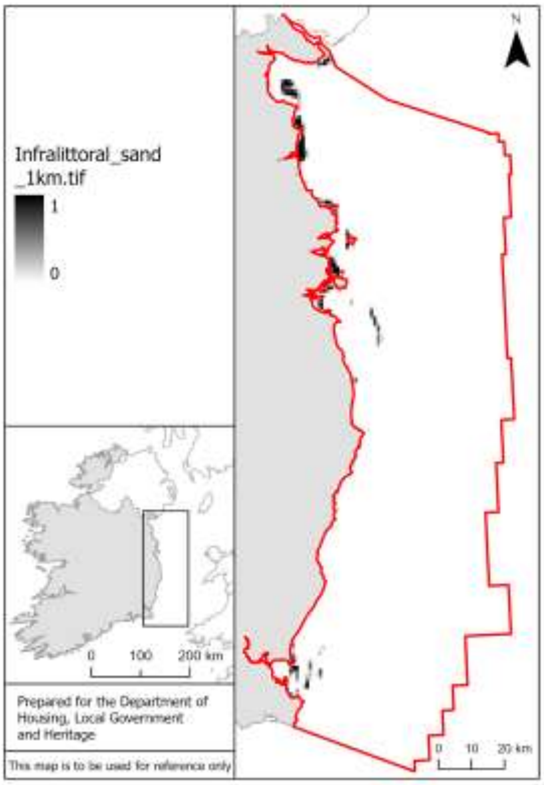
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Prepared for the Department of Housing, Local Government and Heritage
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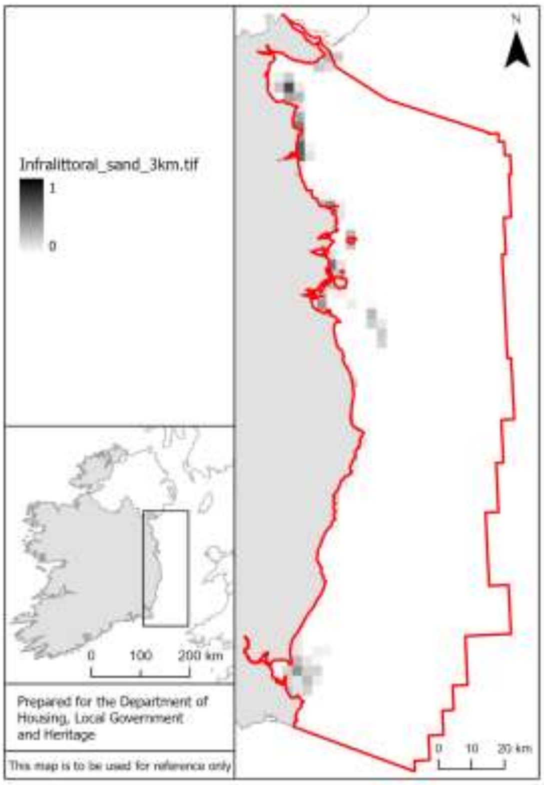
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Prepared for the Department of Housing, Local Government and Heritage
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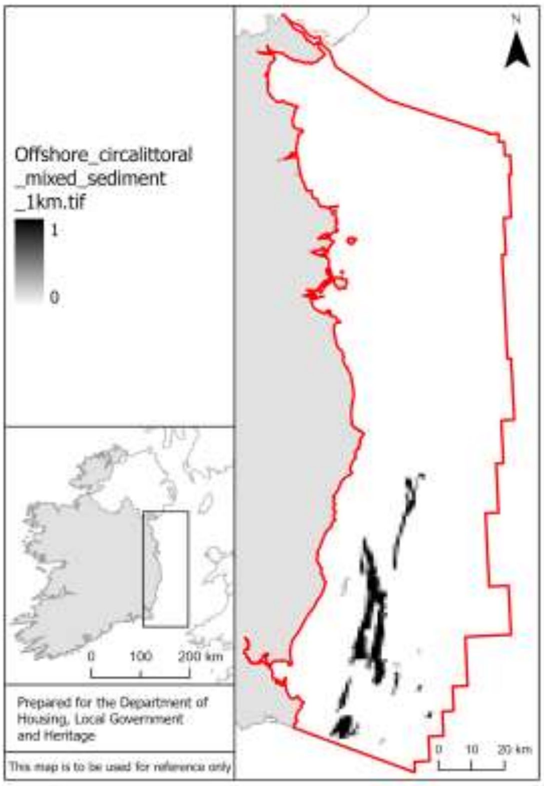
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Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
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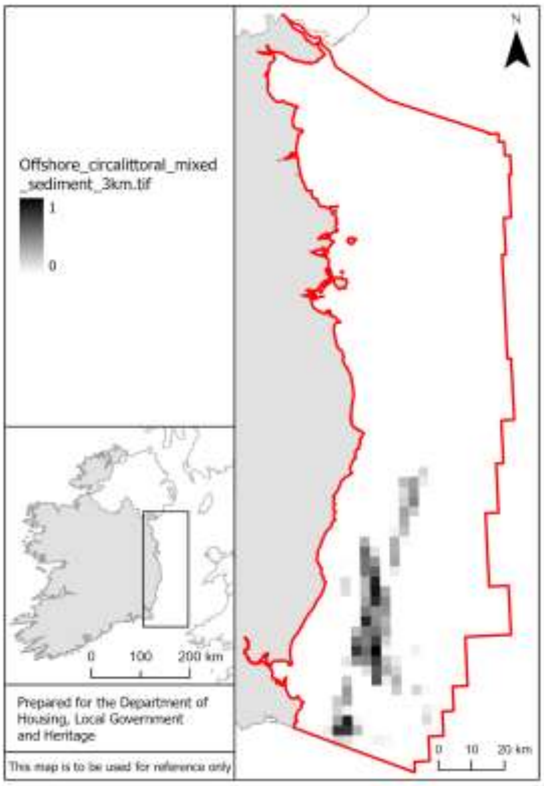
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Prepared for the Department of Housing, Local Government and Heritage
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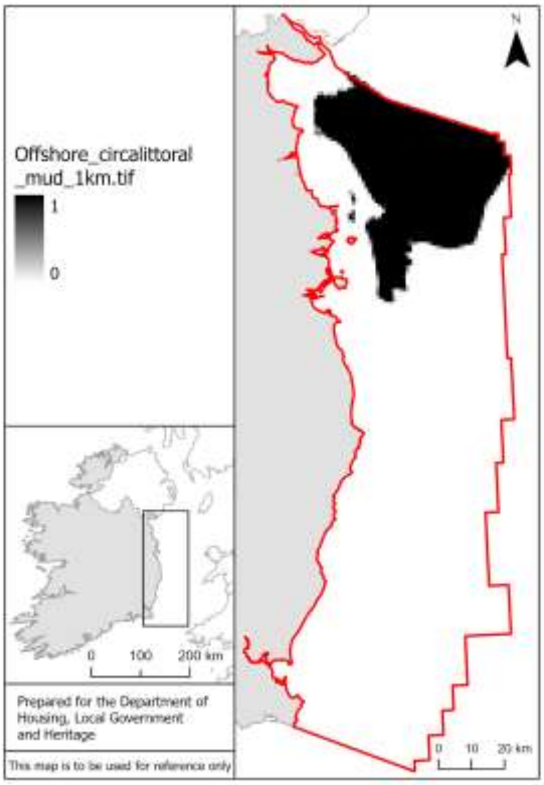
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Prepared for the Department of
Housing, Local Government
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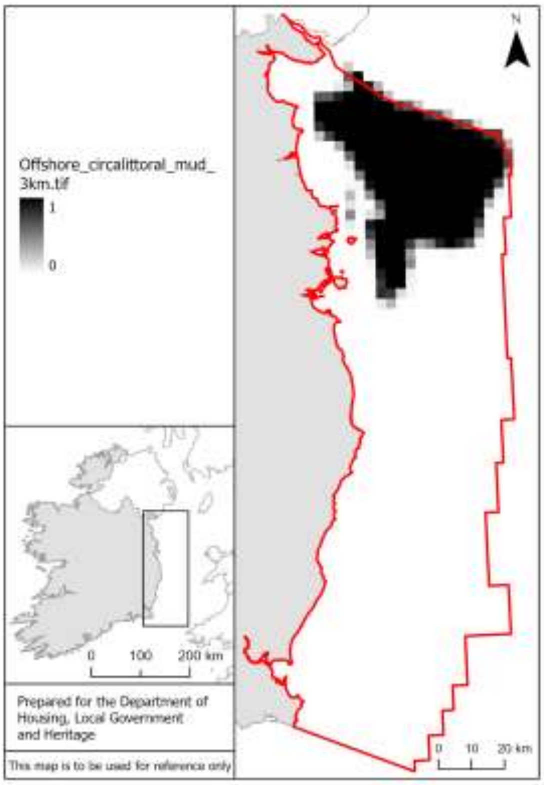
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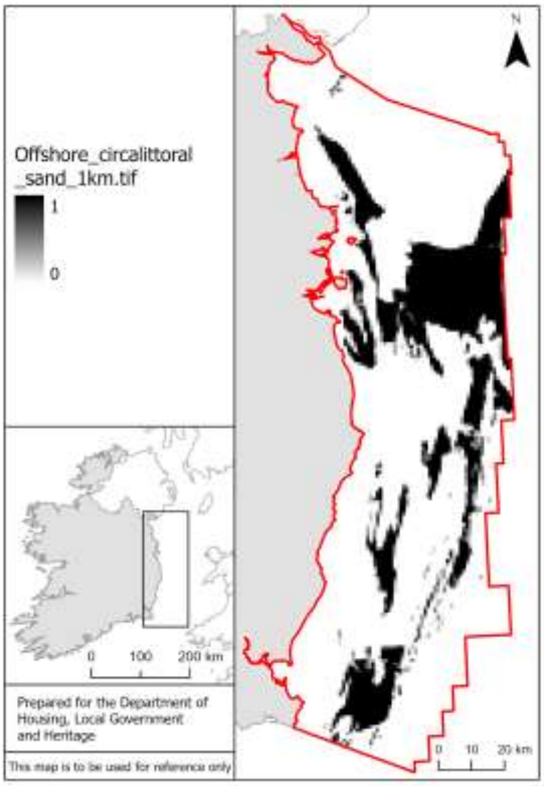
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Housing, Local Government
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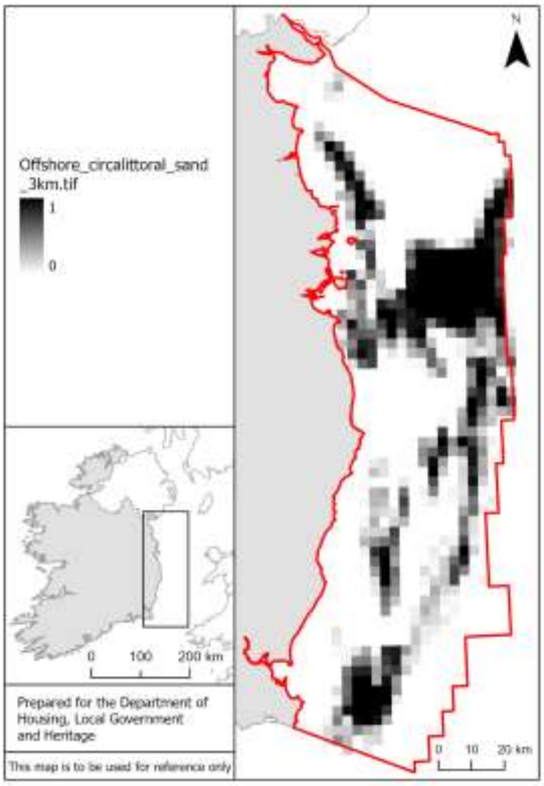
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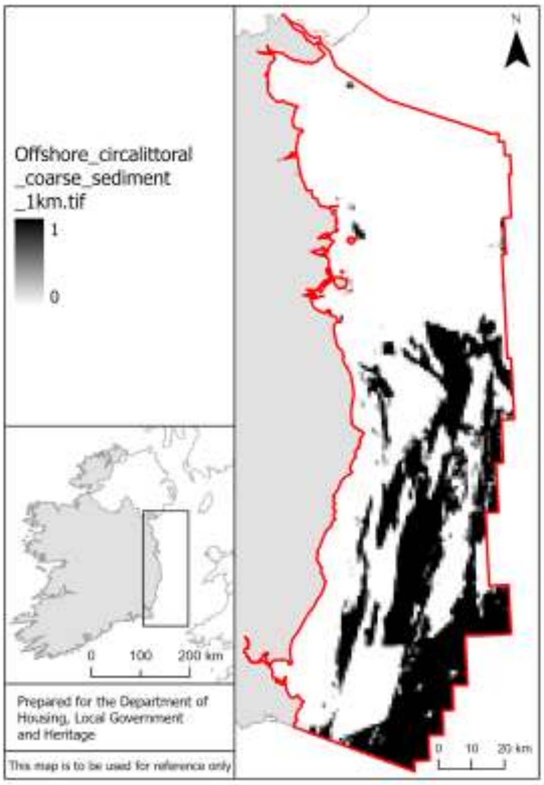
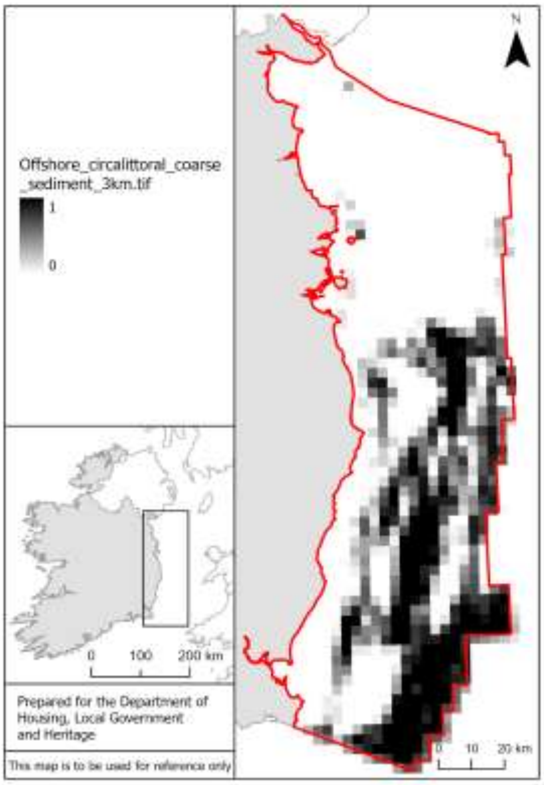
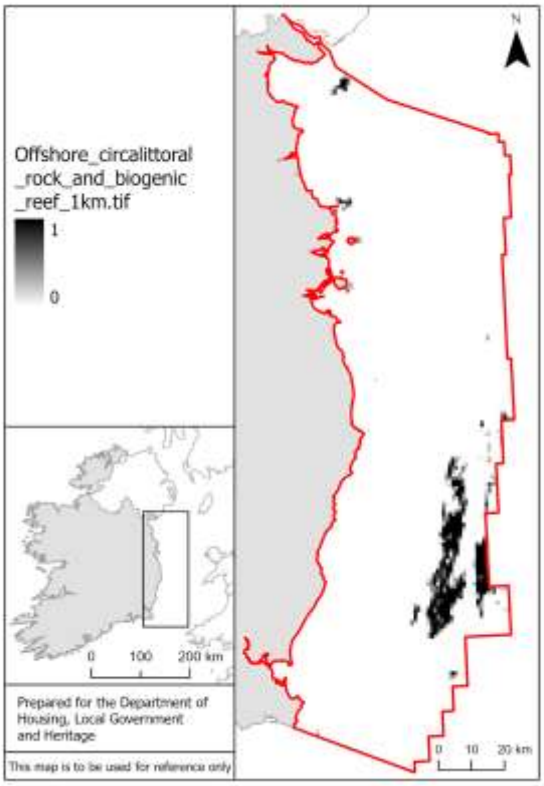
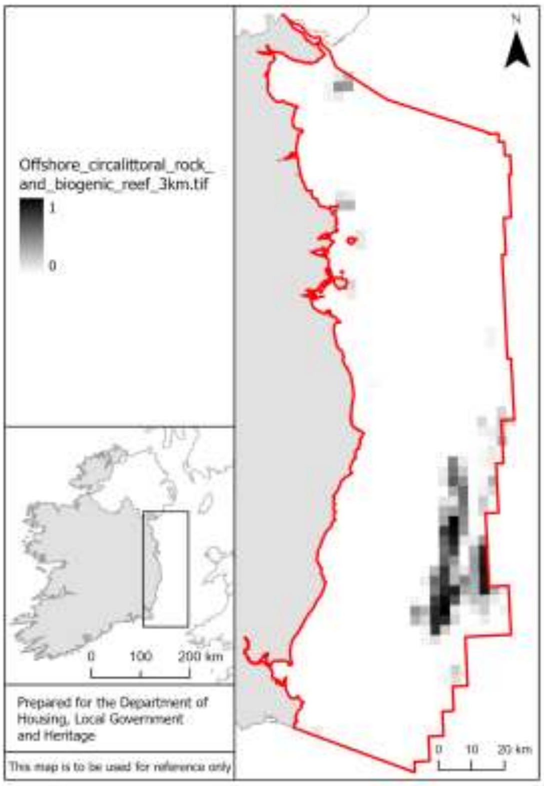




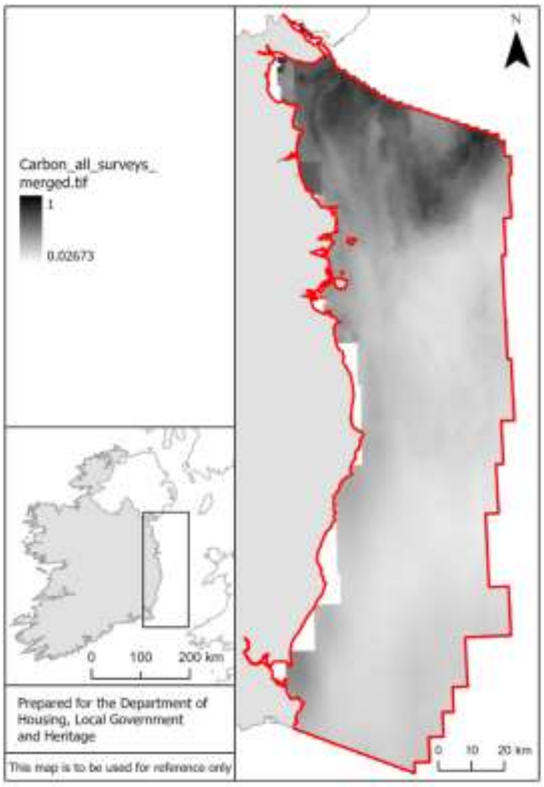


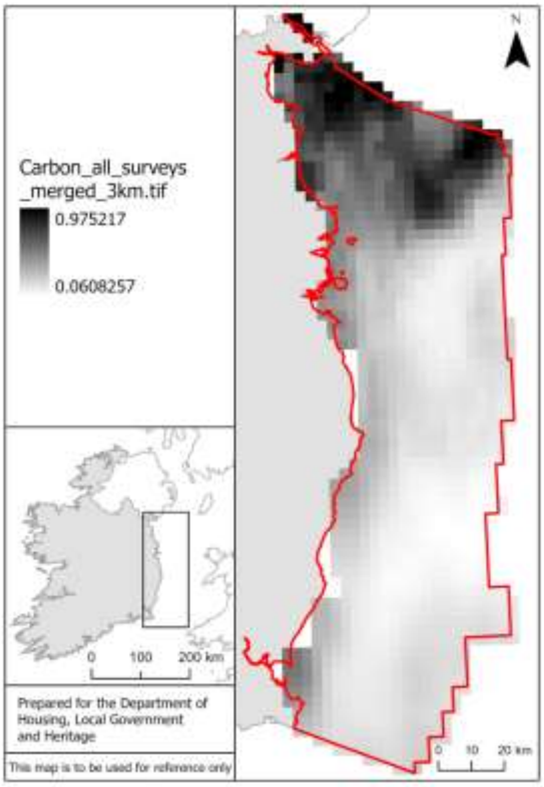


38. Carbon sequestration

Available merged data layer generated from the individual data layers of the studies by

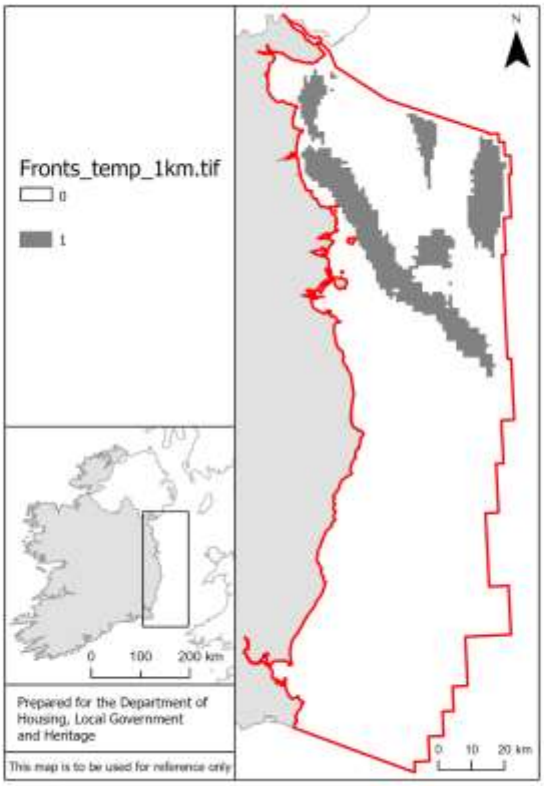
Smeaton, Wilson and Diesing used unmodified.





40. Western Irish Sea Front

Based on modelled temperature layers from the Marine Institute for each month. Maximum contrast in water column structure was calculated as the variance of dT values in 9-cell blocks. These values were summed across all 12 months, areas where there was very low variance were removed, and the cell values converted to presence/absence to flag areas of high variance (contrast). 'Absence' cells surrounded by at least 3 'presence' were converted to presence to construct a contiguous feature.



Fronts_temp_1km.tif
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Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
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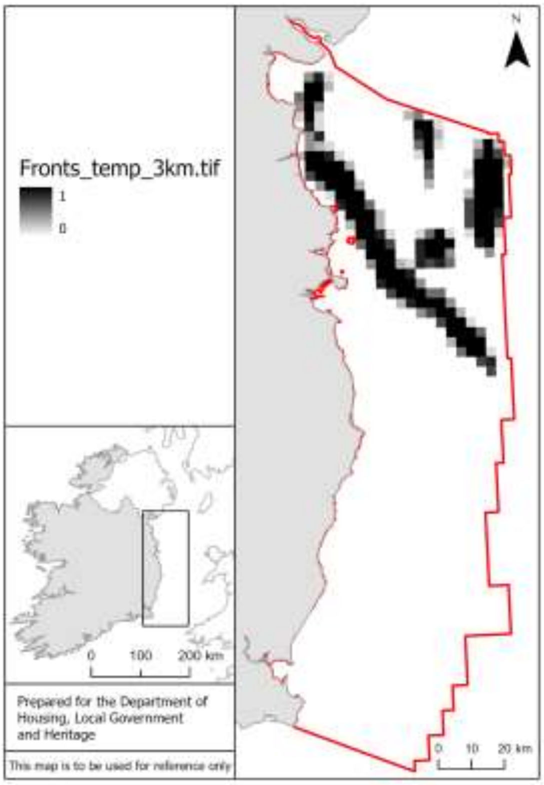

Fronts_temp_3km.tif
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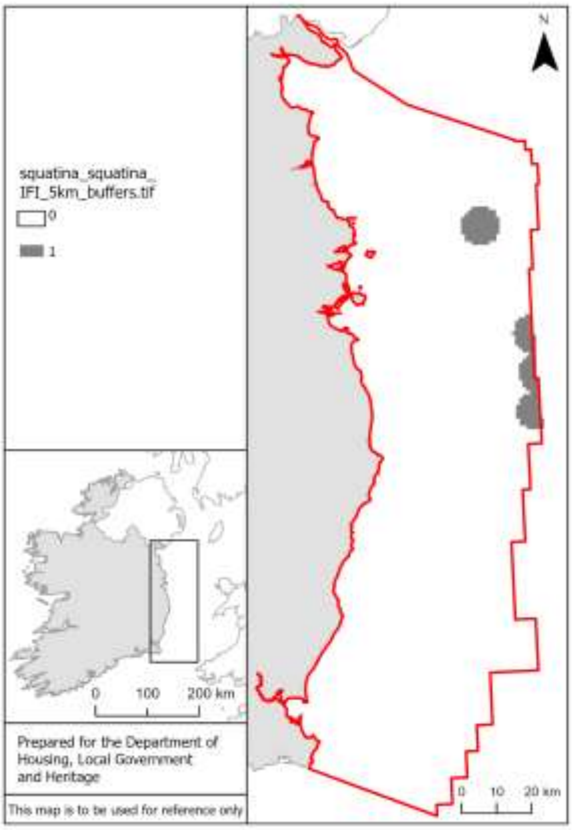
0 100 200 km
Prepared for the Department of Housing, Local Government and Heritage
This map is to be used for reference only
N
0 10 20 km

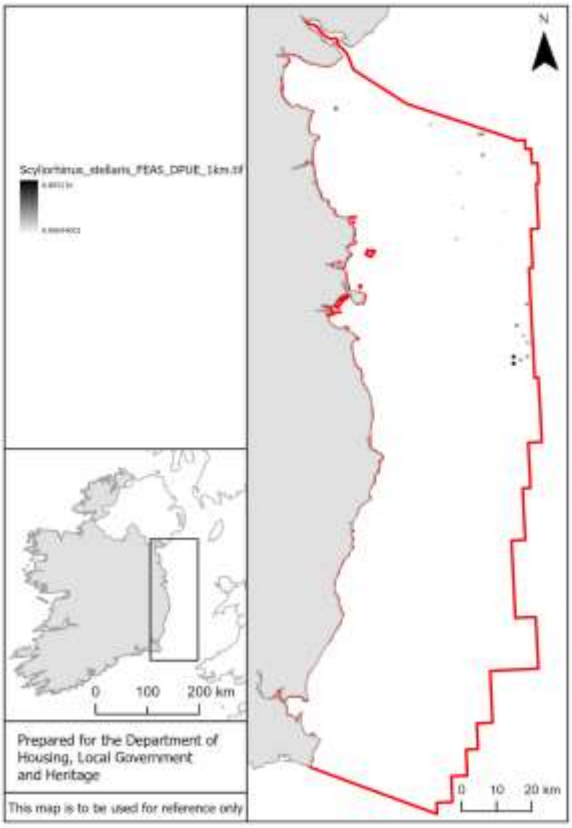
Used as 'extra species' in Zonation evaluation of data-poor features.

2. Angel shark
Some records exist to show areas of interest, but not enough information to confidently identify distribution within the region. Points are based on estimated location of tag/recapture.

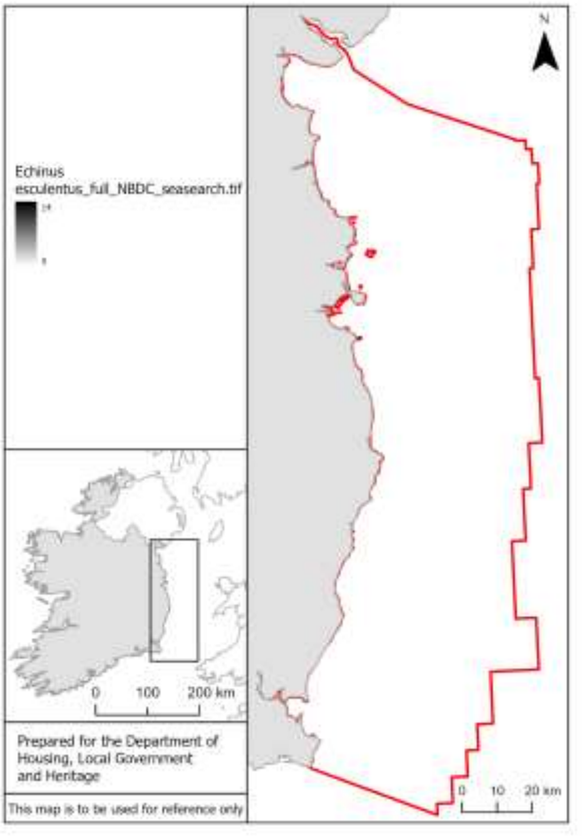


5. Bull Huss

Discards show some localization, but there are gaps in knowledge about the relative importance of these areas.

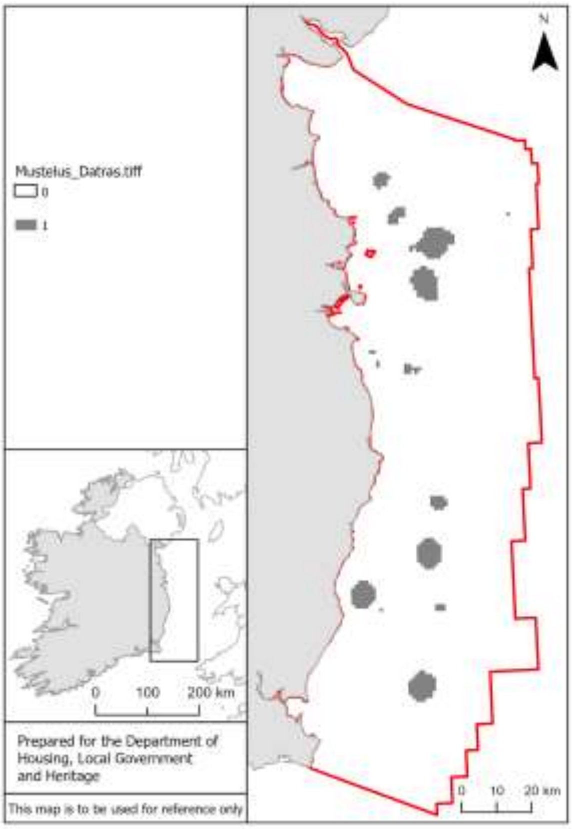


8. Edible sea urchin
Some areas identified from citizen science surveys, but not clear how far this represents range.



14. Starry smooth-hound

Some catches in DATRAS surveys. Data transformed by mean for year. Interpolated by kriging based on a geostatistical model. Areas of above average catch identified in binary raster. Not clear if this represents all important areas.

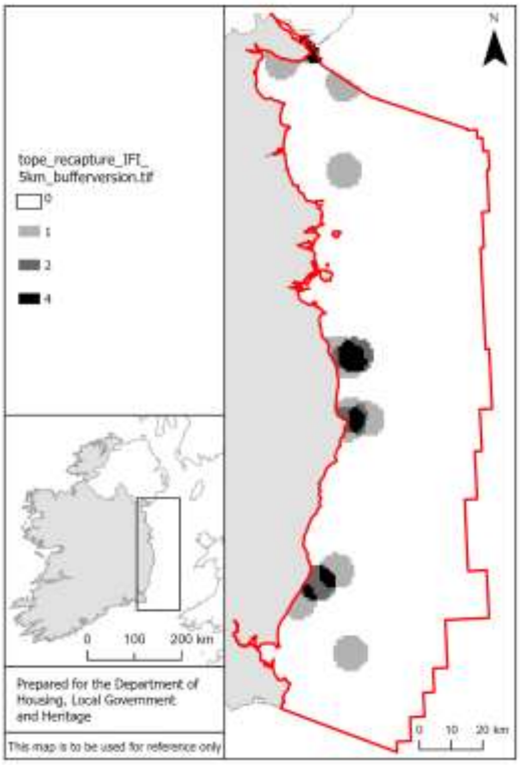


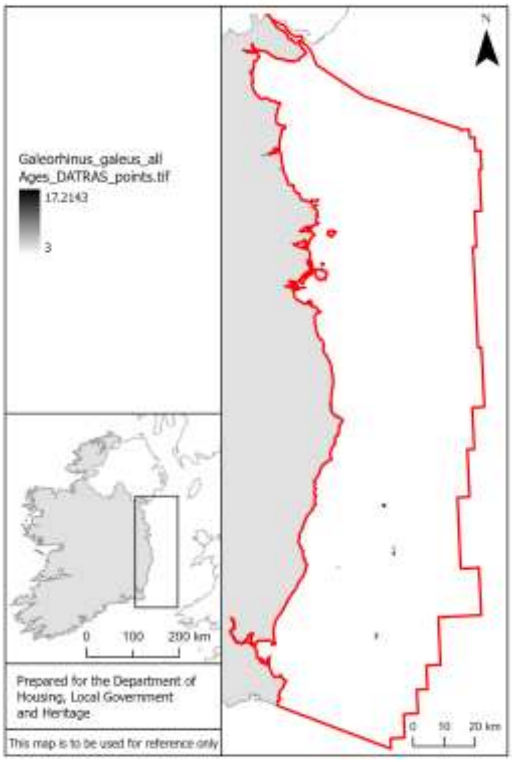
16. Tope

Limited data. Points from catches in DATRAS, but not sufficient evidence to interpolate by kriging. Shows where species occurs, but not clear if this captures important areas.

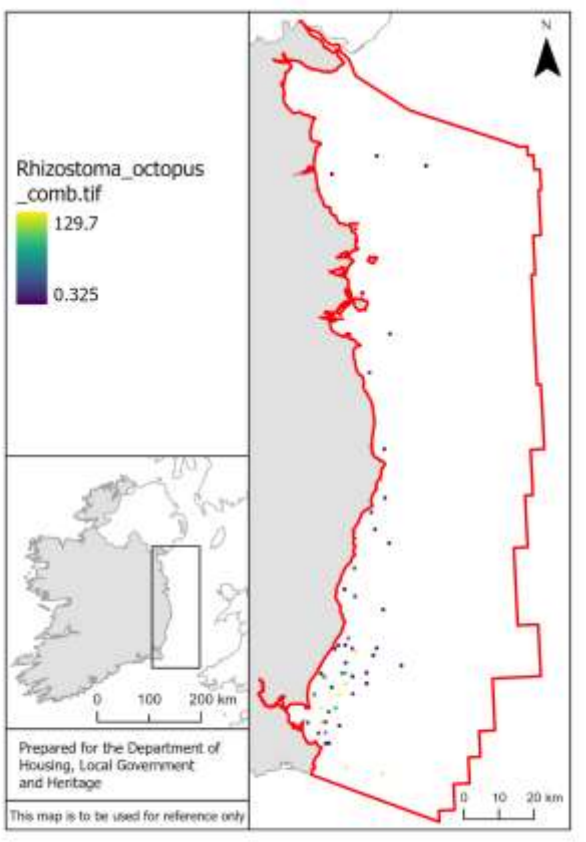
tope_recapture_IFI_5km_bufferversion.tiff

Galeorhinus_galeus_allAges_DATRAS_points.tif





21. Barrel jelly
Survey data, likely to be a persistent area, but the data, from 2003-2004, should be augmented with more recent observations.



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Ball, I.R., Possingham, H. & Watts, M.E. (2009). *Marxan and relatives: Software for spatial conservation prioritisation*. Spatial Conservation Prioritisation: Quantitative Methods & Computational Tools (eds A. Moilanen, K.A. Wilson & H. Possingham), pp. 185–189. Oxford University Press, Oxford, UK.

Hanson, J.O., Schuster, R., Morrell, N., Strimas-Mackey, M., Edwards, B.P.M., Watts, M.E., Arcese, P., Bennett, J., Possingham, H.P. (2023). *prioritizr*: Systematic Conservation Prioritization in R. R package version 8.0.1. Available at https://CRAN.R-project.org/package=prioritizr.

Lehtomäki, J., & Moilanen, A. (2013). Methods and workflow for spatial conservation prioritization using Zonation. *Environmental Modelling & Software*, *47*, 128–137. https://doi.org/10.1016/j.envsoft.2013.05.001

Moilanen, A., Kohonen, I., Lehtinen, P., Jalkanen, J., Virtanen, E., & Kujala, H. (2002). Zonation 5 v1.0 user manual. https://zonationteam.github.io/Zonation5/

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403(6772)*, 853–858. https://doi.org/10.1038/35002501

Rodrigues, A.S., Cerdeira, O.J., Gaston, K.J. (2000). Flexibility, efficiency, and accountability: adapting reserve selection algorithms to more complex conservation problems. *Ecography*, *23*, 565–574. https://doi.org/10.1111/j.1600-0587.2000.tb00175.x

Appendix 6
Features that were considered for inclusion in this project, but failed to meet the criteria and so were excluded

This list is not an exhaustive compilation of all possible features that could be discussed for inclusion as a feature in Ireland's future MPA network. It simply reports some of the additional discussion undertaken within the constrained time frame of the current project. Consideration was also given the list of features proposed during the public consultation on the MPA Advisory Group Report and a sub-set of those features was included in the project (as listed in Table 3.1.1, main report).

Feature name	Scientific name	Feature type	Justification for exclusion	Further information
Atlantic bluefin tuna	*Thunnus thynnus*	Species	Existing protection and/or management	Managed under the Common Fisheries Policy (2016)
Birdbeak dogfish	*Deania calcea*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Black corals	*Antipatharia spp.*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Blackmouth catshark	*Galeus melastomus*	Species	The western Irish Sea was not deemed a significant part of its range	
Blue shark	*Prionace glauca*	Species	The western Irish Sea was not deemed a significant part of its range	
Bramble shark	*Echinorhinus brucus*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Burrowing anemone	*Edwardsia spp, Mesacmaea mitchelli, Scholanthus callimorphus, Cerianthus lloydii*	Species	Listed as priority species by NI Environment Agency or the Welsh Government but not on OSPAR or IUCN lists	Criteria not directly applicable to Ireland and wider research and discussion considered necessary for inclusion. Therefore not included in this project, but may merit inclusion in future features lists
Carbonate mounds		Habitat	Existing protection and/or management, being on the OSPAR list of threatened and/or declining habitats. Defined by OSPAR as a deep water/oceanic feature. The western Irish Sea is thus excluded.	Submarine structures made by leaking gases, some of which may contain carbonates of various kinds, are a listed habitat type under Habitats Directive Annex I. The Codling Fault Zone SAC is such a site in the western Irish Sea.
Celtic Sea Front		High biodiversity	Very limited overlap with the area of interest.	
Cod	*Gadus morhua*	Species	Existing protection and/or management	Managed under the Common Fisheries Policy (2016)

Common cuttlefish	*Sepia officinalis*	Species	The western Irish Sea was not deemed a significant part of its range	
Common eelgrass	*Zostera marina*	Habitat	Existing protection and/or management	Protected under the EU Habitats Directive
Common skate (blue and flapper skate)	*Dipturis spp.* complex	Species	The western Irish Sea was not deemed a significant part of its range	Any spatial management would be restorative, as common skate are considered absent
Common smoothhound	*Mustelus mustelus*	Species	The western Irish Sea was not deemed a significant part of its range	No records in the western Irish Sea
Common stingray	*Dasyatis pastinaca*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Common thresher shark	*Alopias vulpinus*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Coral Maërl	*Phymatolithon calcareum*	Habitat	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Deep-sea sponge aggregations		Habitat	The western Irish Sea was not deemed a significant part of its range	
DeFolin's lagoon snail	*Caecum armoricum*	Species	The western Irish Sea was not deemed a significant part of its range	
Electric ray	*Tetronarce nobiliana*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
European spiny lobster	*Palinurus elephas*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
European sturgeon	*Acipenser sturio*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Fan mussel	*Atrina fragilis*	Species	The western Irish Sea was not deemed a significant part of its range	No records in the western Irish Sea
Giant goby	*Gobius cobitis*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Gulper shark	*Centrophorus granulosus*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Haddock	*Melanogrammus aeglefinus*	Species	Existing protection and/or management	Managed under the Common Fisheries Policy (2016)
Horse mackerel	*Trachurus trachurus*	Species	Existing protection and/or management	Managed under the Common Fisheries Policy (2016)
Kaleidoscope jellyfish	*Haliclystus auricula*	Species	The western Irish Sea was not deemed a significant part of its range	
Kelp forests	*Laminariales*	Habitat	Excluded due to incidental protection gained by close association with Reef, which has existing protection and/or management.	Reef is a listed habitat under Annex I of the Habitats Directive
Kitefin shark	*Dalatias licha*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea.

Lace corals	*Stylasteridae spp.*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea.
Lagoon sand shrimp	*Gammarus insensibilis*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Leafscale gulper shark	*Centrophorus squamosus*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Leatherback turtle	*Dermochelys coriacea*	Species	Existing protection and/or management	Protected under the EU Habitats Directive
Loggerhead turtle	*Caretta caretta*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Long-snouted seahorse	*Hippocampus guttulatus*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Lophelia pertusa reefs	*Lophelia pertusa*	Habitat	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea.
Northeast Atlantic spurdog	*Squalus acanthias*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Northern horsemussel beds	*Modiolus modiolus beds*	Habitat	The western Irish Sea was not deemed a significant part of its range	Limited records of individuals but no records of *Modiolus modiolus beds* in the western Irish Sea
Ocean sunfish	*Mola mola*	Species	The western Irish Sea was not deemed a significant part of its range	
Peacock's tail	*Padina pavonica*		Listed as priority species by NI Environment Agency or the Welsh Government but not on OSPAR or IUCN lists	Criteria not directly applicable to Ireland and wider research and discussion considered necessary for inclusion. Therefore not included in this project, but may merit inclusion in future features lists
Porbeagle shark	*Lamna nasus*	Species	Not amendable to spatial protection	Current evidence suggests this highly mobile species is not amenable to spatial protection
Portuguese dogfish	*Centroscymnus coelolepis*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Primary productivity	*N/A*	Ecosyste m service	Not considered separately in this project	Part of the rationale for including ocean fronts and recognised as a benefit of protection afforded to algae and seagrass under the Habitats Directive
Rabbitfish	*Chimaera monstrosa*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Round ray	*Rajella fyllae*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Sandy skate	*Leucoraja circularis*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea

Scarlet and gold star-coral	*Balanophyllia regia*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Seagrass beds		Habitat	Seagrass if it occurs in shallow subtidal waters or in intertidal areas would be protected as part of large shallow inlets and bays designated under the HD	
Sea lamprey	*Petromyzon marinus*	Species	Existing protection and/or management	Habitats Directive
Seamounts	*N/A*	Habitat	The western Irish Sea was not deemed a significant part of its range	No records in the western Irish Sea
Shagreen skate	*Leucoraja fullonica*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Small eyed ray	*Raja microocellata*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Southern cup coral	*Caryophyllia inornata*	Species	Listed as priority species by NI Environment Agency or the Welsh Government but not on OSPAR or IUCN lists	Criteria not directly applicable to Ireland and wider research and discussion considered necessary for inclusion. Therefore, not included in this project, but may merit inclusion in future features lists.
Stony corals	*Scleractinia spp.*	Habitat	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Sunset cup coral	*Leptosammia pruvoti*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Tall sea pen	*Funiculina quadrangularis*	Habitat	Included in ‘Sea pen and burrowing megafauna community’	
Tentacled lagoon worm	*Alkmaria romijni*	Species	Listed as priority species by NI Environment Agency or the Welsh Government but not on OSPAR or IUCN lists	Criteria not directly applicable to Ireland and wider research and discussion considered necessary for inclusion. Therefore, not included in this project, but may merit inclusion in future features lists
Undulate Skate	*Raja undulata*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
Weymouth carpet coral	*Hoplangia durotrix*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea
White skate	*Rostroraja alba*	Species	The western Irish Sea was not deemed a significant part of its range	No (or limited) records in the western Irish Sea

Appendix 7
Full list of data sources considered with assessments of data quality

Dataset Name	Data Owning Organisation	Data Quality	Comment
Angel Shark Locations	Angel Shark Ireland	Low / Insufficient for SCP	Spatially imprecise
Aquaculture Sites	Department of Agriculture, Food & Marine	Good; observed	
Barrel Jellyfish Aerial Surveys	University College Cork	Low / Insufficient for SCP	Aged Data
Bord Iascaigh Mhara (BIM) Seed Mussel Beds	Bord Iascaigh Mhara	Modelled from good data	
Cargo Vessel Density	EMODnet	Good; observed	
Danger Areas	Irish Aviation Authority	Good; observed	
Dedman et al. (2015) Species Distribution Model (SDM)	Dedman et al. (2015)	Modelled from moderate data	
Diesing et al. (2017) Carbon Sequestration	Diesing et al. (2017)	Modelled from moderate data	
EMODnet Macroalgal	EMODnet	Moderate; observed	Spatial Gaps
Estuaries of Ireland	Department of Housing, Local Government, and Heritage	Good; observed	
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	
Exploration Wells	Department of Environment, Communications & Climate	Good; observed	
GBIF Dog Whelk	GBIF	Low / Insufficient for SCP	
Harbour Limits	Marine Institute	Good; observed	
Herring Spawning Grounds	Agri-Food & Biosciences Institute	Modelled from good data	
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data	
Inland Fisheries Ireland (IFI) Water Framework Directive (WFD) Fish Ecological Status	Inland Fisheries Ireland	Good; observed	
Inland Fisheries Ireland Tag and Recapture	Inland Fisheries Ireland	Moderate; observed	Spatial Gaps
Inshore Fisheries VMS	Marine Institute	Good; observed	

International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for Exploration of the Seas	Good; observed	Surveys used: NIGFS and IGFS
Irish Kelp Forests	Kate Schoenrock (Environmental Protection Agency and Irish Research Council)	N/A	Not within the AOI
Irish Whale & Dolphin Group (IWDG) Basking Shark Sightings	Irish Whale & Dolphin Group	Moderate; observed	
Marine Institute Observer At Sea Sampling Data	Marine Institute	Moderate; observed	
Marine Institute Oceanographic Models	Marine Institute	Modelled from good data	
Marine Institute Razor Clam Survey	Marine Institute	Moderate; observed	
Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data	
Marine Institute Water Framework Directive Benthic Data	Marine Institute	Moderate; observed	
MDAC Mounds	National Parks & Wildlife Services	Modelled from moderate data	
Military and Law Enforcement Vessel Density	EMODnet	Good; observed	
National Biodiversity Data Centre (NBDC) Seaweeds of Ireland	The British Phycological Society	Low / Insufficient for SCP	Aged
National Biodiversity Data Centre Seasearch	Seasearch	Moderate; observed	
NPWS Macroalgal	National Parks & Wildlife Services (NPWS)	Moderate; observed	Spatial Gaps
ObSERVE Megafauna Sightings	University College Cork	Moderate; observed	
ObSERVE predicted Basking Shark Distribution	University College Cork	Modelled from moderate data	
Offshore Pipelines	Department of Housing, Local Government & Heritage	Good; observed	
OSPAR Seapens and Burrowing Communities	OSPAR	Modelled from good data	

Passenger Vessel Density	EMODnet	Good; observed	
Pot Fishing	Marine Institute	Good; observed	
Protected Shipwrecks	National Monuments Service	Good; observed	
Service Vessel Density	EMODnet	Good; observed	
Smeaton and Austin (2022) Carbon Sequestration	Smeaton and Austin (2022)	Modelled from moderate data	
Survey Effort	Marine Institute	Good; observed	
Tanker Vessel Density	EMODnet	Good; observed	
Tug and Towing Vessel Density	EMODnet	Good; observed	
Wilson et al., (2018) Carbon Sequestration	Wilson et al. (2018)	Modelled from moderate data	
Windfarm Licence Polygons	Department of Housing, Local Government & Heritage	Good; observed	

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Appendix 8
Datasets used for each feature in *prioritizR*, data sources and quality

Feature	Data Source										
	OSPAR Seapens & Burrowing Communities	Marine Institute Razor Clam Survey	Marine Institute WFD Benthic Data	DATRAS kriged data	EUSeaMap	Marine Institut VMS and logbook data	Dedman et al SDM	IWDG Basking Shark Sightings & OBSERVE Megafauna sightings combined	BIM Seed Mussel Beds	Marine Institute Oceanographic Models	Estuaries of Ireland & IFI WFD Fish Ecological Status	Diesing, Smeaton & Wilson combined
1. American Plaice				Modelled from good data								
2. Basking Shark								Moderate; observed				
4a. Blonde Ray (adults)						Modelled from good data	Modelled from moderate data					
4b. Blonde Ray (juvenile)							Modelled from moderate data					
6a. Cuckoo Ray (adults)						Modelled from good data	Modelled from moderate data					
6b. Cuckoo Ray (juvenile)							Modelled from moderate					

Feature	Data Source											
	OSPAR Seapens & Burrowing Communities	Marine Institute Razor Clam Survey	Marine Institute WFD Benthic Data	DATRAS kriged data	EUSeaMap	Marine Institut VMS and logbook data	Dedman et al SDM	IWDG Basking Shark Sightings & OBSERVE Megafauna sightings combined	BIM Seed Mussel Beds	Marine Institute Oceanographic Models	Estuaries of Ireland & IFI WFD Fish Ecological Status	Diesing, Smeaton & Wilson combined
							data					
9. European Eel											Good; observed	
10. Icelandic cyprine (ocean quahog)		Moderate; observed										
13a.Spotted Ray (adult)						Modelled from good data	Modelled from moderate data					
13b. Spotted Ray (juvenile)							Modelled from moderate data					
15a. Thornback Ray (adult)						Modelled from good data	Modelled from moderate data					

Feature	Data Source											
	OSPAR Seapens & Burrowing Communities	**Marine Institute Razor Clam Survey**	**Marine Institute WFD Benthic Data**	**DATRAS kriged data**	**EUSeaMap**	**Marine Institut VMS and logbook data**	**Dedman et al SDM**	**IWDG Basking Shark Sightings & OBSERVE Megafauna sightings combined**	**BIM Seed Mussel Beds**	**Marine Institute Oceanographic Models**	**Estuaries of Ireland & IFI WFD Fish Ecological Status**	**Diesing, Smeaton & Wilson combined**
17. Turbot						Modelled from good data						
18. Witch Flounder						Modelled from good data						
19. Ross worm reefs			Moderate; observed									
20. Sea-pen & burrowing megafauna	Modelled from good data											
22. Herring Spawning Grounds					Modelled from good data							
23. Forage Fish				Modelled from good data								

Feature	Data Source											
	OSPAR Seapens & Burrowing Communities	Marine Institute Razor Clam Survey	Marine Institute WFD Benthic Data	DATRAS kriged data	EUSeaMap	Marine Institut VMS and logbook data	Dedman et al SDM	IWDG Basking Shark Sightings & OBSERVE Megafauna sightings combined	BIM Seed Mussel Beds	Marine Institute Oceanographic Models	Estuaries of Ireland & IFI WFD Fish Ecological Status	Diesing, Smeaton & Wilson combined
24. Subtidal Mussel Beds									Modelled from good data			
25-37. MSFD Habitats					Modelled from good data							
38. Carbon Sequestration												Modelled from good data
40. Western Irish Sea Front										Modelled from good data		

Appendix 9
Additional experts consulted for advice, information or data

Dr Andy Wheeler	University College Cork	Carbonate mounds and methane-derived authigenic carbonates (MDACS)
Dr Brendan McHugh	Marine Institute	Chemical contaminant impact
Dr Colm Lordan	Marine Institute	General fisheries advice
Cliona O'Brien	National Parks & Wildlife Service, DHLGH	Marine SAC and SPA site identification, and ongoing developments
Dr David Lyons	National Parks & Wildlife Service, DHLGH	HD-listed marine species/habitats, associated communities and conservation designations
Dr David Tierney	National Parks & Wildlife Service, DHLGH	Marine bird designation analyses and ongoing SPA identification work
Prof. Emer Rogan	University College Cork	Expertise and information on basking sharks
Dr Eoghan Daly	Marine Institute	Hydrodynamic models
Dr Evin McGovern	Marine Institute	Chemical contaminant impact
Dr Garvan O'Donnell	Marine Institute	Nutrient enrichment
Dr Glenn Nolan	Marine Institute	Hydrodynamic models
Grainne Devine	BIM	Aquaculture data and advice
Dr Hans Gerrittsen	Marine Institute	Fishing Effort
Hannah Hood	Joint Nature Conservation Committee, UK	UK MPA designations & associated information sources

Dr Joe McGovern	Marine Institute	Hydrodynamic models
Jon Rees	CEFAS	Wind farm wake formation, sediment resuspension, interactions with frontal systems
Prof. Jonne Kotta	University of Tartu, Estonia	Bluewise4All tool
Dr Karl Brady	Underwater Archaeology Unit, National Monuments Service, DHLGH	Shipwrecks, associated distribution, status & conservation measures
Katie Gilham	NatureScot	Stakeholder engagement
Dr Margot Cronin	Marine Institute	Chemical contaminant impact
Dr Mark Coughlan	University College Dublin	Carbon sequestration
Dr Mark Jessopp	University College Cork	ObSERVE Programme Phase 1 & Phase 2 aerial surveys & data
Mathieu Lundy	AFBI, Northern Ireland	Herring, sprat and/or sandeel shapefiles. Seapen data from UWTV surveys of FU15
Dr Maurice Clarke	Marine Institute	Fisheries monitoring
Paul Coleman	Marine Institute	Benthic habitats
Dr Russell Poole	Marine Institute	Eels
Dr Tomasz Debrowski	Marine Institute	Hydrodynamic models
Dr William Roche	Inland Fisheries Ireland	Diadromous fish and angling
Dr Yvonne Leahy	Planning Division, DHLGH	Marine geogenic/biogenic structures, MDACS and associated biodiversity
Dr Kathryn Schoenrock	University of Galway	Macro algae, kelp forests

Wind Energy representatives	Multiple organisations	Data and unpublished information; online meeting organised by Wind Energy Ireland

Appendix 10
Case reports

1. American plaice or long rough dab (*Hippoglossoides platessoides*)

Irish name: Daba fada garbh

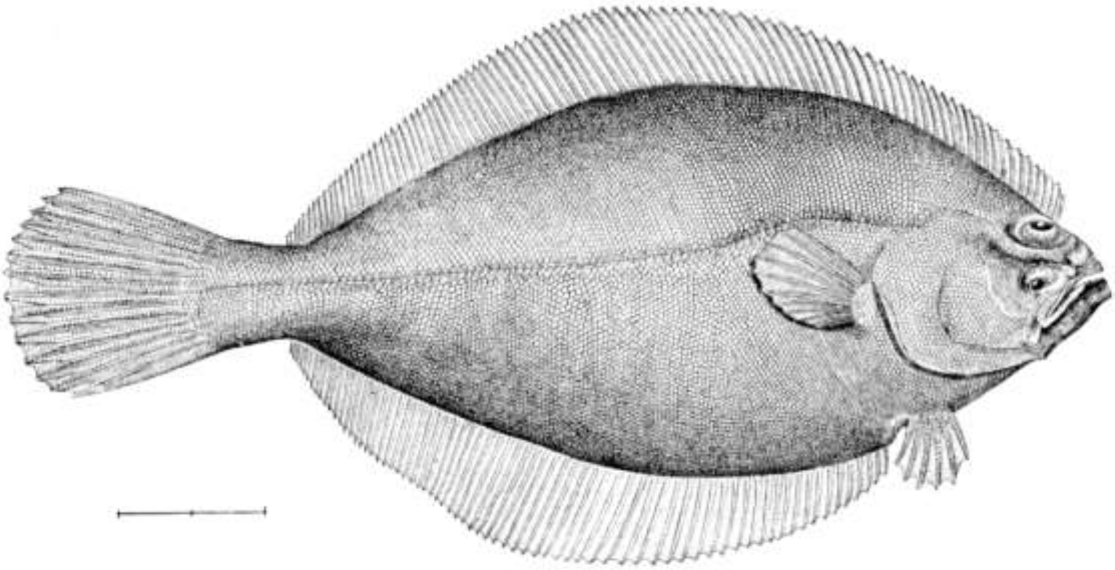

Figure 1. American plaice or long rough dab, *Hippoglossoides platessoides* (Fabricius, 1780), Public Domain, https://commons.wikimedia.org/w/index.php?curid=677815

Background

American plaice or long rough dab is a species of right-eye flounder from the family Pleuronectidae. It occurs on both sides of the North Atlantic Ocean mostly on soft bottoms at depths between 90 and 250 m. It feeds primarily on invertebrates and small fishes. Eggs and larvae are pelagic and spawning occurs from March to May. Two subspecies are recognized, *H. p. platessoides* from north-western Atlantic, and *H. p. limandoides* from the north-eastern Atlantic (Source: Fishbase).

Life history attributes vary significantly between populations (longevity, growth rate, age/size at maturity etc.). In European waters, this species has experienced marked reductions in the age and size of first maturity due to fishing pressure. It is a commercial species, primarily taken as bycatch. This species is well researched within the assessment region, and stocks are monitored to varying degrees. The largest European stock, in the North Sea, is increasing in biomass, and biomass is at record high levels. The majority of other monitored European stocks are also increasing in biomass. This species is managed by Total Allowable Catch regulations in the North Sea but not in the western Irish Sea. (Source: Monroe et al., 2015).

Rationale for spatial protection in the western Irish Sea

American plaice is nominated for inclusion with particular reference to its listing as Endangered by the global IUCN Red List. However, the European Red List places the species in the Least Concern category. Nevertheless, american plaice is not subject to individual management or stock assessment in the western Irish Sea and there are no fishing restrictions in place under the Common Fisheries Policy (2015) so the precautionary principle was applied and spatial management is considered.

The western Irish Sea is a significant part of its range. Data on the distribution of this species in the Irish Sea is comprehensive; catch and positional data are available from the fishery (logbooks and VMS) and the IBTS survey reports CPUE, length, weight, age, sex and maturity from scientific hauls spread across the area in a stratified design.

American plaice are amenable to spatial protection owing to its close association to certain substrate types. At least one spatially protected areas in Iceland has shown increased numbers of juvenile American plaice inside an area closed to fishing (Jaworski et al., 2006)

Sensitivity assessment

The highest associated sensitivity scoring for American plaice was in relation to physical loss or alteration of its habitat and its targeted and non-targeted removal (bycatch) by fishing. Elements of both of these pressure classification were deemed a medium sensitivity (with medium confidence). Due to its close association with soft sediments, resistance to physical loss and change of sediment type were scored as low but, as they are mobile, have pelagic eggs and larvae, and have a long association with pressures relating to fisheries, resilience was scored medium.

One study in the western Atlantic found evidence to suggest the health of bottom-dwelling flatfish at three sites was impaired by chronic exposure to sediment contaminated with PAHs or PCBs. Overall, however, there was not enough literature to form an assessment of sensitivity.

American plaice were assessed as not sensitive to waterflow changes but it should be noted that the transport and retention of their eggs and larvae to suitable areas of habitat in the Irish Sea may rely on certain ocean fronts/currents and large-scale disruption of such features could disrupt settlement of larvae.

Further research needs

Evidence to identify the potential effect of multiple pressures was insufficient to form an assessment. These pressures included chemical (transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances). There is limited knowledge about the sensitivity of different fish species to environmental pollutants. This species has been suggested as a possible species for biomonitoring in the northern Atlantic due to its wide distribution and presence in both offshore and coastal areas (Ellestat et al., 2011).

Figure 2. Global geographic distribution of American plaice or long rough dab, *Hippoglossoides platessoides*, from www.aquamap.org.

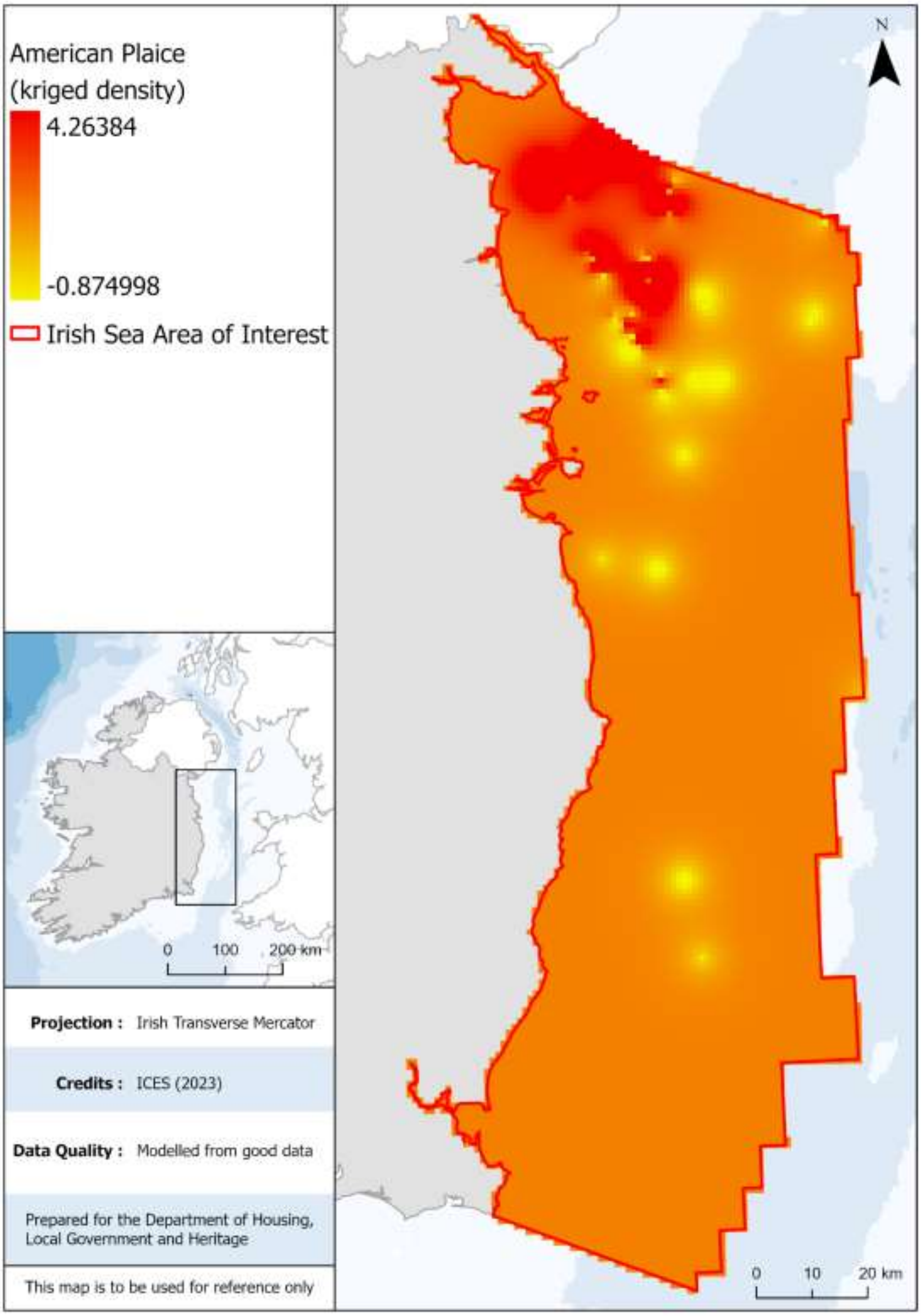

Figure 3. Data available for American plaice or long rough dab, *Hippoglossoides platessoides*, in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Sparse data for this species
Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data		

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2. Angel shark (*Squatina squatina*)

Irish name: ***Bráthair***

Figure 1: Angel shark *Squatina squatina* © Edward Farrell (IUCNredlist.org)

Background

The angel shark is a demersal species found on the continental shelf, from 1 – 150 m depth, in Europe and the Mediterranean (Ellis et al., 2021; Lapinski and Giovos, 2019; Morey et al., 2019). It is an ambush predator, possibly preferring sandy substrates where it can burrow into the sand, awaiting prey to swim past (Meyers et al., 2017; Morey et al., 2019), although it is found on a range of habitat types (Barker et al., 2022). In northern Europe, the species may make seasonal migrations into shallow warm coastal areas for pupping and/or mating (Barker et al., 2022), and Tralee Bay was a very important area for the species in Ireland (Shephard et al., 2019). Mark–recapture data for Angel sharks tagged in Ireland have shown that a high proportion of fish are recaptured from the original release location, although occasionally individuals can undertake longer-distance movements of up to 1,160 km (Quigley, 2006).

Angel sharks have a 2-year reproductive cycle with litter size of less than 7-25 pups, approximately 20-30 cm long at birth (Ellis et al., 2021; Morey et al., 2019). Gestation period is estimated at 8-10 months with pups born during the summer in Irish and UK waters (Compagno et al., 2005; OSPAR, 2008). Individuals may reach a maximum length of 2.4 m, and females and males reach maturity at approximately 1-1.5 m and 0.8-1.3 m respectively (Morey et al., 2019). The reproductive age, rate of reproductive and natural mortality are unknown, although similar species have a generation length of approximately 15 years (Cailliet et al., 1992).

Rationale for spatial protection in the western Irish Sea

Angel sharks have been almost completely removed from Irish waters due to overexploitation (Clarke et al., 2016; Shephard et al., 2019). They have been on the OSPAR List of Threatened and/or Declining Species and Habitats since 2008 (OSPAR, 2008). It is on the Irish red list of cartilaginous species, listed as critically endangered (Clarke et al., 2016), and the IUCN red list assesses the species as critically endangered globally and in Europe (Morey et al., 2019).

Angel sharks are currently managed under several national, European, and Global measures. Angel sharks are on the prohibited species list in the common fisheries policy. Angel shark was listed in Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 2017 (OSPAR, 2021).

Based on current knowledge angel sharks are amenable to spatial protection. Recent observations have recorded angel sharks in the Irish Sea. Historically, the species was apparently highly resident in Irish waters. Nearly 96% (179) of the recaptures were taken in Irish coastal waters and only 4% (8) were recaptured from abroad (Quigley, 2006). In addition, the species undertakes predictable migrations to suitable shallow coastal habitat for reproductive activities (Barker et al., 2022). These two factors make the species amenable to spatial protection.

Sensitivity assessment

The highest associated sensitivity scoring for angel sharks was in relation to its targeted and non-targeted removal (bycatch) by fishing (high confidence). The main threat to angel sharks is from fisheries, primarily through the non-targeted removal of the species. Angel sharks were reported as common throughout European shelf waters in the 19^{th} and 20^{th} centuries (OSPAR, 2021), including the Irish Sea (Morey et al., 2019). As a long lived and slow maturing species, the angel shark is assessed as highly sensitive to fishing pressure with a high degree of confidence. Following a precautionary approach, angel sharks were deemed sensitive to transition elements and organo-metal contamination (low confidence), hydrocarbon and PAH contamination (low confidence). Angel sharks were deemed to have a low sensitivity to heavy smothering and siltation changes which may result from bottom trawling activities (low confidence). As a coastal species with a historical distribution in shallow tidally energetic areas, the angel shark is unlikely to be impacted by water clarity changes and light siltation (low confidence).

Following a precautionary principle, angel sharks were assessed as sensitive to some shipping related pressures (low confidence). Due to their demersal or benthic nature, the angel shark is unlikely to be sensitive to collision, although quantitative evidence is lacking (low confidence). Angel sharks were assessed as Not Sensitive to underwater noise, however, the impacts of anthropogenic noise on elasmobranch species are very poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al., 2021), whereas research in the wild indicates an equivocal response to boat traffic (Rider et al., 2021). Hearing ability in demersal species seems to be most sensitive to low frequencies from nearby sources (Casper, 2006) suggesting sharks may not be sensitive to vessel-related noise (low confidence).

Offshore energy impacts on elasmobranchs are poorly understood at present, however, the angel shark is likely to be sensitive to certain changes to the seabed because of some ORE related pressures. This species, due to its apparent high seasonal residency and the importance of coastal areas to important young/juvenile life history stages, is deemed sensitive at high and medium level to some seabed changes which may occur during ORE construction (low confidence). Angel sharks were deemed not sensitive or as having low sensitivity to most other physical and chemical pressures, although the confidence in these assessments is low and, in some instances, there is little or no evidence available. For instance, although sharks in general are considered electrosensitive and angel sharks are not considered an exception, they are deemed to have a low sensitivity to electromagnetic fields (EMF) (low confidence). Other similar species are affected by electromagnetic fields from high voltage cables (Gill et al., 2009; Hutchison et al., 2020), therefore, some impact on angel sharks is possible. The cumulative long-term impacts of large offshore energy developments are unknown currently. Post construction, wind farms may provide refugia and artificial reef communities which could prove beneficial to some species of elasmobranch. Construction activities may displace some species; however, quantitative data is absent.

Further research needs

Further work is required to identify population size, population trends, migrations and movements, essential habitats, spawning and nursery areas. Equally, discard quantity and survival require further investigation. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment, or relieved heavily on expert judgement. These pressures included the effects of changes in suspended solids (water clarity), smothering and siltation changes (light and medium), electromagnetic energy, death or injury by collision, transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances and the introduction or spread of invasive non-indigenous species.

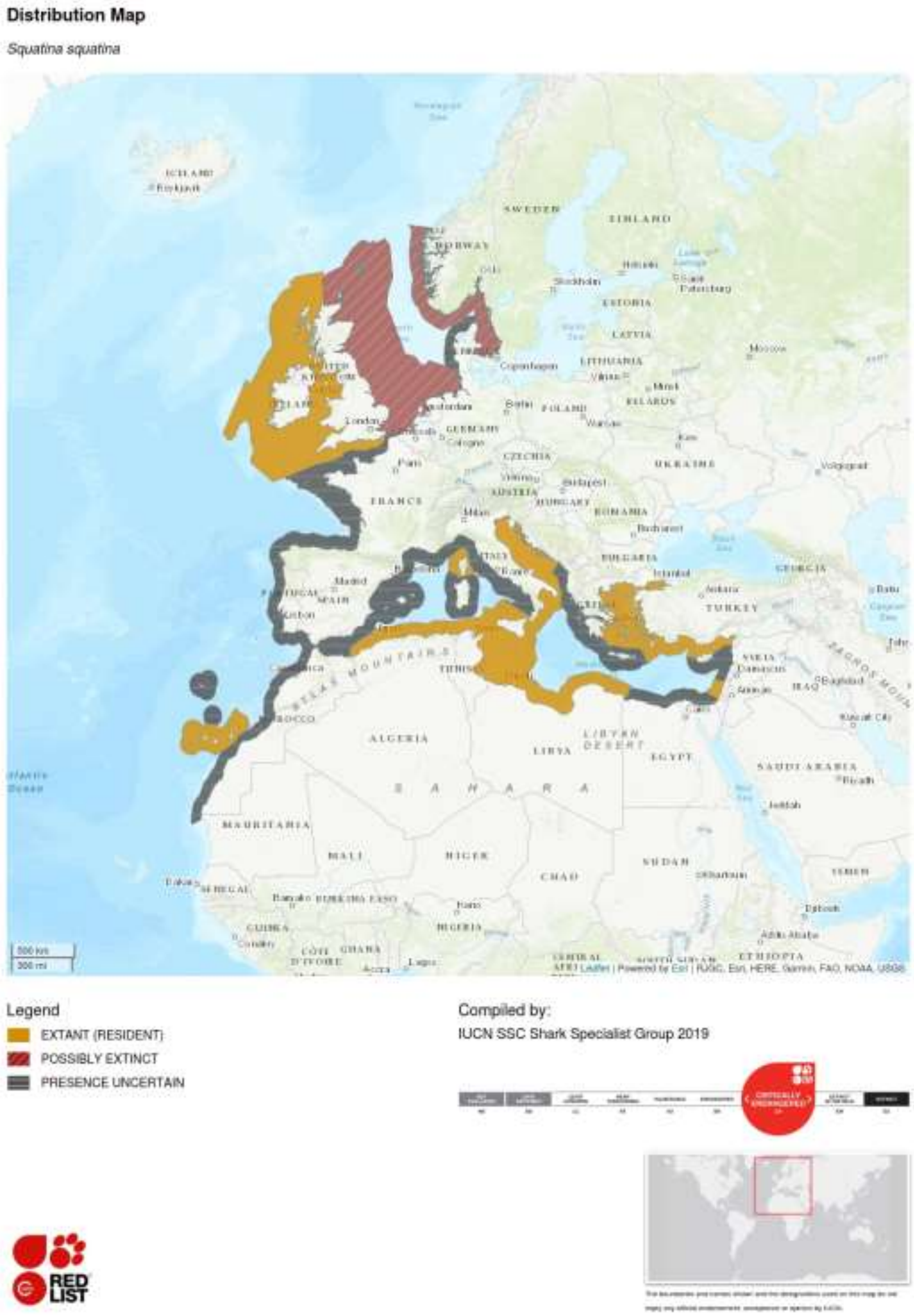

Figure 3. Geographic distribution of Angel sharks in the northeast Atlantic (https://www.iucnredlist.org/species/39332/117498371#geographic-range)

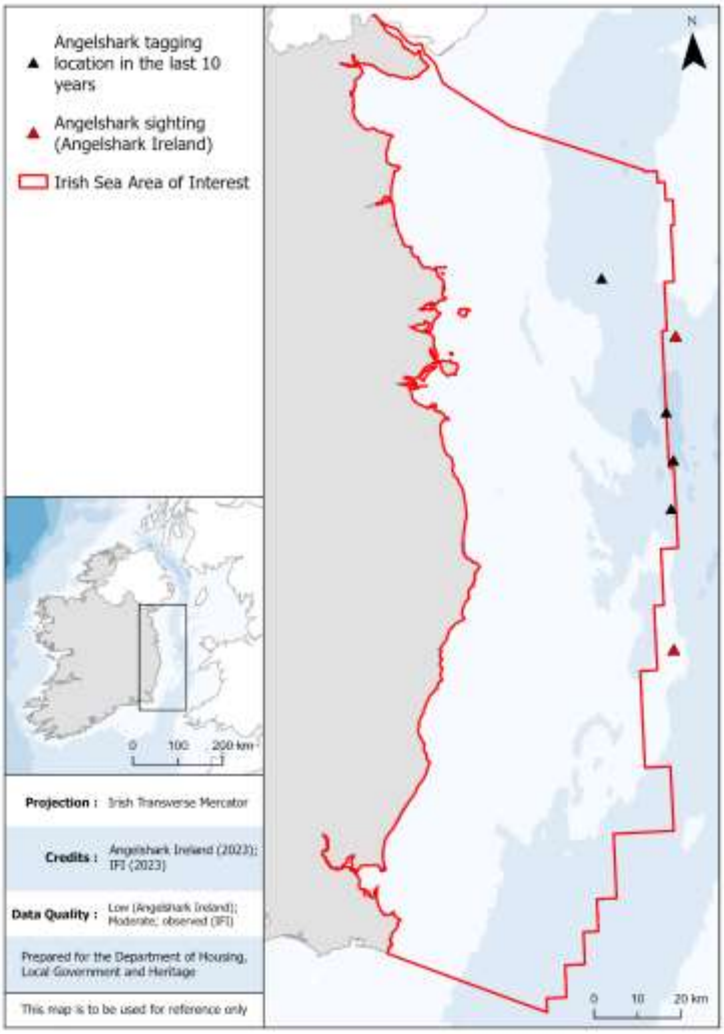

Figure 2. Angel shark sightings recorded in the Irish Sea using data from Inland Fisheries Ireland and the Angel shark Ireland project.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Angel Shark Locations	Angel Shark Ireland	Low/Insufficient for SCP		Anecdotal, low spatial resolution
Inland Fisheries Ireland Tag and Recapture	Inland Fisheries Ireland	Moderate; observed		Data is sparse for this species

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3. Basking shark (*Cetorhinus maximus*)

Irish name: *An Liamhán Gréine*

Figure 1: Basking shark *Cetorhinus maximus* © Edward Farrell (IUCNredlist.org)

Background

Basking sharks are the second largest fish species in the world , reaching 12 m and 4 tonnes (Compagno, 1984; Sims, 2008). They are named after their habit of "basking" on the surface (Sims et al., 2015). They are one of only three shark species in the world that filter feeds on planktonic prey and it is only in recent years, with the use of satellite tracking, that their ecology is being revealed (Sims et al., 2015). They are a pelagic species that occurs primarily in the temperate and boreal waters of the Atlantic, and the Mediterranean Sea (Compagno, 1984). Long distance migrations south of the equator and across the Atlantic have been recorded recently and indicate large variation in movement patterns amongst individual sharks (Gore et al., 2008; Sims et al., 2003; Witt et al., 2012). Most data from the Irish Sea related to sightings of sharks on the surface, however, they likely spend large amounts of time in deeper waters off the west coast feeding during the winter months (Sims et al., 2003). Basking sharks most likely share the reproductive traits of other lamoid shark species, bearing live young (Sims et al., 2015; Sims, 2008) after a long gestation period of 12 – 36 months (Compagno, 1984; Sims et al., 2015). Basking sharks reach maturity at approximately 5-7 m total length, with an estimated age of 12-16 years, reaching 8-10 m in length after 16-20 years (Compagno, 1984; Pauly, 1978). The maximum length is estimated at between 13 and 14 m (Holden, 1975; Parker and Stott, 1965), and maximum age is estimated at 40-50 years (García et al., 2008), with a generation time of 34 years.

Rationale for spatial protection in the western Irish Sea

Basking sharks have a long history of exploitation in the Northeast Atlantic and the population was severely depleted in a short period by over fishing (Clarke et al., 2016). They have been on the OSPAR List of Threatened and/or Declining Species and Habitats since 2003 (OSPAR, 2008). It is on the Irish red list of cartilaginous species, listed as endangered (Clarke et al., 2016), and IUCN red list assess the species as endangered globally and in Europe (Sims et al., 2015). Basking shark were also added to the Irish Wildlife Act in 2022. Despite the protection conferred on the species and although there is some increase in sightings in recent years, there are large uncertainties over the population trend (OSPAR, 2008; Sims et al., 2015) and thus spatial protection is warranted.

Basking sharks are currently managed under several national, European, and Global measures. Basking shark are on the prohibited species list in the common fisheries policy. They are also included in the EU finning regulation, listed by Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Conservation of Migratory Species of Wildlife Animals (CMS).

Based on current knowledge basking sharks are amenable to spatial protection. Basking shark are recorded in the Irish Sea (Clarke et al., 2016). Basking sharks are filter feeders and are often associated with frontal systems which promote enhanced primary productivity and aggregate their zooplankton prey. In the Irish Sea, there are multiple fronts driven by riverine outputs, tides and seasonal difference in temperature and density (Hill et al., 2008; Le Fevre, 1987), many of which are predictable occurring in the same positions daily, monthly, or annually. These features present reliable feeding opportunities for basking sharks (Miller et al., 2015; Sims, 2008), and thus are amenable to spatial protection.

Sensitivity assessment

The highest associated sensitivity scoring for basking shark was in relation to its targeted and non-targeted removal (bycatch) by fishing (high confidence). The main threat to basking sharks is from fisheries, primarily through the targeted removal of the species. Historically, landings of over 1000 individuals per year were recorded in Irish waters from 1951 to 1955, with peak landings of 5266 tonnes across the Northeast Atlantic in 1979 (ICES, 2016). The overall result of fishery efforts was thought to have reduced the basking shark population to less than half of its original size over a 100 year period (Sims et al., 2015). Basking sharks have a long generation time and slow maturity which makes them sensitive to exploitation and the population is still recovering from exploitation in the 19th and 20th centuries.

Following a precautionary principle, basking sharks were assessed as sensitive to some shipping related pressures (low confidence). Due to their feeding behaviour, remaining on the surface for long periods, basking sharks were assessed as having a medium sensitivity to death or injury by collision. In general sharks are resilient to injury, however, basking sharks are likely to be vulnerable to vessels of all sizes, particularly when travelling at high speed, however, the evidence of rates of injury, death and possibly recovery are poor, and this was assessed as low in confidence. Basking sharks were assessed as Not Sensitive to underwater noise (low confidence), however, the impacts of anthropogenic noise on elasmobranch species are very poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al., 2021), whereas research in the wild indicates an equivocal response to boat traffic (Rider et al., 2021). Hearing ability in demersal species seems to be most sensitive to low frequencies from nearby sources (Casper, 2006) suggesting basking sharks may not be sensitive to vessel-related noise.

Offshore energy impacts on elasmobranchs are poorly understood with the species deemed either not sensitive to relevant pressures, or those pressures deemed not relevant. An expansion of offshore energy development will likely result in increased vessel traffic in specific areas, and this sensitively is mentioned in the previous section. Basking sharks are deemed not sensitive to most physical, chemical, and biological pressure (low confidence), or there is not enough evidence available to assess their sensitivity. For instance, although sharks in general are considered electrosensitive and basking sharks are not considered an exception, they are deemed not sensitive to electromagnetic fields (EMF) due to their pelagic nature (low confidence). This assessment has low confidence, as all research to date has studied EMF and demersal, benthic, including catsharks and skates/rays (Gill et al., 2009; Hutchison et al., 2020).

Further research needs

Further work is required to identify population size, population trends, migrations and movements, essential habitats, spawning and nursery areas. Equally, discard quantity and survival require further investigation. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment, or relieved heavily on expert judgment. These pressures included the effects of changes in suspended solids (water clarity), smothering and siltation changes (light and medium), electromagnetic energy, death or injury by collision, transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances and the introduction or spread of invasive non-indigenous species.

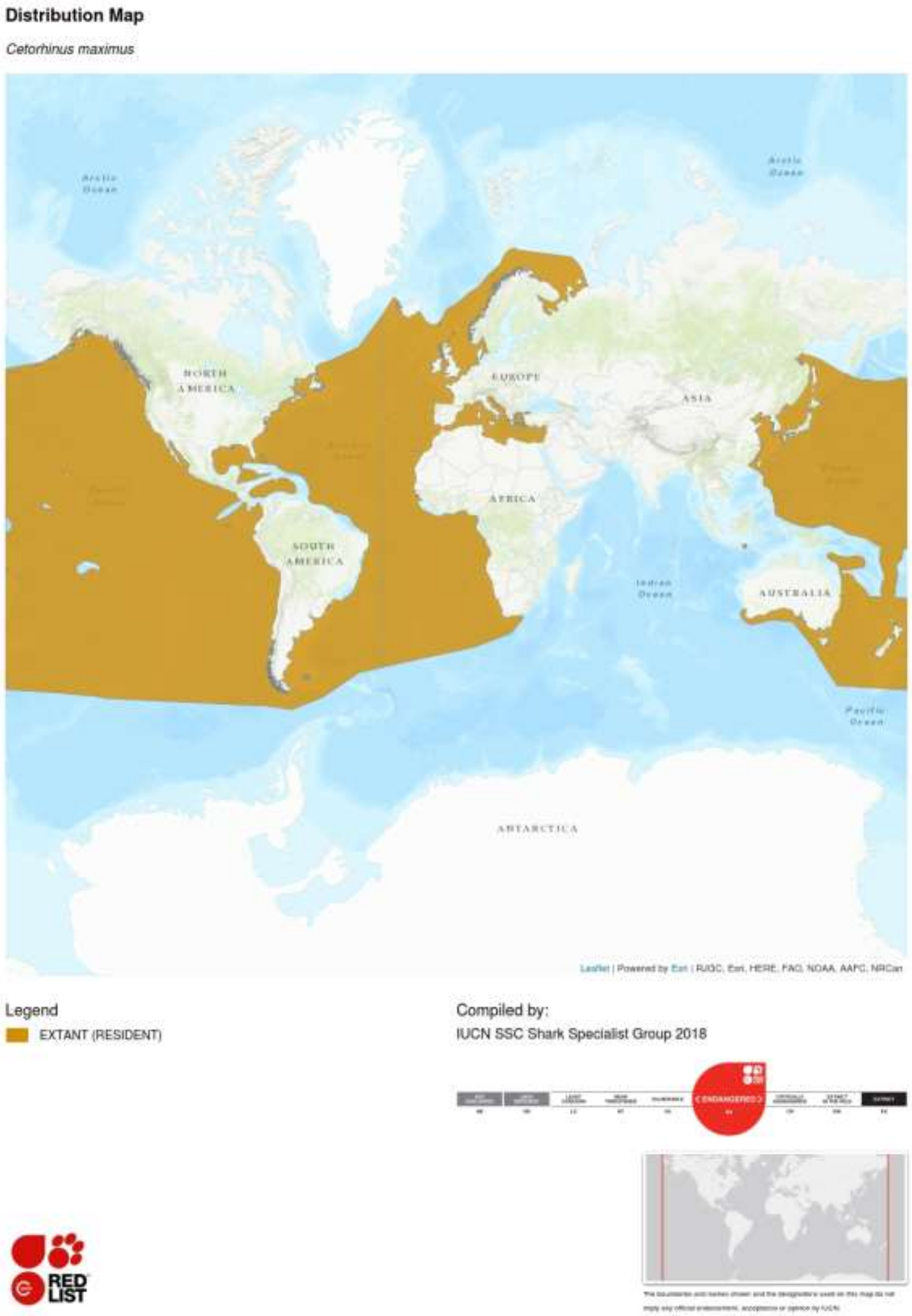

Figure 2. Geographic distribution of the basking shark (https://www.iucnredlist.org/species/4292/166822294#geographic-range)

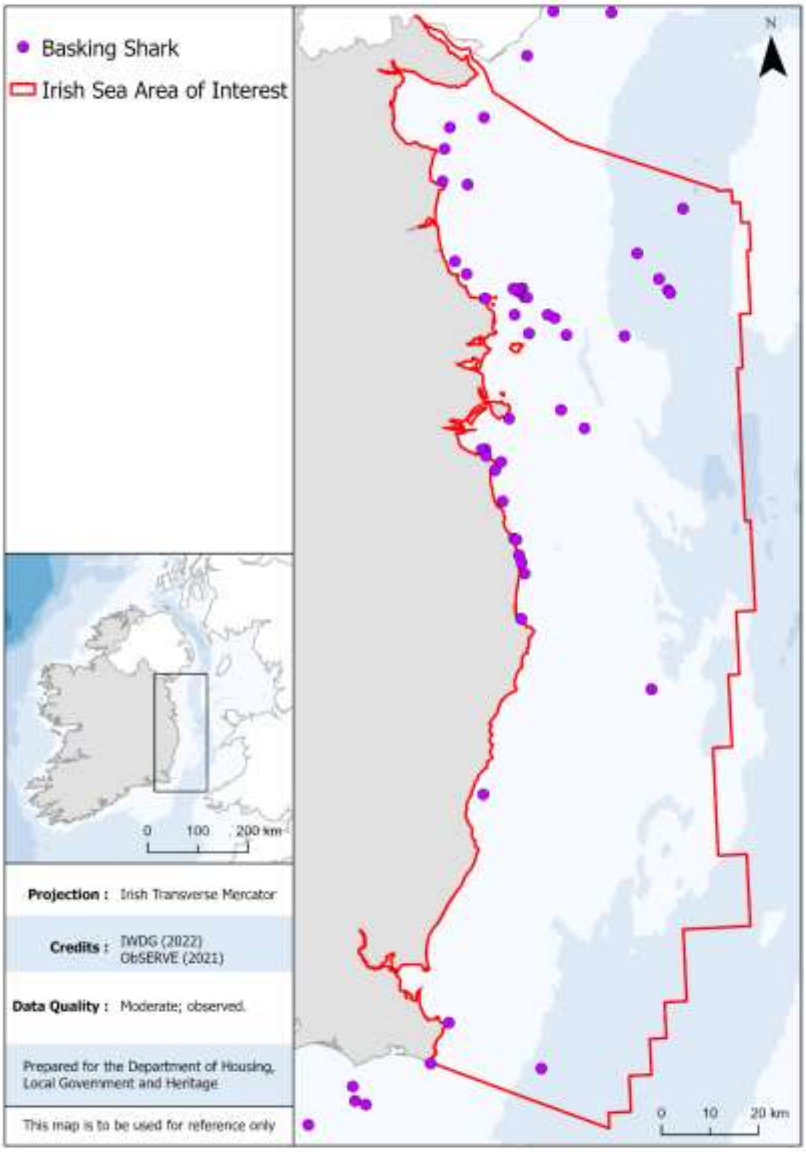

Figure 3. Basking shark sightings in the Irish Sea using data from the IWDG and the OBSERVE project.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Irish Whale & Dolphin Group (IWDG) Basking Shark Sightings	Irish Whale & Dolphin Group	Moderate; observed		
OBSERVE Megafauna Sightings	University College Cork	Moderate; observed		

ObSERVE predicted Basking Shark Distribution	University College Cork	Modelled from moderate data		

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4. Blonde ray (*Raja brachyura*)

Irish name: Roc fionn

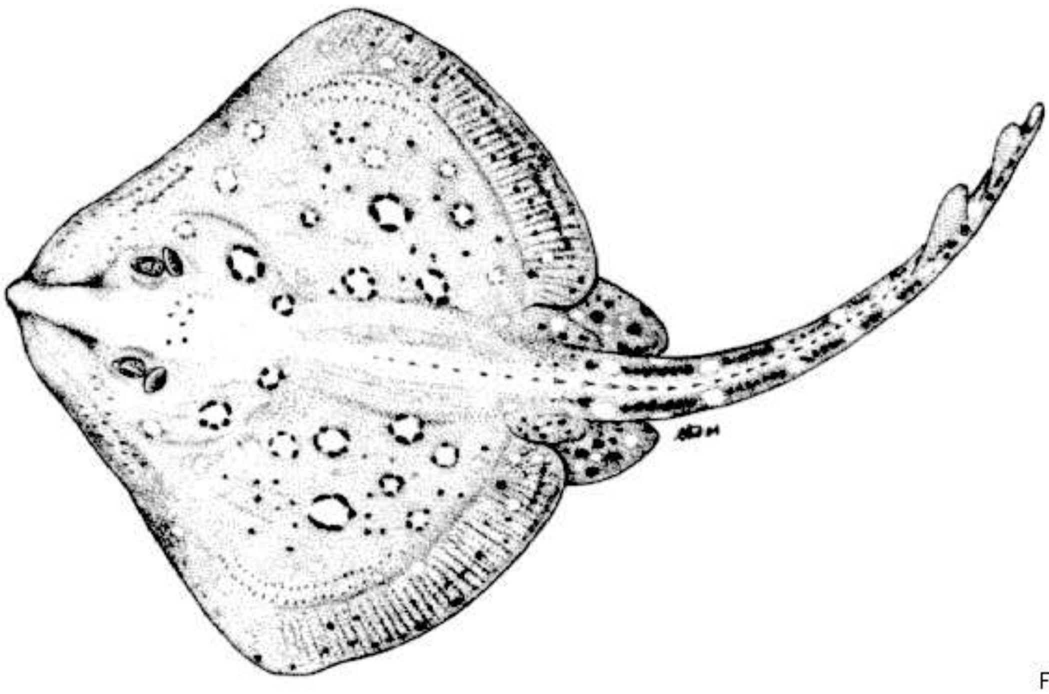

Figure 1: Blonde ray *Raja brachyura* from Bauchot (1987)

Background

Blonde rays are a medium-sized skate species in the Class Chondrichthyes. Blonde rays are a demersal species that is commonly seen inshore and in shelf waters at 14-146 m, though may occur deeper in the southern parts of its range (Ellis et al. 2005). Blonde rays have a preference for sandbanks and soft sediments (Ellis et al. 2005; Martin et al. 2010). Juveniles are thought to feed on small crustaceans and larger individuals feed on fish (Ellis et al. 1996). Blonde rays have a maximum size of approx. 120 cm total length (Stehmann & Burkel, 1984), making it the largest skate species commercially caught in Irish waters. Blonde rays have a maximum age of 15 years (Gallagher et al. 2005). In the Irish Sea the length and age at maturity (for 50% of fish) was reported as 82 cm total length and 4.6 years for males, and 84 cm total length and 5.5 years for males (Gallagher et al. 2005). Blonde rays are thought to reproduce between February and August (Ebert & Stehmann, 2013), and produce approx. 30 egg cases per year that take seven months to hatch (Holden et al. 1971; Ebert & Stehmann, 2013). Blonde rays are distributed in the Northeast Atlantic and Mediterranean Sea (Ebert & Stehmann, 2013). ICES considers blonde rays distributed in the Irish Sea, Celtic Seas and the Bristol channel a single stock (ICES 2020). Species-specific studies on the movement of blonde rays are limited. Studies of skate species in the UK and worldwide suggest high site fidelity and short dispersal distances (Steven 1936; Templemen 1984, Walker et al. 1997;

King & McFarlane, 2010, Ellis et al. 2011). Two studies have identified broadscale movements in the range of 2340 km from mark-recapture tagging (King & McFarlane, 2010; Bird et al. 2020), and The Marine Sportfish Tagging Programme has identified blonde ray movements of more than 100 km by individuals tagged in Irish waters (734 individuals, tagged between 1971 and 2009).

Rationale for spatial protection in the western Irish Sea

Blonde rays were nominated for inclusion with particular reference to its conservation listing under OSPAR and/or listing as Near Threatened in Ireland, Europe and globally. Total bycatch is not quantified in the Irish Sea, and the population size is currently not known (ICES, 2020). According to Clarke et al. (2016) existing data suggests the juvenile population is increasing over time in the Irish Sea, however, available evidence for adults suggests probable overexploitation. Blonde rays are currently managed under a generic total allowable catch (TAC). However, given population size and discard quantity cannot be quantified, we recommend a precautionary approach is applied and spatial protection of this species is considered.

Blonde rays are currently managed under a generic total allowable catch (TAC) with other named ray species. The group TAC applies to rays including thornback (*R. clavata*), painted (*R. microoecllata*), spotted (*R. montagui*), cuckoo (*Leucoraja naevus*) (Common Fisheries Policy, 2016). Since 2008, European countries are required to record most skate and ray landings by species to help generate a better picture of current population trends. There is potential to misidentify blonde rays with the spotted ray (*R. montagui*), which has led to misreported landings in several countries (ICES, 2021).

Based on current knowledge blonde rays are amenable to spatial protection. A high proportion of spawning stock is thought to be in the Irish Sea (Dedman et al. 2017), however, specific egg laying and nursery sites have yet to be identified. It is likely that like other rays that shallow coastal waters are used as nursery grounds (Shark Trust, 2009).

Sensitivity assessment

The highest associated sensitivity scoring for blonde ray was in relation to its targeted and non-targeted removal (bycatch) by fishing (high confidence[3]). Blonde rays are a commercially important species, and are targeted by trawl, gill nets, trammel nets and longlines across much of its range, and also caught as bycatch (ICES, 2009). Literature on blonde ray post-release survival is conflicting (BIM, 2019; Amelot, 2021). In the Celtic Seas ecoregion blonde ray was identified as the most vulnerable of the generic TAC rays to gillnet and otter trawl fisheries owing to its life history and ecology (McCully Phillips et al. 2015). Following a precautionary approach, blonde rays were deemed sensitive to transition elements and organo-metal contamination (low confidence), hydrocarbon and PAH contamination (low confidence). Blonde rays were deemed moderately sensitive to heavy smothering and siltation changes linked to fisheries activities (low confidence). This perceived sensitivity is owing to their benthic nature, and due to their sessile and slow maturing egg cases which likely require well aerated water for survival.

[3] Confidence statements (low, medium, high) are derived from the sensitivity scoring evidence base. See appendix 5d for further details.

Following a precautionary principle, blonde rays were identified as sensitive to some shipping related pressures including contaminants (low confidence). The impacts of anthropogenic noise on elasmobranch species are poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al., 2021), whereas research in the wild indicates an equivocal response to boat traffic (Rider et al., 2021). Hearing ability in demersal species seems to be most sensitive to low frequencies from nearby sources (Casper, 2006) suggesting blonde ray may not be sensitive to vessel-related noise.

Offshore energy impacts on elasmobranchs are poorly understood, however, blonde rays were deemed moderately sensitive or sensitive to several offshore energy impacts. Pressures including physical loss of marine habitat and physical change to another seabed type were deemed moderate sensitivity (low confidence) owing to limited mobility of early life stages. Blonde rays were deemed moderately sensitive to heavy smothering and siltation changes (low confidence) due to their sessile and slow maturing egg cases, which likely require well aerated water for survival. Given the nursery areas for egg laying have not been delineated in the western Irish Sea, a precautionary approach is recommended. Construction activities may displace some elasmobranch species, although quantitative data is absent. Electromagnetic fields from high voltage cables are likely to affect the behaviour of some species (Gill et al., 2009; Hutchison et al., 2020), however, long-term impacts are unknown at present. Post construction, wind farms may provide refugia and artificial reef communities which could prove beneficial to some species of elasmobranch. Construction activities may displace some species, however, quantitative data is absent.

Further research needs

Further work is required to identify population size, population trends, migrations and movements, essential habitats, spawning and nursery areas. Equally, discard quantity and survival requires further investigation. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment, or relieved heavily on expert judgement. These pressures included the effects of changes in suspended solids (water clarity), smothering and siltation changes (light and medium), electromagnetic energy, death or injury by collision, transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances and the introduction or spread of invasive non-indigenous species.

Figure 2. Global geographic distribution of blonde ray (*Raja brachyura*) from Ellis et al. (2009)

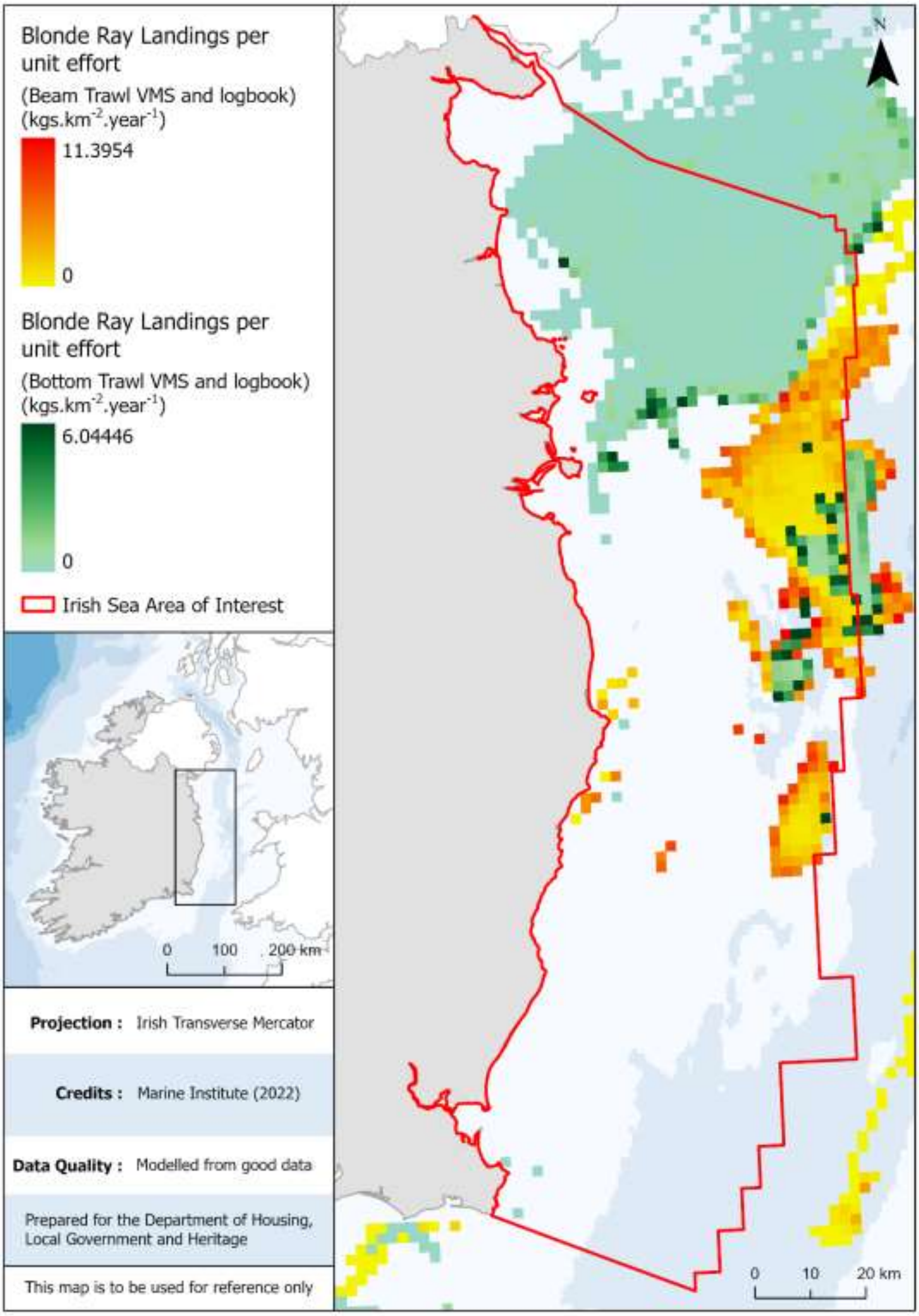

Figure 3. Distribution of blonde ray (*Raja brachyura*) in the western Irish Sea as identified by ICES international fishing effort and swept area ratios and VMS.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Dedman *et al.* (2015) Species Distribution Model (SDM)	Dedman *et al* (2015)	Modelled from moderate data		
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Data is sparse for this species
Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data		

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5. Bull huss (*Scyliorhinus stellaris*)

Irish name: Fíogach mór

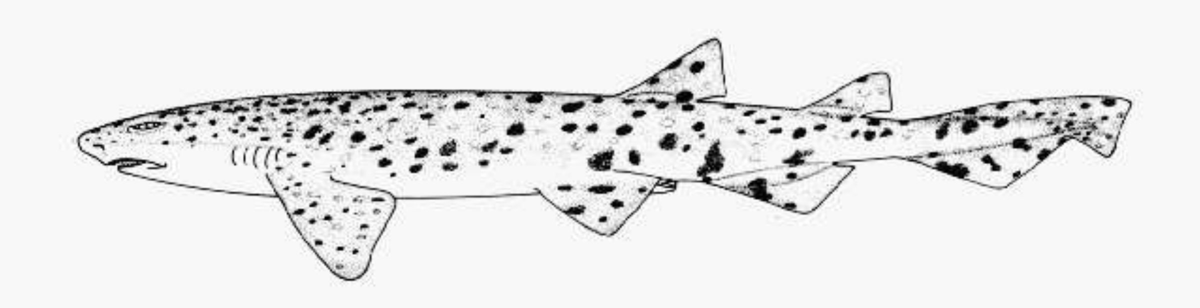

Figure 1. Bull huss (*Scyliohinus stellaris*) from Compagno (1984)

Background

The bull huss is a medium-sized cartilaginous fish species in the Class Chondrichthyes, and is the largest species of cat shark in Irish waters. The bull huss has a max. reported total length of 170 cm ("www.fishbase.se", n.d.). It is a predominately demersal species with a depth range of 1-400 m (Reiner, 1996), and is usually found between 20 - 63 m (Compagno, 1984). Bull huss are associated with a variety of bottom-types, including rocky or coralline ground, and algal-covered (e.g., kelp forest) bottom types ("www.fishbase.se", n.d.). Bull huss are benthic feeders, and feed on molluscs, crustaceans, and fish, including small sharks. Maximum age and size-at-maturity are unknown, based on the small-spotted catshark (*Scyliorhinus canicula*) females are thought to mature at 9 years and reach a maximum age of 17 years (Rodríguez-Cabello *et al.* 2005). Scyliorhinids are thought to be productive species compared to other demersal elasmobranchs (McCully Phillips et al. 2015), however, information on their exact bull huss life history is limited. Bull huss are oviparous, with two eggs released at a time (one from each oviduct; Compagno, 1984). Eggs are laid in spring and summer in shallow water, with estimates of total eggs laid per year ranging from 9-41 (based on animals kept in captivity; Capapé et al. 2006). Bull huss young hatch from their egg cases after around 9 months (Capape et al. 2006). Bull huss are distributed within the northeast Atlantic (from southern Scandinavia and the British Isles) and the Mediterranean Sea (Morocco) (Compagno, 1984). Its recorded presence in tropical west Africa is uncertain, and may be due to misidentification with the West African catshark (*S. cervigoni*). Migration, dispersal and mixing between populations is unknown. A study of this species in a tidal sea lough suggests it has high site fidelity (Sims et al. 2005).

Rationale for spatial protection in the western Irish Sea

Bull huss was nominated for inclusion with particular reference to its conservation listing by the IUCN as Near Threatened at a European and global scale. In Ireland it is classified as Least Concern (Clarke et al. 2016). Population trends modelled from standard catch-per-unit-effort (CPUE) in the Irish Sea and Bristol Channel suggest an annual increase of 4.7%, consistent with an increasing population over three generation lengths (48 years) (ICES-WGEF, 2019). However, in the Mediterranean Sea where this species was previously common (pre 1940s), recent research surveys and commercial fisheries suggest bull huss are locally extinct in some areas (Aldebert 1997, Ragonese et al. 2013, Ramírez-Amaro et al. 2020). Population recovery is thought to be affected by low levels of interconnectivity between isolated island-associated populations situated far from the continental coast (Ellis et al. 2009). The latest ICES report (2021) could not quantify landings, catch or discards, and misidentification and categorisation of this species under names such as “dogfish” or “catshark” categories make quantifying landings challenging. Owing to its global population reduction of around 30-49% suspected over three generation lengths (48 years), a precautionary approach is advised.

There are currently no management measures in place for this species in Europe or Ireland. ICES issued a precautionary recommended reduction in landings by 18% for 2022-2023 versus 2018-2020.

The western Irish Sea is an important part of its range. While deemed a species of Least Concern in Ireland (2016), the inability to quantify landings, catch, discards, and its misidentification with other hounds suggests a precautionary approach is followed.

While limited, current knowledge suggests bull huss are amenable to spatial protection. A study of acoustic tracked bull huss in a tidal sea loch suggests refuging behaviour and site fidelity. However, the dispersal and movement ecology of these species is not well understood in an open ocean setting.

Sensitivity assessment

The highest associated sensitivity scoring for bull huss was in relation to its targeted and non-targeted removal (bycatch) by fishing. Bull huss are targeted throughout its range by gill nets, bottom set longlines, bottom trawls, handlines and occasionally pelagic trawls (Shark Trust, 2010). Actual discard quantities are thought to be several times higher than landed quantities (ICES 2021a).

Following a precautionary principle, bull huss were identified as sensitive to some shipping related pressures. While evidence for this species was limited, it is thought that elasmobranchs are vulnerable to environmental pollutants such as transition elements given they are long-lived and consume a range of lower trophic level prey (Dulvy et al. 2017). Elasmobranchs are thought to tolerate high metal levels in their tissues, however, a precautionary approach is applied and bull huss were deemed sensitive to this pressure. The impacts of anthropogenic noise on elasmobranch species are poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al., 2021), whereas research in the wild indicates an equivocal response to boat traffic (Rider et al., 2021). Hearing ability in demersal species seems to be most sensitive to low frequencies from nearby sources (Casper, 2006) suggesting bull huss may not be sensitive to vessel-related noise.

Offshore energy impacts on elasmobranchs are poorly understood, however, bull huss were deemed moderately sensitive to several offshore energy impacts. Pressures including physical loss of marine habitat and physical change to another seabed type were deemed moderate sensitivity owing to limited mobility of early life stages. Bull huss were deemed moderately sensitive to heavy smothering and siltation changes due to their sessile and slow maturing egg cases, which likely require well aerated water for survival. Given the nursery areas for egg laying have not been delineated in the western Irish Sea, a precautionary approach is recommended. Construction activities may displace some elasmobranch species, although quantitative data is absent. Electromagnetic fields from high voltage cables are likely to affect the behaviour of some species (Gill et al., 2009; Hutchison et al., 2020), however, long-term impacts are unknown at present. Post construction, wind farms may provide refugia and artificial reef communities which could prove beneficial to some species of elasmobranch. Construction activities may displace some species, however, quantitative data is absent. Given bull huss are mobile and occupy the lower water column, they were deemed not sensitive to underwater noise.

Further research needs

Key knowledge on the ecology of bull huss including age at maturity, life span, dispersal and population mixing will be necessary to devise an effective management strategy for the species. Identifying nursery areas would help to identify areas of higher perceived sensitivity to pressures including smothering and physical loss of habitat. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment, or relieved heavily on expert judgement. These pressures included changes in suspended solids (water clarity), light smothering and siltation changes, electromagnetic energy, water flow changes, transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances, organic enrichment and the introduction or spread of invasive and non-indigenous species.

Figure 2. Geographic distribution of bull huss (*Scyliorhinus stellaris*) from Finucci, Derrick & Pacoureau et al. (2021)

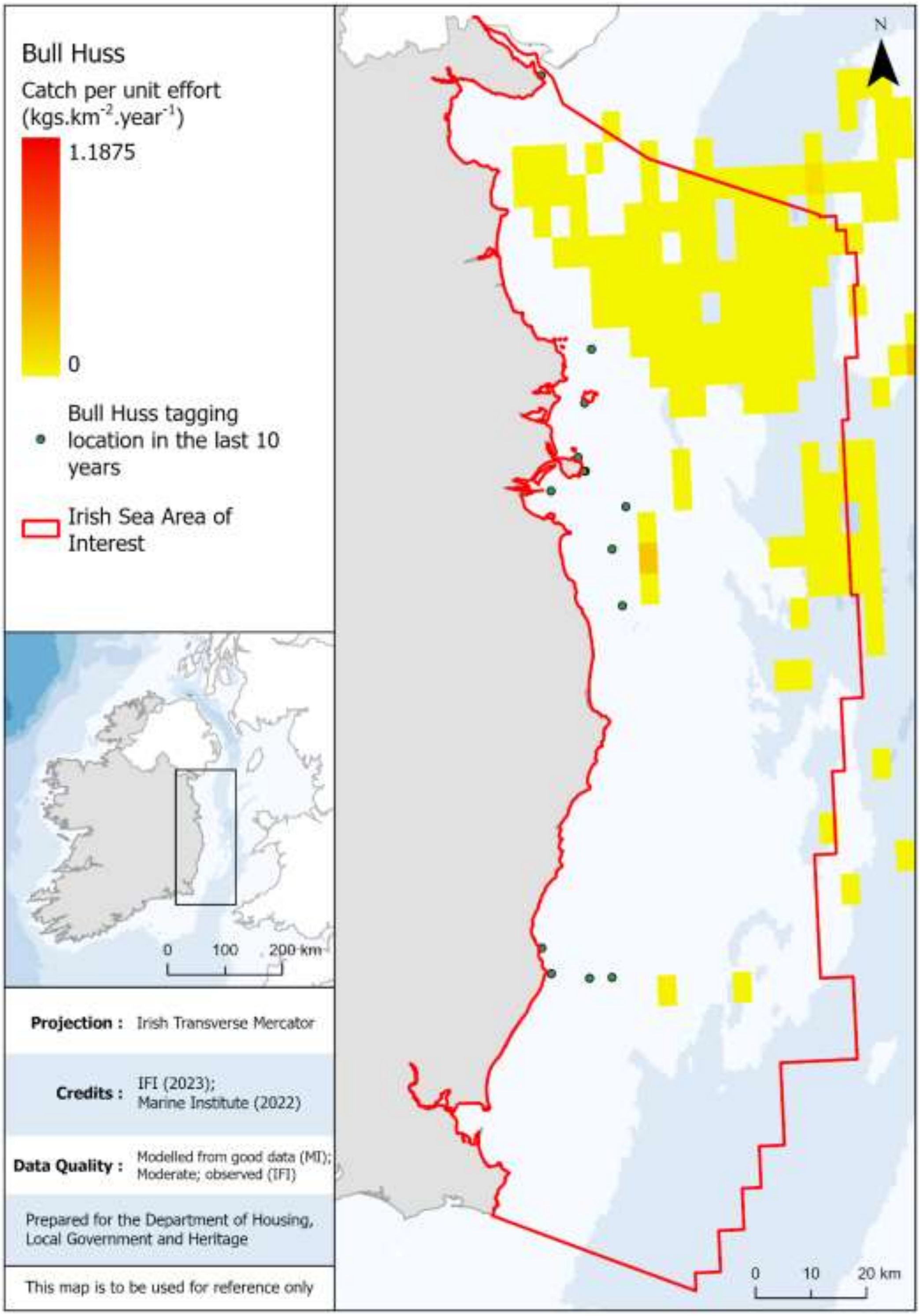

Figure 3. Distribution of bull huss (*Scyliorhinus stellaris*) in the western Irish Sea. Data from Inland Fisheries Ireland tag and recapture data and ICES international fishing effort and swept area ratios and VMS.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
Inland Fisheries Ireland Tag and Recapture	Inland Fisheries Ireland	Moderate; observed		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Data is sparse for this species

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6. Cuckoo ray (*Leucoraja naevus*)

Irish name: *Roc na súl dabh*

Figure 1: Cuckoo ray *Leucoraja naevus* © Edward Farrell (IUCNredlist.org)

Background

Cuckoo rays are a small skate species in the Class Chondrichthyes. They are a demersal species that is most common on sandy sediments in inshore water and shallow shelf seas at 20-500 m (J. Ellis et al., 2007). It is considered an offshore species (Clarke et al., 2016), generally occurring in deeper water in comparison to thornback and spotted rays, and it is abundant in the Irish Sea with a preference for course sand and gravel substrates (J. Ellis et al., 2015; J. R. Ellis, Cruz-Martinez, et al., 2005). In the Irish Sea, cuckoo rays have a broad diet of benthic species with a high proportion of small teleost fish (J. R. Ellis et al., 1996). Spotted rays have a maximum length of approx. 72 cm (J. R. Ellis, Dulvy, et al., 2005; Stehmann & Bürkel, 1984), In the Irish Sea, the length and age at 50% maturity for males and females was reported as 56.9 and 56.2cm (total length) and 4.2 and 4.3 years, respectively (Gallagher et al., 2005). Maximum age is reported as 12 years (Du Buit, 1976). Females lay paired eggs in sandy or muddy substrates, laying 70-150 per individual annually (Breder & Rosen, 1966; Stehmann & Bürkel, 1984). Juvenile cuckoo ray have been observed to be abundant in the southern Irish Sea and St George's Channel and in the Celtic Sea (J. R. Ellis, Cruz-Martinez, et al., 2005). Cuckoo rays are distributed throughout the Northeast Atlantic, including the Celtic and Irish

Sea, and the Mediterranean Sea (J. Ellis et al., 2015) and exhibit high levels of site fidelity (Simpson et al., 2021; Walker, 1996).

Rationale for spatial protection in the western Irish Sea

Cuckoo rays were nominated for inclusion because it was listed as vulnerable on the Irish red list for cartilaginous species in 2016 due to a declining population trend (Clarke et al., 2016).

Spotted rays are currently managed under a generic total allowable catch (TAC) with other named ray species. This TAC includes thornback (*R. clavata*), painted (*R. microoecllata*), blonde (*R. brachyura*), spotted (*Raja montagui*) (Common Fisheries Policy, 2016). ICES considers that "Management of the catches of skates and rays under a combined TAC prevents effective control of single-stock exploitation rates and could lead to the overexploitation of some species." (ICES, 2022). Some misidentification of cuckoo ray in landings data is possible, but is unlikely to be significant and discarding is known to take place and cannot be quantified (ICES, 2022).

Based on current knowledge spotted rays are amenable to spatial protection. Cuckoo ray are recorded throughout the Irish Sea (Clarke et al., 2016; Dedman et al., 2017; ICES, 2022), and it is likely that the shallow sandy/muddy bays along the eastern coastline are important for egg laying and juvenile stages (Breder & Rosen, 1966; Stehmann & Bürkel, 1984). Tagging studies suggest that cuckoo rays tagged in the Irish Sea, generally stay within the Irish Sea, although movements of >100 km were common (Bird et al., 2020). This would suggest that cuckoo rays move more than some other demersal ray species (Simpson et al., 2021) and area protection should be designed around a skate/ray generic distribution.

Sensitivity assessment

The highest associated sensitivity scoring for cuckoo ray was in relation to its targeted and non-targeted removal (bycatch) by fishing (high confidence). The main threat to cuckoo rays is from fisheries (figure 2), primarily through the non-targeted removal of the species. Cuckoo rays are not considered commercially important and are generally by-caught in trawl and gillnet fisheries that target other more valuable species (ICES, 2022). Following a precautionary approach, cuckoo rays were deemed sensitive to transition elements and organo-metal contamination (low confidence), hydrocarbon and PAH contamination (low confidence). Cuckoo rays were deemed to have a medium sensitivity to heavy smothering and siltation changes which may result from bottom trawling activities (low confidence). While adults will likely move away from heavy siltation pressure, the sessile benthic eggs are vulnerable to becoming covered over and deprived of oxygenated fresh water.

Following a precautionary principle, cuckoo rays were assessed as sensitive to some shipping related pressures including contaminants (low confidence). There is no evidence that shipping activity directly impacts demersal rays, and the risk of collision was assessed as Not Relevant. Cuckoo rays were assessed as Not Sensitive to underwater noise (low confidence), however, the impacts of anthropogenic noise on elasmobranch species are very poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al., 2021), whereas research in the wild indicates an equivocal response to boat traffic (Rider et al., 2021). Hearing ability in demersal species seems to be most sensitive to low frequencies from nearby sources (Casper, 2006) suggesting cuckoo ray may not be sensitive to vessel-related noise.

Offshore energy impacts on elasmobranchs are poorly understood, however, cuckoo rays were deemed moderately sensitive or sensitive to several offshore energy impacts. Physical loss of marine habitat, abrasion/disturbance of the seabed, and heavy smothering/siltation were assessed at a medium sensitivity (low confidence) owing to limited mobility of early life stages. Other ORE associated pressures were assessed as Low or Not sensitive (e.g., water flow changes), however, the quality, applicability and concordance of the available evidence is low and, in some instances, non-existent. For instance, cuckoo ray are electrosensitive and can detect weak electromagnetic fields (EMF) (Gill & Taylor, 2001). Other similar species are affected by electromagnetic fields from high voltage cables (Gill et al., 2009; Hutchison et al., 2020), therefore, some impact on cuckoo ray is possible. The cumulative long-term impacts of large offshore energy developments are unknown currently. Post construction, wind farms may provide refugia and artificial reef communities which could prove beneficial to some species of elasmobranch. Construction activities may displace some species; however, quantitative data is absent.

Further research needs.

Further work is required to identify population size, population trends, migrations and movements, essential habitats, spawning and nursery areas. Equally, discard quantity and survival require further investigation. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment, or relieved heavily on expert judgment. These pressures included the effects of changes in suspended solids (water clarity), smothering and siltation changes (light and medium), electromagnetic energy, death or injury by collision, transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances and the introduction or spread of invasive non-indigenous species.

Figure 2. Geographic distribution in the northeast Atlantic (https://www.iucnredlist.org/species/161626/48949434#geographic-range)

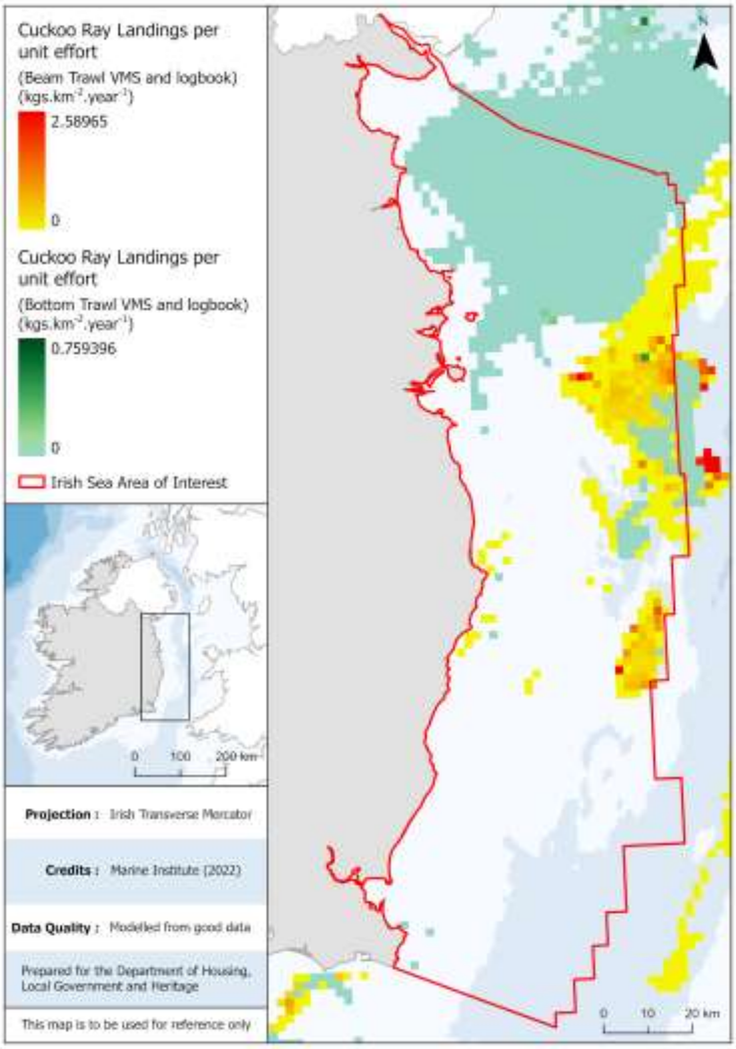

Figure 3. Distribution of cuckoo ray (*Leucoraja naevus*) in the western Irish Sea. Data from ICES international fishing effort and swept area ratios and VMS.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Dedman *et al.* (2015) Species Distribution Model (SDM)	Dedman *et al* (2015)	Modelled from moderate data		
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Data is sparse for this species

Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data		

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7. Dog Whelk *(Nucella lapillus)*

Figure 1: Dog whelk, *Nucella lapillus.* © Dr Keith Hiscock (marlin.ac.uk)

Background

The shell of *Nucella lapillus* is broadly conical, bearing spiral ridges and consisting of a short, pointed spire, dominated by the last whorl. The shell is usually up to 3 cm in height by 2 cm broad but may reach up to 6 cm in height (Crothers, 1985), while the shell colour is variable but usually white. A short, open siphonal canal leads from the base of the aperture and the outer lip of the aperture is thin in young specimens, becoming thickened and toothed internally with age. The animal itself is white or cream coloured with white speckles, and a flattened head. The head bears two tentacles, each bearing an eye about one third of the length of the tentacle from its base. It is found on wave exposed to sheltered rocky shores from the mid shore downwards. Rarely present in the sublittoral but may be abundant in areas exposed to extremely strong tidal stress. They are gregarious and common amongst barnacles and mussels on which they feed.

Adult *Nucella lapillus* may be seen spawning or copulating in spawning aggregations, developing in early spring, sometimes summer. The egg capsules of Nucella lapillus are vase shaped, about 8mm high, usually yellow, and found attached to hard substrata in crevices and under overhangs. The number of capsules laid depends on the female's food reserves, age and temperature and although each capsule may contain ca 600 eggs, 94% of the eggs are unfertilized and function as 'nurse eggs' and are fed upon by the developing embryos (Fretter & Graham, 1994; Crothers, 1985). Capsules have been reported to release 12 -15 'crawl-away' hatchlings per capsule (Crothers, 1985), 13-36 hatchlings per capsule (Feare, 1970) or 25-30 hatchlings per capsule (Graham, 1988) (Tyler-Walters, 2007).

Application of feature list inclusion criteria

Nucella lapillus is listed by OSPAR with reference to its decline and sensitivity and was therefore nominated for inclusion on the feature list. The western Irish Sea is an important part of the species range and is amenable to spatial protection.

Sensitivity assessment

A sensitivity analysis was not carried out on *Nucella lapillus* at this time due to the time constraint for this report and its limited relevance due to the lack of data.

The decline of *N. lapillus* has been linked to contamination effects of tributyltin (TBT) compounds used in antifouling paints (*OSPAR Commission, 2008)*. TBT has been banned from use on boats since which time populations have begun to recover. Evans *et al.* (1996) reported marked recovery of many populations from the North Sea and Clyde Sea and that although ports were 'hot spots' of TBT contamination the populations of *Nucella lapillus* were not sterile and produced enough offspring to survive. However, several populations in semi-enclosed areas with high boating activity in southwest England had become extinct (Tyler-Walters, 2007).

Further research needs

Further information is needed on the current population status and distribution of *Nucella lapillus.* A comprehensive sensitivity analysis is also required.

Figure 2. Global distribution of *Nucella lapillus*, Source: https://mapper.obis.org/?taxonid=140403

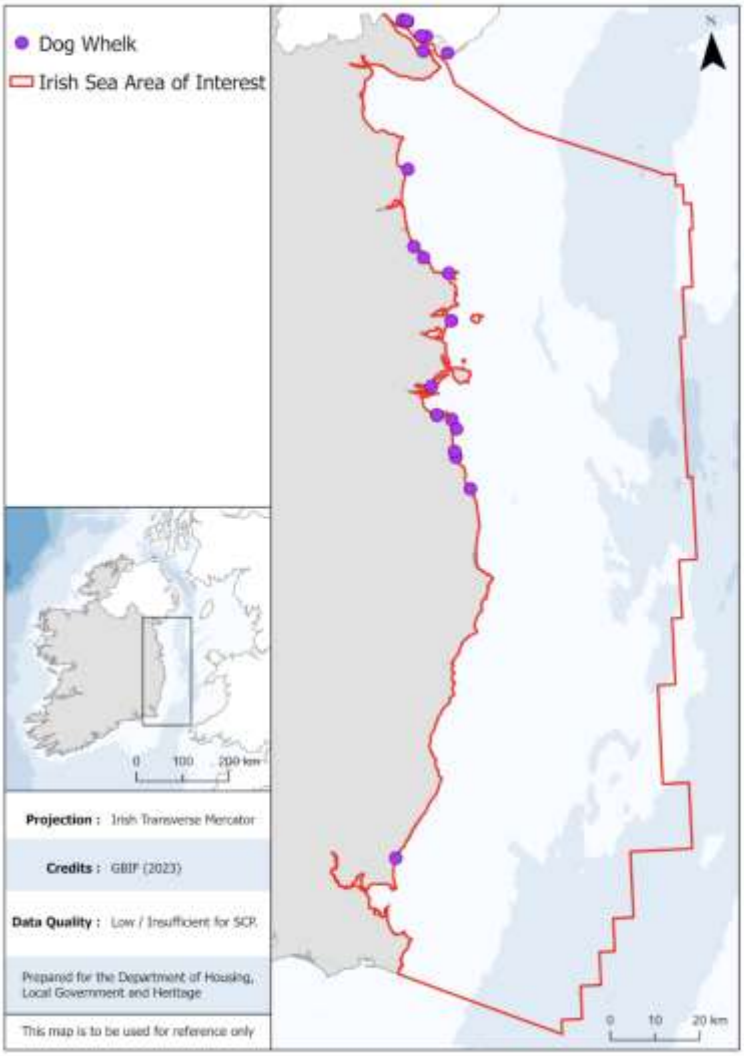

Figure 3. Data available for Dog whelk, *Nucella lapillus* in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
GBIF Dog Whelk	GBIF	Low / Insufficient for SCP	GBIF Dog Whelk	

References

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8. Edible Sea Urchin (*Echinus esculentus*)

Figure 1: Edible Sea Urchin, *Echinus esculentus.* © Sue Scott (marlin.ac.uk)

Background

A large globular sea urchin, reaching up to 15 -16 cm in diameter at 7-8 years of age. The test may be relatively flat in shallow water but taller in deep water with spines closely covering the test. *E. esculentus* is found on rocky substrata from the sublittoral fringe to circa 40 m, although it may be found at depths of 100 m or more. It is an omnivorous grazer feeding on seaweeds (e.g., *Laminaria* spp. sporelings), Bryozoa, barnacles and other encrusting invertebrates (Tyler-Walters, 2008).

Maximum spawning occurs in spring although individuals may spawn over a protracted period. The number of eggs produced will vary with location and nutritive state of the adult, but it is likely to be high. Comely & Ansell (1989) demonstrated differences in reproductive condition between sites and habitats. Planktonic development is complex and takes between 45 -60 days in captivity (MacBride 1914). Recruitment is sporadic or variable depending on locality, e.g., Millport populations showed annual recruitment, whereas few recruits were found in Plymouth populations during Nichols studies between 1980-1981 (Nichols 1984). Settlement is thought to occur in autumn and winter (Comely & Ansell, 1988). Newly settled juveniles have an ambital diameter of 0.68 - 0.95mm (Nichols 1984) (Tyler-Walters, 2008).

Application of feature list inclusion criteria

Echinus esculentus was nominated for inclusion on the features list with particular reference to its listing on IUCN. The species is listed as near threatened globally on the IUCN red list. The western Irish Sea is a significant part of its distribution and it is amenable to spatial protection. However, further research is required to determine the full extent of *E. esculentus* distribution in the western Irish Sea.

Sensitivity assessment

***Echinus esculentus* are highly sensitive to pressures associated with construction and operation of ORE as well as bottom trawling and dredging/beam trawling (low confidence).** All marine habitats and benthic species are considered to have a resistance of 'None' to physical loss (to land or freshwater habitat) and to be unable to recover from a permanent loss of habitat (resilience is 'Very Low')(high confidence) (Tyler-Walters et al., 2018). *Echinus esculentus* can be found on a variety of habitats including crevices/fissures, boulders, rockpools and overhangs showing preference towards habitats with high rugosity and heterogeneity. Therefore, a change from hard rock or soft rock to sediment or artificial structures would result in loss of suitable habitat and loss of the species from the affected area. Hence, resistance is assessed as **'None'.** The change is defined as permanent so that resilience is assessed as **'Very low'** and sensitivity is assessed as **'High'** (low confidence).

Echinus esculentus was assessed as not sensitive to pressure associated with the shipping sector (low confidence).

Further research needs

Further research on the distribution of *Echinus esculentus* is required for the western Irish Sea.

Figure 2. Global distribution of *Echinus esculentus*, Source: https://mapper.obis.org/?taxonid=124287

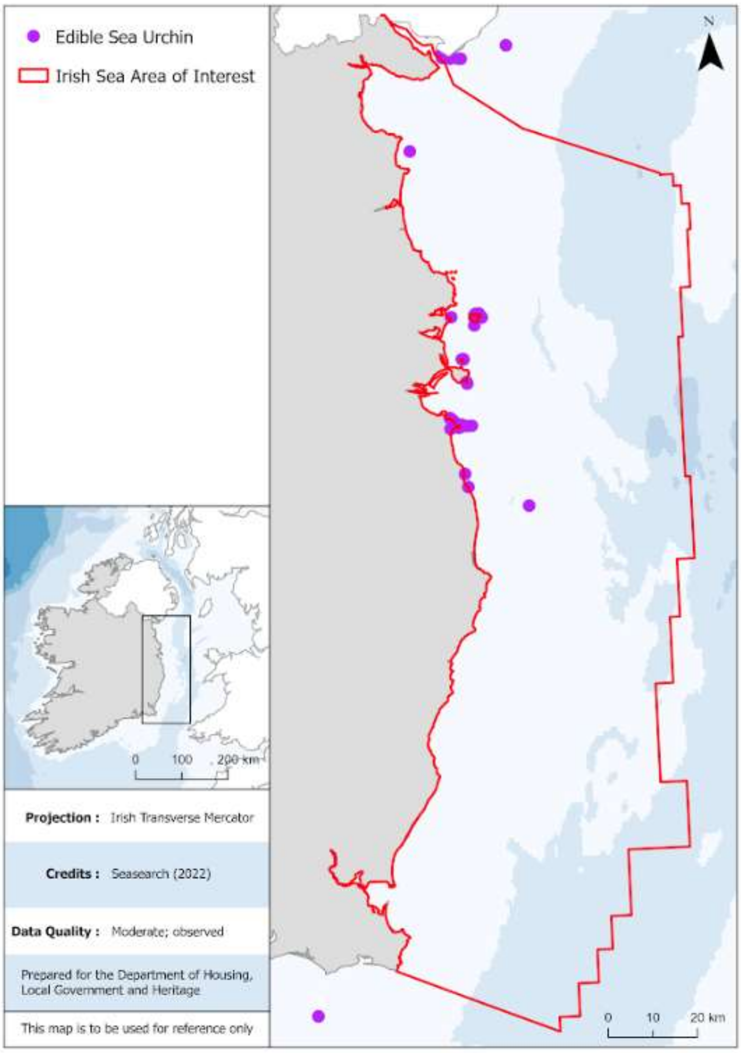

Figure 3. Data available for Edible sea urchin, *echinus esculentus* in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Marine Institute Water Framework Directive Benthic Data	Marine Institute	Moderate; observed		
National Biodiversity Data Centre Seasearch	Seasearch	Moderate; observed	NBDC Seasearch	

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9. European Eel *(Anguilla anguilla)*

Irish name: Easgann Eorpach

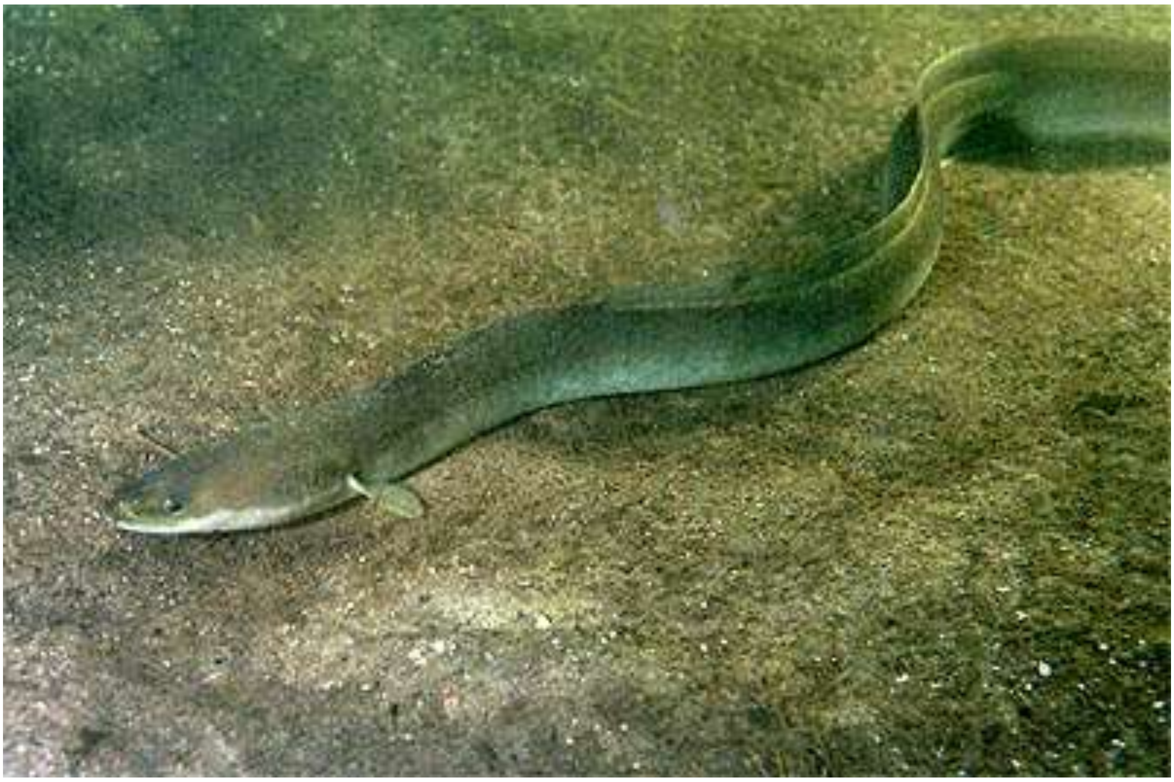

Figure 1. European Eel, *Anguilla anguilla* (Linnaeus, 1758) © By GerardM - http://www.digischool.nl/bi/onderwaterbiologie/ , CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=284678

Background

The European eel is long and snake-like in shape with a tough, slimy skin, which can be black, brown, or dark olive green in colour above, paler and yellowish on the underside (Avant 2007). The adult eel is most abundant in estuaries and low salinity pools but is also found around the coast in permanent tide pools, on the lower shore and shallow sublittoral; being nocturnal it is inactive during the day under rocks or weed or in soft sediment (Avant 2007). European eel has a complex life history that is poorly understood. It involves migration of mature adults from European rivers and estuaries to the Sargasso Sea in the west Atlantic for spawning, and the subsequent return of juveniles. They metamorphose twice, part of the life cycle spent in freshwater and part in estuarine or full sea water (Whitehead *et al*., 1986).

European eel is an OSPAR listed species with the latest Quality Status Report (QSR) stating "*the European eel is widely distributed in marine, coastal, brackish and freshwater habitats of Europe and occurs from the Atlantic coast of north Africa, in all of Europe (including Baltic Sea) and in the Mediterranean waters of Europe and northern Africa. In addition, the European eel also occurs in the Canary Islands, Madeira and the Azores Islands, and in Iceland* (Figure 2).

Rationale for spatial protection in the western Irish Sea

European eel was nominated for inclusion with particular reference to its conservation listing under OSPAR and listing as Near Threatened or greater (Irish, EU or Global Red List). European eel are listed as Critically Endangered by the IUCN Red List, Irish and European Red List. European eel is also listed as Critically Endangered globally. According to the 2022 OSPAR assessment "*The status of European eel is still very poor in all OSPAR Regions where the species occurs, as glass eel recruitment, although stable since 2010, remains at a very low level with no clear sign of an upturn. Eel is a panmictic species which affects its management. While the pressure of commercial fishing on the stock appears to be decreasing in the current assessment period (2010 to 2021), other pressures (dams, turbines, habitat loss, pollution, poaching, diseases and pathogens, climate change, etc.) still pose a significant threat to the species.*"

Fishing restrictions: ICES (2022) advises that when the precautionary approach is applied, there should be zero catches in all habitats in 2023. This applies to both recreational and commercial catches and includes catches of glass eels for restocking and aquaculture.

It is known that most of the rivers emptying into the western Irish Sea contain European eel (Table 1). Eels use the Irish sea as a migration route, incoming as juvenile glass eel and outgoing as mature silver eel heading for spawning grounds. The exact routes taken by eels in the Irish Sea are not known and distributional data for the marine portion of their life-cycle is very sparse.

Based on current knowledge certain stages of the European eel's life-cycle are amenable to spatial protection (other than the freshwater phase, which does not fall within the scope of the current project study). ICES (2022) advises based on ecosystem based management considerations that: all non-fisheries related anthropogenic mortalities should be zero; and that the quantity and quality of eel habitats should be restored; this includes restoring connectivity and the physical, chemical, and biological properties of the habitats. Estuaries are an important habitat for the species (high confidence) that fall within the area of interest and are amenable to spatial protection.

Sensitivity assessment

The highest associated sensitivity scoring for European eel was in relation to barriers to movement, physical loss of (estuarine) habitat, and targeted and non-targeted removal (bycatch) by fishing. Barriers to movement primarily relates to river access being impeded by dams, weirs, turbines *etc*., which are outside of the scope of this study, but the cumulative effect of ORE installations on the migration routes of European eels is poorly understood (high confidence). Targeted and non-targeted removals of eels in the western Irish Sea are prohibited, so although sensitivity is high, incidence is low. Physical loss of estuarine habitat has been identified as a key sensitivity (high confidence) and adult eels are known to be abundant in this habitat.

Offshore energy impacts on European eel are poorly understood, however, based on existing knowledge eel may be sensitive to some of the associated sectoral pressures.

There is evidence that electromagnetic fields can affect eel movement but it is not yet known whether the magnitude of such disturbance is significant over the scale of their entire migration. However, due to the large distances over which European eels migrate, the effects of a pressure (or indeed local spatial protection) may not be immediately evident, spatially or temporally.

Following the precautionary principle, European eel were identified as sensitive to some shipping related pressures (low confidence). This mainly relates to transition elements, organo-metal, hydrocarbon and PAH contamination of essential estuarine habitats.

Further research needs

Key knowledge on the distribution of European eel in the western Irish Sea remains limited and requires further investigation. The limited number of research studies on the effect of electromagnetic fields means it is difficult to recommend specific measures. More research is needed, particularly field studies on the cumulative effect of multiple ORE installations. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment. These pressures included synthetic compound contamination and introduction of other substances.

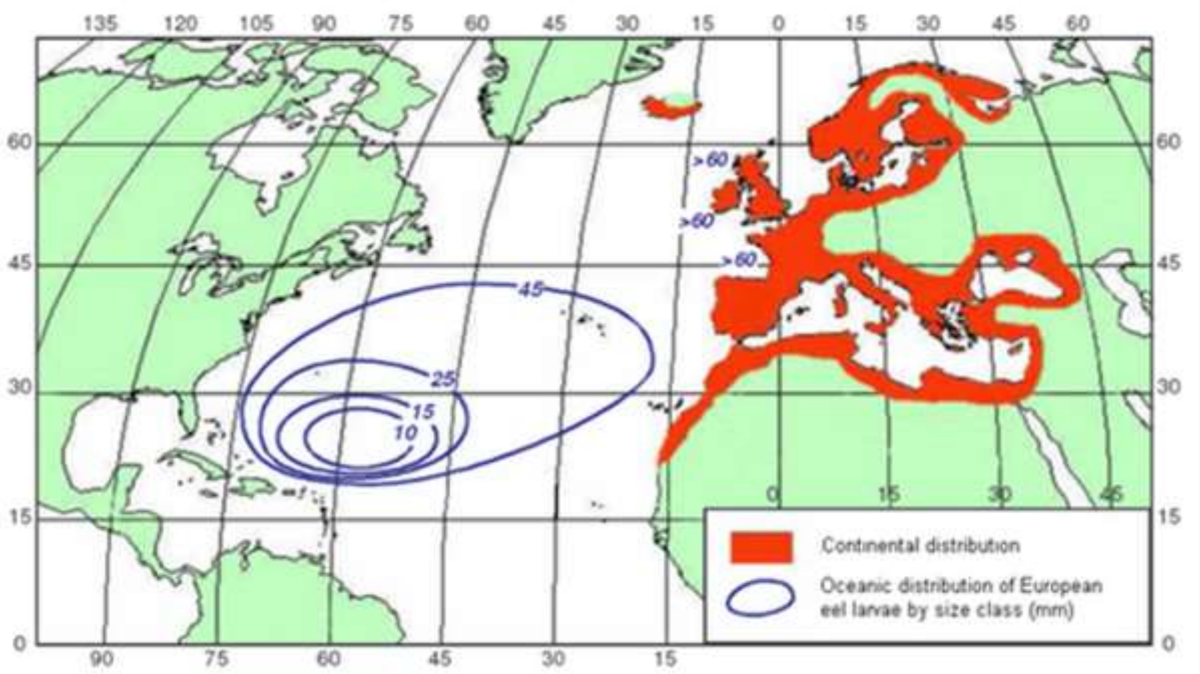

Figure 2. Global distribution of European Eel, Source: OSPAR QSR 2022 (adapted from Adam, 1997).

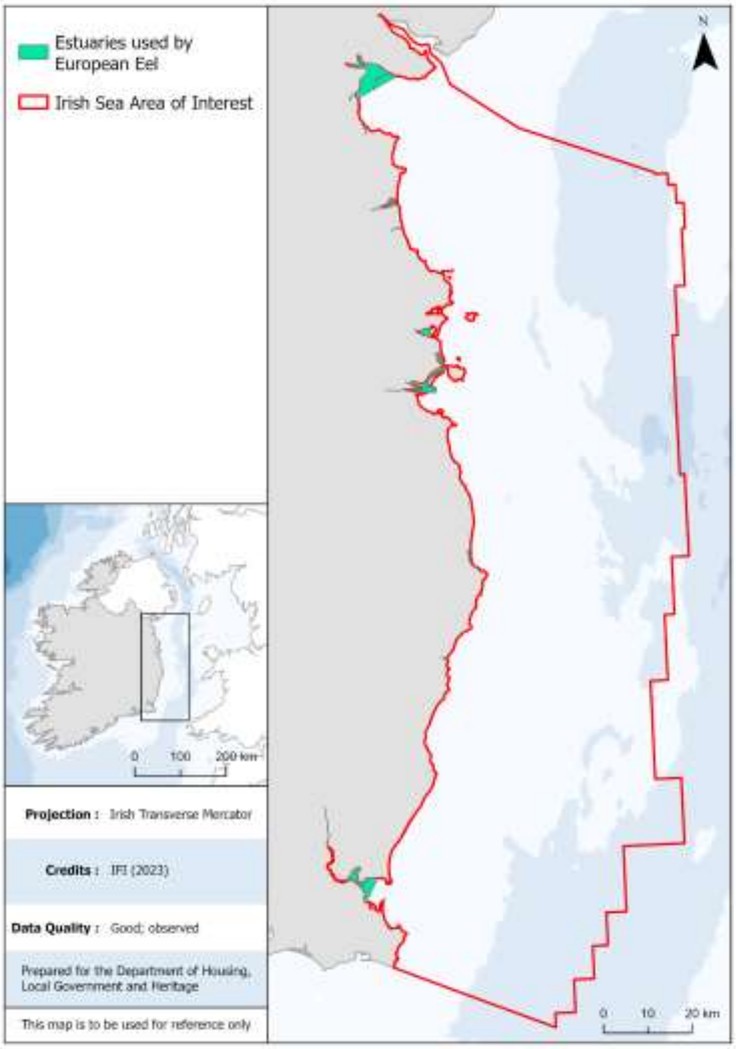

Figure 3. Data available for European eel, *Anguilla anguilla*, in the western Irish Sea.

Data sources and quality

No data relating to the distribution of European eel in the Irish Sea was available. It is known that eel migrate through the area to many rivers on the east coast of Ireland, but their exact route is unknown. Estuaries are an essential habitat for European eel, therefore estuaries associated with known eel rivers were included in the SCP process (Figure 3, Table 1).

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Estuaries of Ireland	Department of Housing, Local Government, and Heritage	Good; observed	Estuaries	
Inland Fisheries Ireland (IFI) Water Framework Directive (WFD) Fish Ecological Status	Inland Fisheries Ireland	Good; observed	WFD Fish Ecological Status	

Table 1. List of rivers containing European eel that are named in the Irish Eel management Plan on the east and southeast coast of Ireland. ERBD = Eastern River Basin District, NBIRBD = Neagh Bann International River Basin District, SERBD = South Eastern River Basin District.

DISTRICT	NAME	River Basin District
Wexford	Three Mile Water	ERBD
Dublin	Dargle (River)	ERBD
Dublin	Shanganagh	ERBD
Dublin	Newtownmountkennedy	ERBD
Dublin	Newcastle [Wicklow]	ERBD
Dublin	Vartry (River)	ERBD
Dublin	Rathnew (River)	ERBD
Wexford	Potter's (River)	ERBD
Wexford	Avoca (River)	ERBD
Wexford	Redcross (River)	ERBD
Dublin	Dodder (River)	ERBD
Dublin	Tolka (River)	ERBD
Dublin	Liffey (River)	ERBD
Drogheda	Delvin (River)	ERBD
Dublin	Broad Meadow (River)	ERBD
Dublin	Ballough (Stream)	ERBD
Drogheda	Nanny (River)	ERBD
Dublin	Ballyboghil	ERBD
Drogheda	Boyne (River)	ERBD
Drogheda	Termonfeckin	NBIRBD (ROI)
Dundalk	Castletown (River)	NBIRBD (ROI)
Dundalk	Flurry (River)	NBIRBD (ROI)
Dundalk	Castletown (River)	NBIRBD (ROI)
Dundalk	Fane (River)	NBIRBD (ROI)
Dundalk	Glyde (River)	NBIRBD (ROI)
Dundalk	Dee (River)	NBIRBD (ROI)
Waterford	Annestown (Stream)	SERBD
Waterford	Dalligan (River)	SERBD
Waterford	Mahon (River)	SERBD
Waterford	Tay (River)	SERBD
Waterford	Colligan (River)	SERBD
Waterford	Brickey (River)	SERBD
Waterford	Suir (River)	SERBD
Waterford	Glen (River)	SERBD
Waterford	Lingaun (River)	SERBD
Waterford	Pil (River)	SERBD
Waterford	Black Water	SERBD
Waterford	Ballymoat (Stream)	SERBD

Waterford	Dawn (River)	SERBD
Waterford	Clodiagh (River)	SERBD
Waterford	John's River	SERBD
Waterford	Whelanbridge (River)	SERBD
Waterford	Nore (River)	SERBD
Waterford	Barrow (River)	SERBD
Waterford	Aughnavaud (River)	SERBD
Waterford	Pollmounty (River)	SERBD
Wexford	Duncormick	SERBD
Waterford	Corock (River)	SERBD
Waterford	Owenduff (River)	SERBD
Wexford	Sow (River)	SERBD
Wexford	Slaney (River)	SERBD
Wexford	Blackwater (River)	SERBD
Wexford	Inch (River)	SERBD
Wexford	Owenavorragh (River)	SERBD

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10. Icelandic cyprine (Ocean quahog) *Arctica islandica*

Irish name: Breallach quahog

Figure 1: Icelandic cyprine, *Arctica islandica.* © Dr Hilmar Hinz (marlin.ac.uk)

Background

Arctica islandica has a heavy, thick, oval to rounded shell up to 13 cm in length. The shell is sculptured with numerous fine concentric lines and the beaks are anterior. It has a thick glossy periostracum that is brown in smaller individuals, becoming greenish brown to black in larger specimens. Arctica islandica is found at extreme low water level but predominantly on sublittoral firm sediments including level offshore areas, buried (or part buried) in sand and muddy sand that ranges from fine to coarse grains (Tyler-Walters & Sabatini, 2017). *Arctica islandica* is the last surviving species of the family Arcticidae that dates back to the Jurassic and reached its highest diversity in the Cretaceous ca 135-65 million years ago (Morton, 2011).

Application of feature list inclusion criteria

Arctica islandica is listed by OSPAR with reference to its decline and was therefore nominated for inclusion on the feature list. A. islandica is a long-lived and slow maturing species that takes between ca 5 and ca 15 years to reach maturity depending on location (Tyler-Walters & Sabatini, 2017).

The western Irish Sea is a significant part of the species distribution and is not currently protected or conserved. As a sessile benthic species, adult stages are amenable to spatial protection.

Sensitivity assessment

***Arctica islandica* is highly sensitive to pressures associated with the construction and operation of offshore wind farms (high confidence).** All marine habitats and benthic species are considered to have a resistance of 'None' to physical loss (to land or freshwater habitat) and to be unable to recover from a permanent loss of habitat (resilience is 'very low') (high confidence) (Tyler-Walters et al., 2018). *A.islandica* is highly sensitive to physical change of the seabed (high confidence) and sediment type (low confidence). A change to natural or artificial hard substratum would remove the sedimentary habitat required by the species. *Arctica islandica* is recorded from sandy muds, muddy sands, and fine to coarse sands (Rees & Dare, 1993; Cargnelli *et al.*, 1999). A change to muds and gravels may impair burrowing, and muds may impair filter feeding. As a result, the population is likely to suffer mortality (Tyler-Walters & Sabatini, 2017).

***Arctica islandica* is highly sensitive to fishing related activities (high confidence).** Mechanical damage and incidental catch of *A.islandica* from bottom fishing gear is known to damage shells and lead to direct mortality (Piet et al., 1998; Fonds, 1991, Klein & Whitbaard, 1995). This may have a particularly significant effect on sub-adult individuals as shell strength is correlated with size. *A.islandica* can live with some shell damage but repeated disturbance may lead to death. After its planktonic larval stage *A.islandica* settles on the seabed and is relatively stationary. It is therefore unlikely to move away or burrow rapidly to avoid damage from rapidly approaching beam trawls (OSPAR Commission, 2008).

Pressures associated with Shipping were **'Not Assessed'** and further information is needed on the sensitivity of A. islandica to these pressures.

Further research needs

There is insufficient evidence on the effects of chemical pressures on A. islandica to form an assessment. The pressures requiring more research include transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances. In addition, insufficient evidence was found to suggest that *Arctica islandia* populations were adversely affected by invasive non-indigenous species.

Figure 2. Global distribution of *Arctica islandica*, Source: https://obis.org/taxon/138802

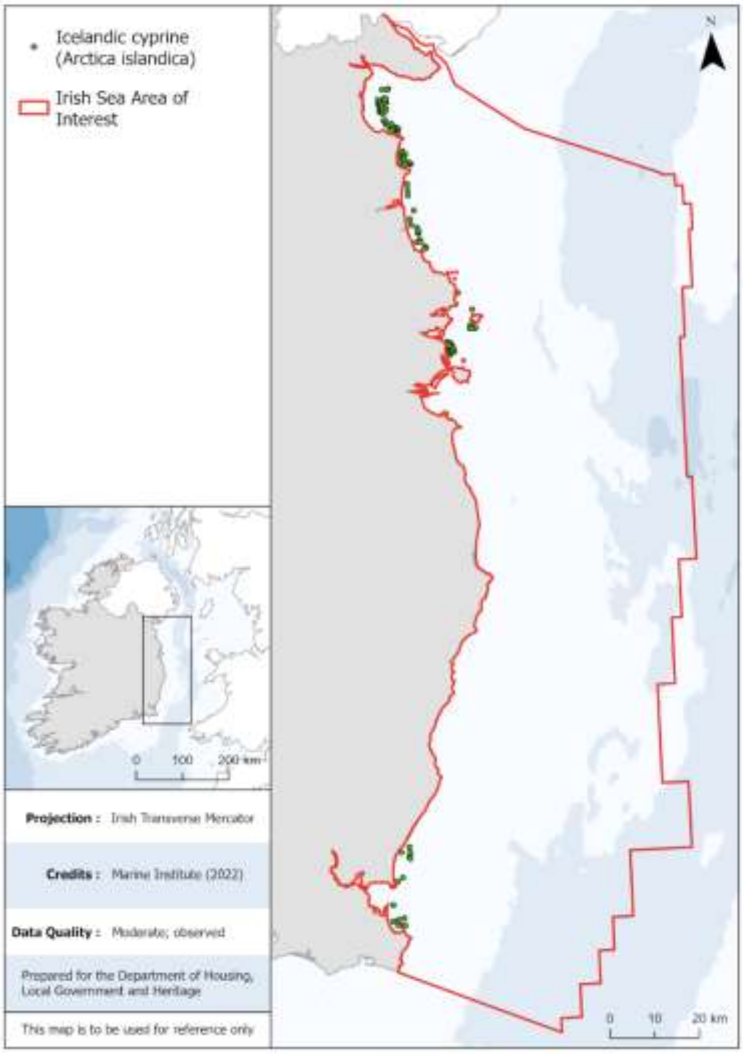

Figure 3. Data available for Icelandic cyprine, *arctica islandica* in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Marine Institute Razor Clam Survey	Marine Institute	Moderate; observed		
Marine Institute Water Framework Directive Benthic Data	Marine Institute	Moderate; observed		

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11. Pink sea fan (*Eunicella verrucosa)*

Figure 1: Pink sea fan, *Eunicella verrucosa.* © Dr Keith Hiscock (marlin.ac.uk)

Background

Eunicella verrucosa is an erect colonial gorgonian that varies from white to deep pink in colour. Colonies may be up to 50 cm high but more often up to 25 cm and they are found mainly on upward facing bedrock in areas where water movement is moderately strong from depths of 4 metres to over 50m. Recruitment in gorgonians is reported to be sporadic and/or low (Yoshioka 1996; Lasker *et al.* 1998; Coma *et al.* 2006). The growth rate can be highly variable. An increase in branch length of up to 6 cm was reported in some branches in one year but virtually none in others in Lyme Bay populations over a year. In the morphologically similar *Paramuricea clavata* in the Mediterranean, Coma *et al.* (1995) described reproduction and the cycle of gonad development. Spawning occurred 3-6 days after the full or new moon in summer. Spawned eggs adhered to a mucus coating on female colonies; a feature that would be expected to have been readily observed if it occurred in *Eunicella verrucosa*. Maturation of planulae took place among the polyps of the parent colony and, on leaving the colony, planulae immediately settled on surrounding substrata. It seems more likely that planulae of *Eunicella verrucosa* are released immediately from the polyps and are likely to drift (Readman & Hiscock, 2017).

Rationale for spatial protection in the western Irish Sea

Eunicella verrucosa was nominated for inclusion on the features list with reference to its listing on IUCN. The species is listed as globally vulnerable on the IUCN red list. Limited information is available on the distribution of *E. verrucosa* in the western Irish Sea and further data is required. There are however records in the southeast of Ireland and around the Isle of Man.

Sensitivity assessment

***Eunicella verrucosa* is highly sensitive to three of the pressures from the sensitivity analysis carried out.** The three pressures are associated with the construction and operation of offshore wind farms and each of the four fishing related activities.

All marine habitats and benthic species are considered to have a resistance of ‘None’ to physical loss (to land or freshwater habitat) and to be unable to recover from a permanent loss of habitat (resilience is ‘Very Low’)(high confidence) (Tyler-Walters et al., 2018). Physical change to another seabed type was assessed as highly sensitive (high confidence). A change to an artificial hard substratum does not automatically result in loss of suitable habitat for *Eunicella verrucosa*. However, artificial substratum may differ in character from natural habitats and may be associated with other pressures such as the presence of oil leaking from fuel tanks or the presence of antifoulant. However, a change to sedimentary substrata would result in the loss of suitable substratum for *Eunicella verrucosa*. Based on the loss of suitable habitat for the species, resistance to this pressure is assessed as ‘none’. Resilience is assessed as ‘very low’ as the pressure benchmark refers to a permanent change (Readman & Hiscock, 2017). E. verrucosa is also highly sensitive to removal of target species and would have no resistance to harvesting (low confidence).

***Eunicella verrucosa* is moderately sensitive to pressures associated with the shipping sector (medium confidence).** The species was assessed to have a medium sensitivity to the introduction or spread of invasive non-indigenous species (medium confidence). *Solidobalanus fallax* is an invasive southern species barnacle only recently recorded in south west England (Southward *et al.*, 2004) and, along with hydroids and bryozoans, have been observed fouling (primarily damaged or diseased) gorgonians (Hall-Spencer *et al.*, 2007). Fouling smothers the sea fan polyps and the membrane that covers the skeleton thus killing the live tissue of the sea fan. Eventually this can weaken the fan structure to the extent that fragmentation occurs. Therefore, resistance is assessed as ‘**Medium**’, resilience as ‘**Medium**’ and sensitivity as ‘**Medium**’. Due to the constant risk of new invasive species, the literature for this pressure should be revisited (Readman & Hiscock, 2017).

Figure 2. Global distribution of *Eunicella verrucosa*, Source: https://mapper.obis.org/?taxonid=125366

Further research needs

Further research is required on the distribution of E. *verrucosa* in the western Irish Sea. Information on the life history of the species is also needed to fully understand reproduction and recruitment. Additionally, the chemical pressure (transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances) were not assessed for this species due to a lack of evidence.

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12. Short snouted seahorse (*Hippocampus hippocampus*)

Figure 1. Short snouted seahorse, *Hippocampus hippocampus*. By © Hans Hillewaert, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=22106851

Background

The short snouted seahorse is in the class Teleosti and is one of two seahorses found in Irish waters. There is limited published research on the ecology of this species, therefore, the life history characteristics referred to in this case study are based largely on review articles on the biology of seahorses (Vincent, 1996; Garrick-Maidment, 1997; Lourie et al. 1999; Garrick-Maidment & Jones, 2004). *H. hippocampus* typically occupy depths of 1-15 m and most commonly observed in <5 m (Sabatini, Nash & Ballerstedt, 2021). It is thought that their depth distribution is likely a result of available habitat and varies throughout their range (Sabatini, Nash & Ballerstedt, 2021). A study in the Arcachon Basin in France suggested that adults make seasonal migrations to deeper waters in winter (Boisseau, 1967). Short-snouted seahorses grow up to 15 cm (Dawson, 1986), and mature at 6-12 months old (Lourie et al. 1999). The exact breeding season is not yet determined but is thought to occur between April to November (Lourie et al. 1999; Garrick-Maidment & Jones, 2004). Seahorses are ovoviviparous, with females depositing eggs into the male brood pouch. Gestation lasts 20-21 days (Garrick-Maidment, 1998), with 50-250 young produced (Garrick-Maidmen, 1998; Sabatini, Nash & Ballerstedt, 2021). Newly hatched young are thought to have a plankton dispersal stage that lasts >8 weeks (fishbase.se, no date), the extent of this dispersal is not yet described. The short snouted seahorse is primarily an eastern Atlantic species, occurring from the Wadden Sea to the Gulf of Guinea, the Canary Islands and along the African coast of

Guinea, and in the Mediterranean (OSPAR Commision, 2009). Short snouted seahorse are found in coastal habitats and estuaries, across both hard (bedrock), soft and vegetated substrate (microalgae and/or seagrass cover) (Sabatini, Nash & Ballerstedt, 2021). Seahorses typically have a small home range and high site fidelity (OSPAR Commission, 2009).

Rationale for spatial protection in the western Irish Sea

Short snouted seahorse were nominated for inclusion with particular reference to its conservation listing under OSPAR. OSPAR considers this species regionally and globally important, highly sensitive, and potentially in decline (OSPAR Commission, 2009).

It is one of two species of seahorse found in western Irish waters. Current evidence suggests declining numbers globally, however, the population size in the western Irish Sea is currently not quantified. Owing to its limited dispersal potential, a precautionary approach suggests spatial protection may be advisable.

Short snouted seahorse are amenable to spatial protection. Species-specific life history characteristics are poorly defined for this species. However, seahorses typically have limited dispersal, high site fidelity and small home ranges.

Sensitivity assessment

Short snouted seahorse are moderately sensitive to several fishing-associated pressures (low confidence). This species is moderately sensitive to fishing gears associated with abrasion/disturbance of the substratum surface or seabed (medium confidence) and highly sensitive to penetration or disturbance of the substratum subsurface (medium confidence). Short snouted seahorses were deemed moderately sensitive to introduction or spread of invasive non-indigenous species (low confidence), targeted removal (medium confidence) and accidental removal (medium confidence). Seahorses are globally exploited for use as medicines, aquarium fisheries, food and curios (Sabatini, Nash & Ballerstedt, 2021). There is no documented targeted removal in the western Irish Sea, however, it is assumed that there is potential for accidental bycatch of the species by trawling gear.

Shipping associated pressures were deemed not applicable or resulting in a low perceived sensitivity (low confidence). Underwater noise related to short-term constant motor noise was identified to cause the long snouted seahorse (*H. guttulatus*) to increase opercular movements and an increased likelihood to abandon their hold fasts (Palma et al. 2019). Its associated resistance was scored as medium by MaRLIN owing to possible effects on reduced recruitment and increased predation risk (Sabatini, Nash & Ballerstedt, 2021), however, its resilience scored high as noise is not thought to cause direct mortality.

Short snouted seahorse are moderately and highly sensitive to several pressures associated with offshore wind farms. All marine habitats and benthic species are considered to have no resistance to physical loss of habitat to land or freshwater habitat, and are unable to recover (low resilience) (Sabatini, Nash & Ballerstedt, 2021). Equally, as previously mentioned, seahorses are moderately sensitive to abrasion, penetration or disturbance of the substratum surface and seabed, pressures associated with the wind farm construction phase.

Further research needs

Key knowledge on the distribution and population size in the western Irish Sea is essential. Knowledge of the life history characteristics for this species are currently limited and requires further investigation.

Data sources and quality

No data was retrieved for this species in the western Irish Sea.

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13. Spotted ray (*Raja montagui*)

Irish name: *Roc breac/ Roc mín*

Figure 1: Spotted ray *Raja montagui* © Natural England/Ross Bullimore

Background

Spotted rays are a small skate species in the Class Chondrichthyes. They are a demersal species that is most common on sandy sediments in inshore water and shallow shelf seas at 28-530 m, though may occur deeper in the southern parts of its range (Ellis, Cruz-Martinez, et al. 2005). It is most abundant in waters less than 100 m in depth (Ellis et al. 2007). Juveniles feed on small crustaceans with larger individuals switching to larger crustaceans, and fishes (Ellis et al. 2007). Spotted rays have a maximum size of approx. 80 cm total length (Ellis, Dulvy, et al. 2005), but average 50 cm in length (Bauchot 1987; Clarke et al. 2016), making it one of the smaller species caught in the Irish Sea. Spotted rays reach a maximum age of 18 (Muus, Nielsen, and Dahlström 1999). Females lay paired eggs during the summer, in sandy or muddy substrates, which hatch after approximately 5-6 months (Breder and Rosen 1966; Serena 2005; Stehmann et al. 1984). Spotted rays are distributed throughout the Northeast Atlantic, including the Celtic and Irish Sea, and the Mediterranean Sea (Ellis et al. 2007) and exhibit high levels of site fidelity (Simpson, Humphries, and Sims 2021; Walker 1996).

Rationale for spatial protection in the western Irish Sea

Spotted rays were nominated for inclusion because they have been on the OSPAR List of Threatened and/or Declining Species and Habitats since 2001. Recent data suggest the species is increasing in abundance in some ICES areas, however, it remains rare in several countries and there are substantial uncertainties in these population trends (OSPAR.org).

Spotted rays are currently managed under a generic total allowable catch (TAC) with other named ray species. This TAC includes thornback (*R. clavata*), painted (*R.*

microoecllata), blonde (*R. brachyura*), cuckoo (*Leucoraja naevus*) (Common Fisheries Policy, 2016). “ICES considers that management of the catches of several stocks under a combined TAC prevents effective control of single-stock exploitation rates and could lead to overexploitation of some stocks.” (ICES 2022). Moreover, while landings are reported at the species level, misidentification of species is considered a challenge, particularly between blonde and spotted rays, therefore, the accuracy of landings is questionable. It is suggested that smaller bodies rays are more resilient to fishing pressure, however, large uncertainties remain with regards landings, discarding and overall population trends for this species.

Based on current knowledge spotted rays are amenable to spatial protection. Spotted ray are recorded throughout the Irish Sea (Clarke et al. 2016; Dedman et al. 2017; ICES 2022), and it is likely that the shallow sandy/muddy bays along the eastern coastline are important for egg laying and juvenile stages (Ellis, Cruz-Martinez, et al. 2005). Furthermore, spotted rays tagged in the North Sea and Western English Channel demonstrate high residency with little minimal range movement (Simpson et al. 2021; Walker 1996). Spotted rays may also have distinct substrate and depth preferences (Simpson et al. 2021) which can be used to design ecologically relevant protected areas.

Sensitivity assessment

The highest associated sensitivity scoring for blonde ray was in relation to its targeted and non-targeted removal (bycatch) by fishing (high confidence). The main threat to spotted rays is from fisheries, primarily through the non-targeted removal of the species. Spotted rays are not considered commercially important and are generally by-caught in trawl and gillnet fisheries that target other more valuable species (ICES 2022) (High confidence). Following a precautionary approach, spotted rays were deemed sensitive to transition elements and organo-metal contamination (low confidence), hydrocarbon and PAH contamination (low confidence). Spotted rays were deemed to have a medium sensitivity to heavy smothering and siltation changes which may result from bottom trawling activities (low confidence). While adults will likely move away from heavy siltation pressure, the sessile benthic eggs are vulnerable to becoming covered over and deprived of oxygenated fresh water.

Following a precautionary principle, spotted rays were assessed as sensitive to some shipping related pressures including contaminants (low confidence). There is no evidence that shipping activity directly impacts demersal rays, and the risk of collision was assessed as Not Relevant. Spotted rays were assessed as Not Sensitive to underwater noise (low confidence), however, the impacts of anthropogenic noise on elasmobranch species are very poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al. 2021), whereas research in the wild indicates an equivocal response to boat traffic (Rider et al. 2021). Hearing ability in demersal species seems to be most sensitive to low frequencies from nearby sources (Casper 2006) suggesting spotted rays may not be sensitive to vessel-related noise.

Offshore energy impacts on elasmobranchs are poorly understood, however, spotted rays were deemed moderately sensitive or sensitive to several offshore energy impacts. Physical loss of marine habitat, abrasion/disturbance of the seabed, and heavy smothering/siltation were assessed at a medium sensitivity (low confidence) owing to limited mobility of early life stages. Other ORE associated pressures were assessed as Low or Not sensitive (e.g., water flow changes), however, the quality, applicability and concordance of the available evidence is low and, in some instances, non-existent. For instance, Spotted ray are electrosensitive and can detect weak electromagnetic fields (EMF) and may generate their own weak EMF (Fritzsch and Moller 1995). Other similar species are affected by electromagnetic fields from high voltage cables (Gill et al., 2009; Hutchison et al., 2020), therefore, some impact on spotted ray is possible (low confidence). The cumulative long-term impacts of large offshore energy developments are unknown currently. Post construction, wind farms may provide refugia and artificial reef communities which could prove beneficial to some species of elasmobranch. Construction activities may displace some species; however, quantitative data is absent.

Further research needs.

Further work is required to identify population size, population trends, migrations and movements, essential habitats, spawning and nursery areas. Equally, discard quantity and survival require further investigation. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment, or relieved heavily on expert judgment. These pressures included the effects of changes in suspended solids (water clarity), smothering and siltation changes (light and medium), electromagnetic energy, death or injury by collision, transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances and the introduction or spread of invasive non-indigenous species.

Figure 2. Geographic distribution in the northeast Atlantic (https://www.iucnredlist.org/species/63146/12623141#geographic-range)

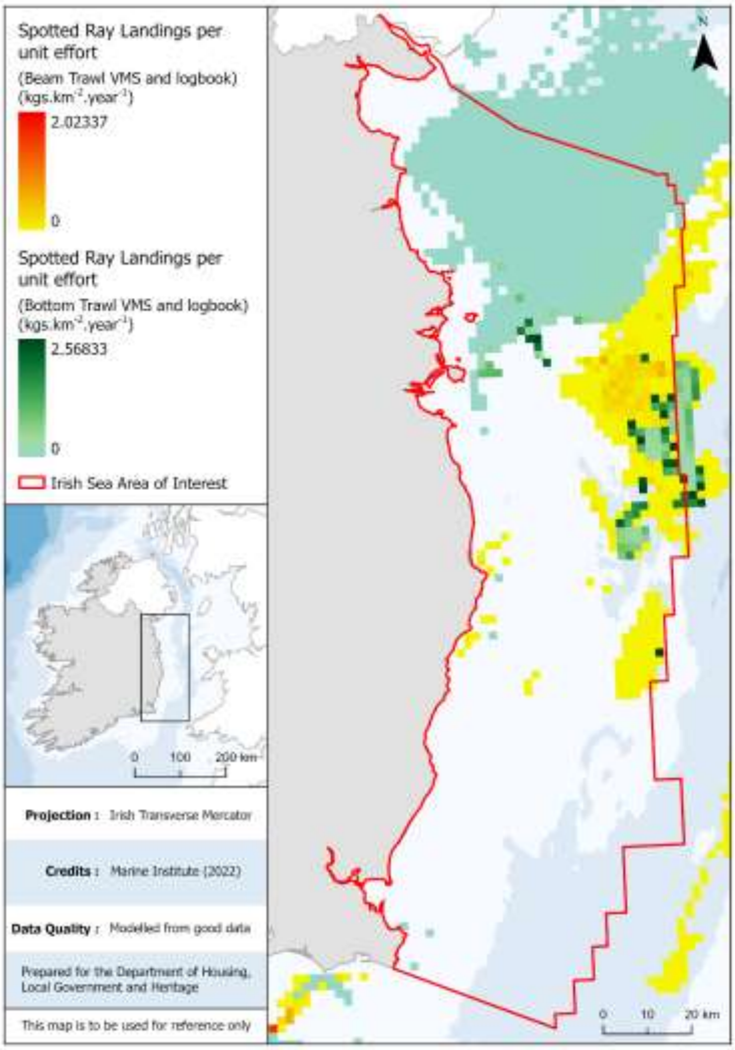

Figure 3. Distribution of spotted ray (*Raja montagui*) in the western Irish Sea. Data from ICES international fishing effort and swept area ratios and VMS.

Data sources and quality

Fisheries data and benthic surveys provide the information on which the status of *R. montagui* has been determined although grouping of the data for multiple ray species may obscure trends and lead to overexploitation (ICES 2022).

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Dedman *et al.* (2015) Species Distribution Model (SDM)	Dedman *et al* (2015)	Modelled from moderate data		

ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Data is sparse for this species
Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data		

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14. Starry smooth-hound *(Mustelus asterias)*

Irish name: Scoirneach ballach

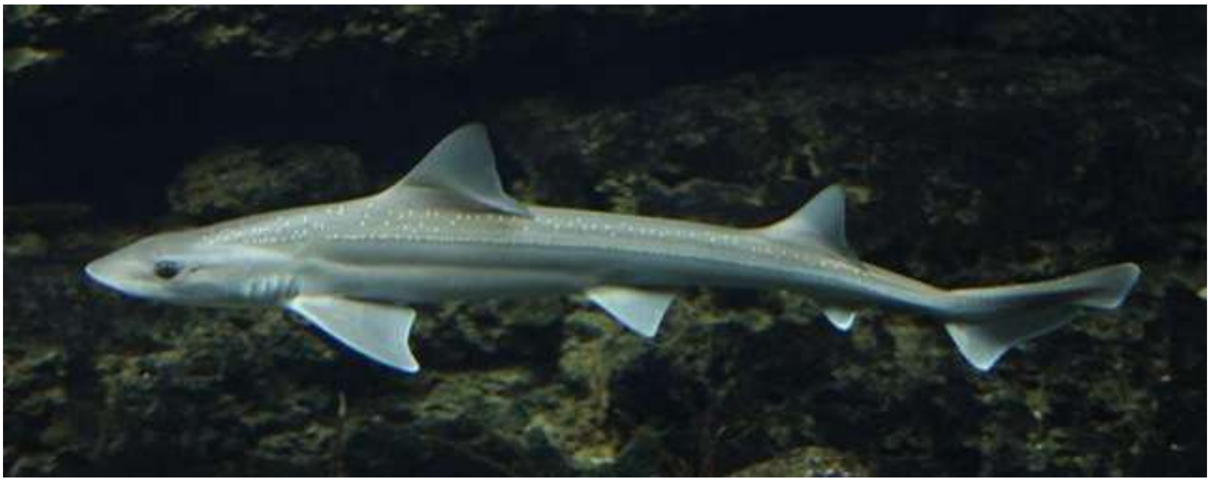

Figure 1: Starry smoothhound shark, *Mustelus asterias* photographed by © Pierre de Chabannes, www.pierrewildlife.com to reproduce permission must be granted from copyright holder.

Background

The starry smooth-hound shark is a relatively small cartilaginous fish species in the Class Chondrichthyes. The starry smoothhound has a max. estimated age of 13 for males, and 18.3 years old for females (Clarke et al. 2016). *M. asterias* have a reported total length of 140 cm total length (Compagno, 1984). In the northeast Atlantic starry smooth-hound reach maturity at around 78 cm total length and 4-5 years for males, and 87 cm total length and 6 years for females (Farrell et al. 2010 a,b). They are a viviparous species that gives birth to live young, with geographic variation in its reproductive traits (Clarke et al. 2016). Gestation lasts for approx 12 months with 6-18 embryos produced, followed by a 12-month resting period (Farrell et al 2010b). There is no published literature on the location of parturition and nursery areas of this species in the Irish Sea, however, neonates and juveniles are periodically abundant in shallow areas of the English Channel, southern North Sea (inc. the Thames Estuary), and Bristol Channel (Ellis et al. 2005). In the eastern Irish Sea (Holyhead, Wales) large pregnant females are seasonally abundant in May (Farrell, 2010c). Starry smooth-hounds are a demersal species with a depth range of 0-350 m (Brito, 1991). In Irish waters they are most commonly encountered in shallow sandy waters, including off the coast of Wicklow and Wexford with a northern expansion in their reported range in recent years (Clarke et al. 2016). Starry smooth-hound sharks have a narrow dietary niche, and are specialised on crustaceans as evidenced by its crushing dentition and species-specific diet studies (Berrow, 1994; Ellis et al. 1996; Phillips, Grant & Ellis, 2019; Biton-Porsmoguer, 2022). *M. asterias* occur in inshore temperature waters of the Northeast Atlantic (Celtic Sea, Irish Sea, North Sea, English Channel, Bristol Channel and Bay of Biscay) and Mediterranean (Compagno, 1984). The ICES Working Group on Elasmobranch Fisheries (ICES WGEF, 2019) considers there one biological stock in the continental shelf of the northeast Atlantic (ICES areas IV, VI-VIII). However, recent tracking work suggests this stock may comprise of at least two sub-populations (Griffiths et al. 2020). One population is thought to spend April to September in coastal waters of the southern North Sea and English

Channel, migrating from October to March to deeper waters in the western English Channel, Celtic Sea and northern Bay of Biscay. The other sub-population appears to reside in the Irish Sea, Celtic Sea and Bristol channel. These findings suggest a degree of philopatry and circannual migration.

Rationale for spatial protection in the western Irish Sea

Starry smooth-hound were nominated for inclusion with particular reference to its IUCN conservation listing as Near Threatened both in Europe and globally. In Irish waters, the population is thought to be stable or increasing over time (abundance trends from International Bottom Trawl Survey data), which led its classification of Least Concern in the Irish Red List (Clarke et al. 2016). ICES species-specific landings are unreliable, with *M. asterias* often reported under generic dogfish and shark landing codes (ICES, 2021). There is also longstanding misidentification of *M. asterias* with the common smooth-hound (*M. mustelus*) and juvenile tope (*Galeorhinus galeus*) (Ferrell, Clarke & Mariani, 2009).

There are currently no management measures in place for this species in Ireland. ICES advice (2021) currently recommends a 4% reduction in landings for 2022-2023 compared to 2020-2021. Discarding and discard survival has yet to be quantified. While deemed a species of Least Concern in Ireland (2016), the inability to quantify landings, discards, and its misidentification with other hounds suggests a precautionary approach is advisable.

The western Irish Sea is likely an important part of its range. Connectivity is not well understood for this species, however, movement data suggests movements of individuals across the Bristol Channel, Irish Sea and Celtic Sea. The western Irish Sea may therefore provide an important area for essential life stages including nursery grounds and breeding, however, further investigation is required.

Based on current knowledge, starry smooth-hound are amenable to spatial protection. Movement data suggests a degree of philopatry and circannual migration (Brevé et al. 2016, Griffiths et al. 2020). However, knowledge on how this species uses the western Irish Sea is limited (e.g., for breeding or nursery areas).

Sensitivity assessment

Several fisheries related activities were related to pressures with medium and high associated sensitivity scorings. Starry smooth-hounds were classed as highly sensitive to direct removal (high confidence). Starry smooth-hound are typically caught using otter trawl and nets, with fewer records for beam trawl and *Nephrops* trawl (Silva & Ellis, 2019). A high degree of smaller individuals are discarded (Silva & Ellis, 2019). Almost all recreational anglers practise catch-and-release for this species (Clarke et al. 2016). Starry smooth-hounds likely play an important role in regulating the inshore food web, therefore unmanaged and poorly quantified commercial landings may affect ecosystem health. *M. asterias* were deemed moderately sensitive to non-targeted removal (high confidence). Additionally, physical loss of habitat (low confidence), physical change of seabed type (moderate confidence), physical change of substrate to another seabed type (moderate confidence) and habitat structures (change or removal of substratum via extraction) (moderate confidence). These habitat-related scorings are related to its specialised diet, whereby functionality of sandy and soft bottom habitats is key to their survival (Biton-Porsomoguer, 2022).

Following a precautionary principle, starry smooth-hounds were deemed sensitive to two shipping related pressures. Elasmobranchs are thought to tolerate high metal levels in their tissues, however, a precautionary approach is applied and *M. asterias* were deemed sensitive to chemical pollutants including transition elements and organo-metal contamination, and hydrocarbon and PAH contamination.

Offshore energy impacts on elasmobranchs are poorly understood, however, based on existing knowledge starry smooth-hounds were deemed sensitive to some of the associated sectoral pressures. As detailed above, a precautionary approach was followed for chemical pollutants therefore this species was deemed sensitive to these associated pressures. *M. asterias* are mobile and demersal (situated in the lower water column), therefore they were not deemed sensitive to underwater noise. Construction activities may displace some elasmobranch species, although quantitative data is absent. There is no species-specific quantitative data on the effects of electromagnetic fields (EMF) from high voltage cables for *M. asterias*. Existing studies suggest EMF are likely to affect the behaviour of some species (Gill et al., 2009; Hutchison et al., 2020), however, long-term impacts are unknown at present (No evidence for this species). Post construction, wind farms may provide refugia and artificial reef communities which could prove beneficial to some species of elasmobranch. Construction activities may displace some species, however, quantitative data is absent.

Further research needs

Species-specific landings and discard data is necessary for this species. Equally, how starry smoothhound use the western Irish Sea particularly as nursery and partition areas is a priority. Evidence on the effects of several pressures on this species is limited and requires further research, including; abrasion/disturbance of substratum surface or seabed, penetration or disturbance of substratum subsurface, changes in suspended solids (water clarity), light smothering and siltation changes, electromagnetic energy, water flow changes, transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances, and organic enrichment.

Figure 2. Geographic distribution of starry smooth-hound (*Mustelus asterias*) from Jabado et al. (2021)

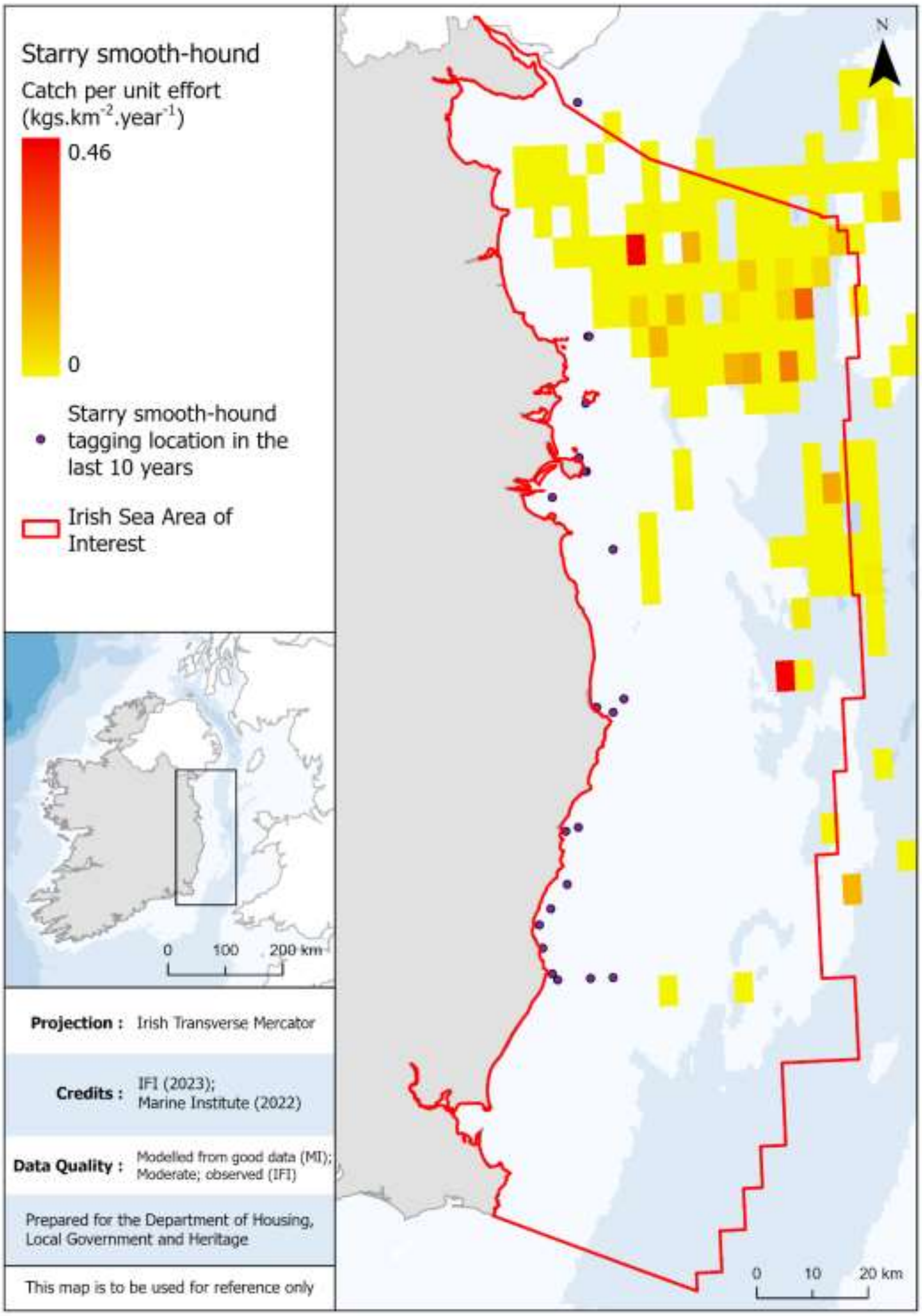

Figure 3. Distribution of starry smooth-hound (*Mustelus asterias*) in the western Irish Sea. Data from Inland Fisheries Ireland tag and recapture data and ICES international fishing effort and swept area ratios and VMS.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
Inland Fisheries Ireland Tag and Recapture	Inland Fisheries Ireland	Moderate; observed		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Data is sparse for this species

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15. Thornback Ray (*Raja clavata*)

Irish name: Roc garbh

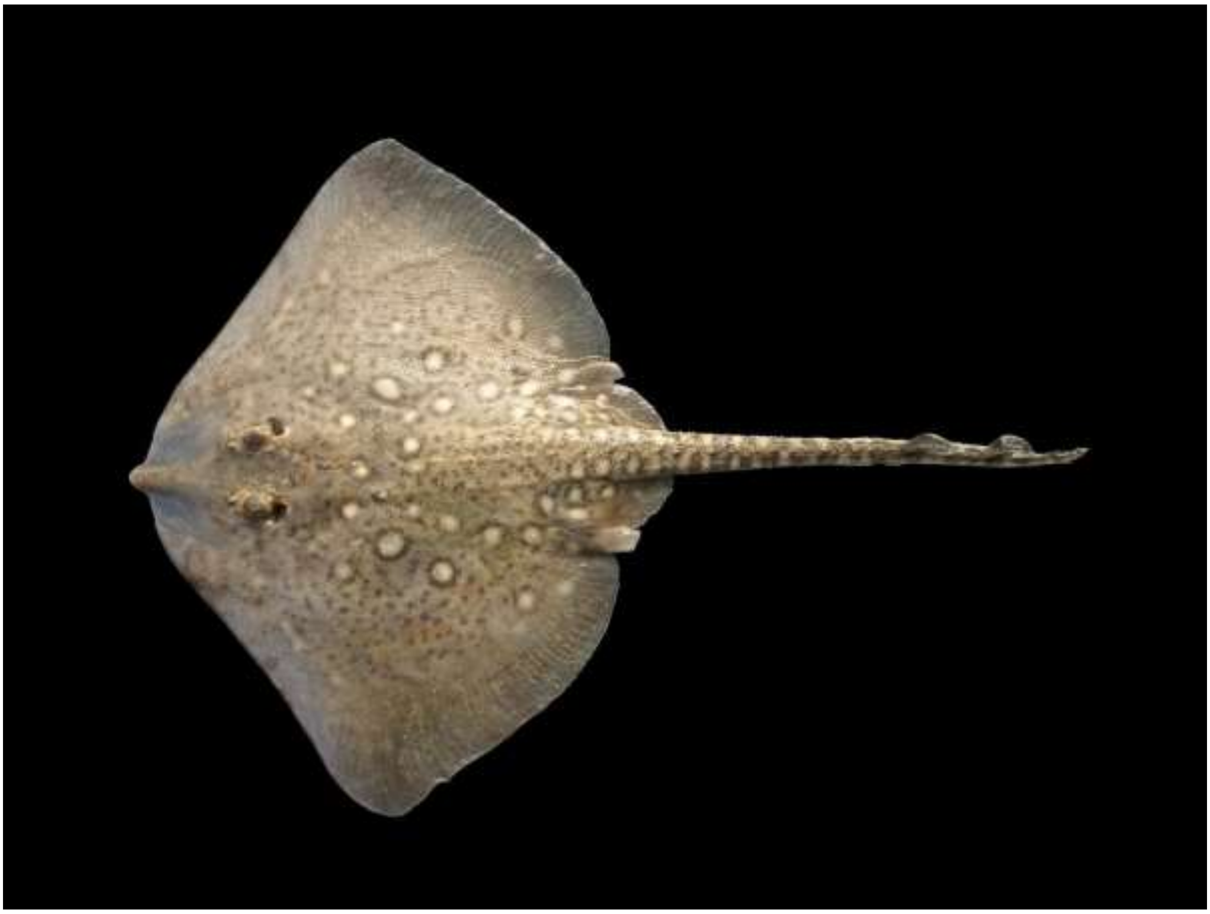

Figure 1: Thornback ray, *Raja clavata* (Linnaeus, 1758), Belgium. Credit: © Hans Hillewaert. Retrieved from https://www.flickr.com/photos/bathyporeia/9074024023/in/photolist-eQ3aZo-iKTBTk-ePQKd4-25zhoEq

Background

The thornback ray is a medium sized cartilaginous fish species in the Class Chondrichthyes. They have a large habitat range occurring in depths from 1-300m with juveniles residing inshore (10-30m depth) and adults occupying offshore waters (Hunter et al., 2006; Walker et al., 1997). Their maximum size is reported at 118cm for females and 98cm for males and a maximum age of 15 years (Walker, 1999, www.fishbase.se, n.d.). Size at maturity ranges regionally, but in general, they are an oviparous, slow maturing species producing 60-140 eggs per individual annually (Holden, 1975). Thornback rays are distributed throughout the North, North-eastern, Eastern Central, and Southeast Atlantic, and the Mediterranean Sea. Globally, genetic studies indicate segregation between the Azores, Mediterranean and the European shelf populations (Chevolot et al., 2006). Three distinct populations are recognized by ICES around Ireland, Northwest, West, and the Irish/Celtic Sea/Bristol Channel. The coastal populations in the Irish Sea (Irish and Wales coast) exhibit low genetic differentiation, possibly due to the genetic drift between Ireland and Wales (Chevolot et al., 2008).

Rationale for spatial protection in the western Irish Sea

This species is listed by OSPAR and the IUCN and classified as Near Threatened globally and as Least Concern in the 2016 Ireland Red List. The population in the Irish Sea experienced a 45% abundance decrease between 1988-1997 but have shown positive population growth since the early 2000's (Clarke et al., 2016; Dulvy et al., 2000). However, populations in the North Sea have been experiencing population decline with pushes to enact species specific management strategies (Wiegand et al., 2011).

Feature is not currently protected or conserved in the western Irish Sea. Thornback rays are covered under the Common Fisheries Policy (2015). However, species specific fisheries management is absent, limiting commercial landings by the total allowable catch ceiling for the named rays group.

It is known whether the western Irish Sea is a significant part of its range. The distribution of the species within the coastal Irish Sea is somewhat well known. They are the most abundant skate in coastal Ireland, with annual government funded trawl surveys capturing them frequently in the Irish Sea. Spawning areas are also present along the east and west Irish coast (Varian et al., 2010). The species shows high site fidelity with a range of 37-111km (Hunter et al., 2005a, 2005b). Although, juveniles and adults do exhibit seasonal migrations, it is not well understood in the Irish Sea.

Based on current knowledge thornback ray are amenable to spatial protection. Owing to egg presence along the Irish coast, useful management measures for thornback ray could include closed areas to protect spawning females. Data storage and mark-recapture tags in the North Sea indicate seasonal migration and high site fidelity for juveniles and adults (Hunter et al., 2006). These individuals are also repeatedly captured in the same coastal areas over long time periods.

Sensitivity assessment

The highest, publication backed, associated sensitivity scoring for thornback rays was in relation to its targeted and non-targeted removal (bycatch) by fishing (medium confidence). Thornback rays are not usually targeted on the Irish coast, instead they are largely captured as bycatch by trawl and gillnet fisheries (Clarke et al., 2016). Although, estimates from the early 2000s indicate a growing and stable population, species specific management is important to avoid another collapse. Currently, the species is managed as part of the generic maximum total allowable catch for named ray species in the Irish Sea and west of Ireland, limiting management effectiveness. Regardless of the impacts of fishing pressure on stock health, the population has experienced a body size reduction. Skippers report decreases in thornback ray body size with recent annual heaviest individual only weighing 60% of the weight of the heaviest thornback in 1977 (Richardson et al., 2006). According to the Irish Specimen Fish Committee, there have been no records of captured >8kg individuals since 2007.

Thornback rays were regarded as not sensitive to shipping-related activities (low confidence). Vessel presence in marine environments produce noise and create a collision risk. Noise impacts on elasmobranch species are poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al., 2021), whereas research in the wild indicates an unclear response to boat traffic (Rider et al., 2021). Hearing ability in demersal elasmobranch species seems to be most sensitive to low frequencies (Casper, 2006), however, hearing range varies depending on the species (Popper and Fay, 1977). Thornbacks are a benthic species, rarely ever rising to the surface, making collision risk minimal.

Offshore energy impacts on elasmobranchs are poorly understood, however, based on existing knowledge thornback ray scored not-sensitive to medium sensitivity to the associated pressures (low confidence). Construction activities may displace some species; however, quantitative data is absent. Thornback rays are generalist and occur on different types of seabeds. There is little evidence to support that they are impacted by offshore energy structures.

Further research needs

Key knowledge on the seasonal migrations of thornback rays in the western Irish Sea remains limited and requires further investigation. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment. Several chemical pressures had insufficient evidence: transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination, introduction of other substances, and organic enrichment. Some physical pressures had no relevant publications and relied solely on scientist knowledge: abrasion/disturbance of substratum surface or seabed, changes in suspended solids, and smother and siltation changes (light and heavy).

Figure 2. Global geographic distribution of thornback ray, *Raja clavata*, from the IUCN.

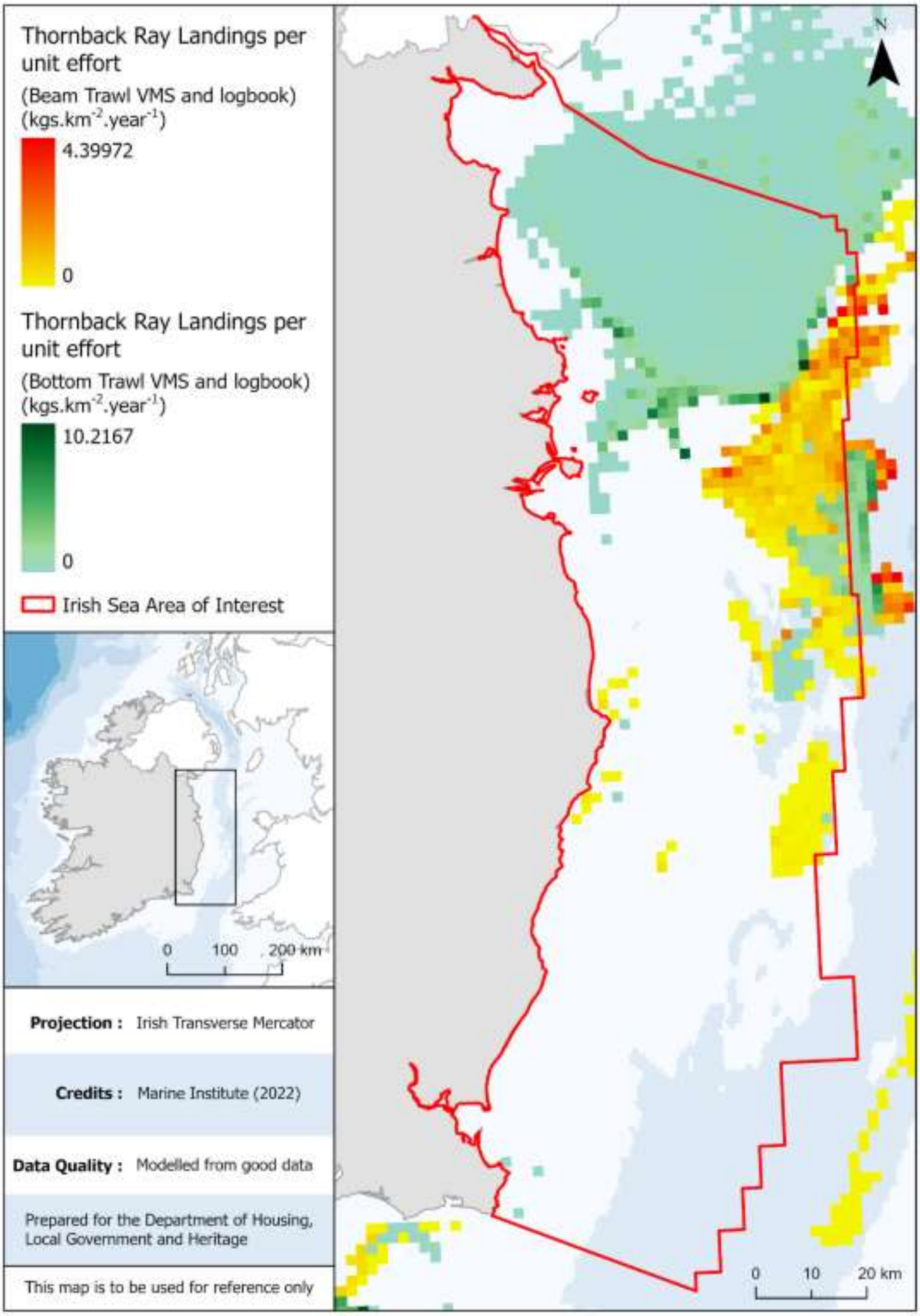

Figure 3. Distribution of thornback rays (*Raja clavata*) in the western Irish Sea. International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS) visualised.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Dedman *et al.* (2015) Species Distribution Model (SDM)	Dedman *et al* (2015)	Modelled from moderate data		
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Data is sparse for this species
Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data		

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16. Tope shark *(Galeorhinus galeus)*

Irish name: Gearrthóir

Figure 1. Tope shark, *Galeorhinus galeus* (Linnaeus, 1758), Chile © L. Ignacio Contreras, Laboratorio de Zoología de Vertebrados, Facultad de Ciencias, U. de Chile. Retrieved from https://www.shark-references.com/species/view/Galeorhinus-galeus

Background

The tope shark is a medium-sized shark in the Class Chondrichthyes. Tope are a bentho-pelagic species with a broad habitat range between 0-826 m depth and is most frequently to depths of 200 m (Walker et al. 2020). The maximum size varies regionally ranging from 155 cm total length in the Southwest Atlantic (Peres and Vooren, 1991) to 200 cm in the Mediterranean Sea (Capapé and Mellinger 1998). Size-at-maturity, size-at-birth and reproductive cycle varies regionally, but in totality this is a slow maturing species that gives birth to live young (litter size averages between 20-35 pups; Walker et al. 2020). Tope are distributed across the Northeast, Eastern Central, Southwest, and Southeast Atlantic, the Mediterranean Sea, the Eastern Indian, and across all of the Pacific, except in the Northwest Pacific (Walker et al. 2020). Tagging and genetic data suggests that there are up to six separate subpopulations of tope globally, and while tope exhibit large-scale movements there is no evidence of population mixing (Walker et al. 2020). In the northeast Atlantic region, there is believed to be a single stock (ICES 2012). Inland Fisheries Ireland data suggests wide migrations between the North Sea, west of Scotland and Ireland south towards the Canary Islands, the Azores, the western Mediterranean and northwest Africa (Fitzmaruice et al. 2003). It should be noted that the northeast Atlantic and Mediterranean stock is thought to be isolated from other global subpopulations, with no genetic mixing between these two stocks (Chabot and Allen, 2009).

Rationale for spatial protection in the western Irish Sea

Tope were nominated for inclusion with particular reference to its conservation listing under OSPAR and/or listing as Near Threatened or greater (Irish, EU or Global Red List). Tope are listed as Vulnerable by the IUCN Red List, Irish and European Red List. Tope is also listed as Critically Endangered globally. Data on tope are limited given landings are often included as “dogfishes and hounds” (Dureuil, 2013). In the Northeast Atlantic, the subpopulation has experienced a 76% decline over the past 79 years (three generation lengths; Walker et al. 2020). There is conflicting evidence as to whether the Northeast Atlantic subpopulation is stable (Walker et al. 2020) or declining (exploratory assessment of catch per unit effort trends from 20 y trawl survey data, Dureuil, 2013). Tope are protected or conserved in the Irish Sea by the Common Fisheries Policy (2015). However, given discards can not be quantified (ICES, 2019) we recommend a precautionary approach is applied and spatial protection of this species is considered.

Fishing restrictions are in place under the Common Fisheries Policy (2015) whereby catch and release is mandatory in EU waters for line-caught tope. Given discards cannot be quantified by ICES (2019) we advise a precautionary principle is applied and spatial management is considered.

It is not known whether the western Irish Sea is a significant part of its range. Data on the distribution of this species in the Irish Sea is limited, with data primarily from mark-recapture programs led by Inland Fisheries Ireland. In the western Irish Sea, juvenile and adult tope (including pregnant females) are caught recreationally across the southeast coast of Ireland along the Wicklow-Arklow coastline, with possible temporal separation between these cohorts.

Based on current knowledge tope are amenable to spatial protection. Owing to its documented use of near-shore breeding areas, useful management measures for tope could include closed areas to capture pupping areas of pregnant females. For example, acoustic tracking data generated in the Southern Hemisphere suggests juvenile young-of-the-year (YOY) tope use shallow nearshore areas, with few YOY returning within their first 1-2 y (McAllister et al. 2015). This finding is also supported by McMillan et al. (2021).

Sensitivity assessment

The highest associated sensitivity scoring for tope was in relation to its targeted and non-targeted removal (bycatch) by fishing. Tope are caught globally as a target species and by bycatch in industrial and small-scale demersal and pelagic gillnet and longline fisheries, and less commonly caught by trawl and hook-and-line fisheries (Walker et al. 2020). Tracking data suggests behavioural plasticity, and potential habitat expansion of adult tope into mesopelagic layers of the high seas, which increases their risk of incidental fisheries capture (Schaber et al. 2022). Tope are not targeted by commercial fisheries in Irish waters and catch-and-release is mandatory in EU waters for line-caught tope (Common Fisheries Policy, 2015). Tope are targeted by sport and recreational fishers in Irish waters, and may be caught as bycatch owing to using both the lower and mesopelagic layers of the water column. The most recent ICES assessment (2019) covering ICES region VIIa states, “discarding is known to take place, but ICES cannot quantify the corresponding catch. Discard survival, which is likely to occur, has also not been estimated”.

Following a precautionary principle, tope were identified as sensitive to some shipping related pressures. It is thought that elasmobranchs are vulnerable to environmental pollutants (Dulvy et al. 2017) such as transition elements given they are long-lived and occupy a high trophic level. Elasmobranchs are thought to tolerate high metal levels in their tissues; however, a precautionary approach is applied and tope were deemed sensitive to chemical pollutants including transition elements and organo-metal contamination, and hydrocarbon and PAH contamination. The impacts of vessel noise on elasmobranch species are poorly understood. Lab based studies suggest noise can increase swimming activity (de Vincenzi et al., 2021), whereas research in the wild indicates an unclear response to boat traffic (Rider et al., 2021). Hearing ability in demersal elasmobranch species seems to be most sensitive to low frequencies (Casper, 2006), however, hearing range varies depending on the species (Popper and Fay, 1977). Tope occupies the bentho-pelagic zone, therefore limited water depth in the western Irish Sea makes vessel sound unavoidable. Ship strike is deemed not to be a significant pressure.

Offshore energy impacts on elasmobranchs are poorly understood, however, based on existing knowledge tope was sensitive to some of the associated sectoral pressures. As detailed above, a precautionary approach was followed for chemical pollutants and therefore tope were deemed sensitive to chemical pollutants including transition elements and organo-metal contamination, and hydrocarbon and PAH contamination. Construction activities may displace some species, however, quantitative data is absent. Bruce et al. (2018) found that seismic survey sounding in Australia led to a significant reduction in tope catch using demersal gillnets. Given tope are very mobile and can exhibit behavioural plasticity, they were deemed not sensitive to underwater noise or electromagnetic fields produced by offshore cabling.

Further research needs

Key knowledge on the distributions of tope in the western Irish Sea remains limited and requires further investigation. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment. These pressures included chemical (transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances) and physical pressures (abrasion/disturbance of substratum surface or seabed, penetration or disturbance of substratum subsurface and barriers to species movement).

Figure 2. Global geographic distribution of tope shark, *Galeorhinus galeus,* from Walker et al. (2020).

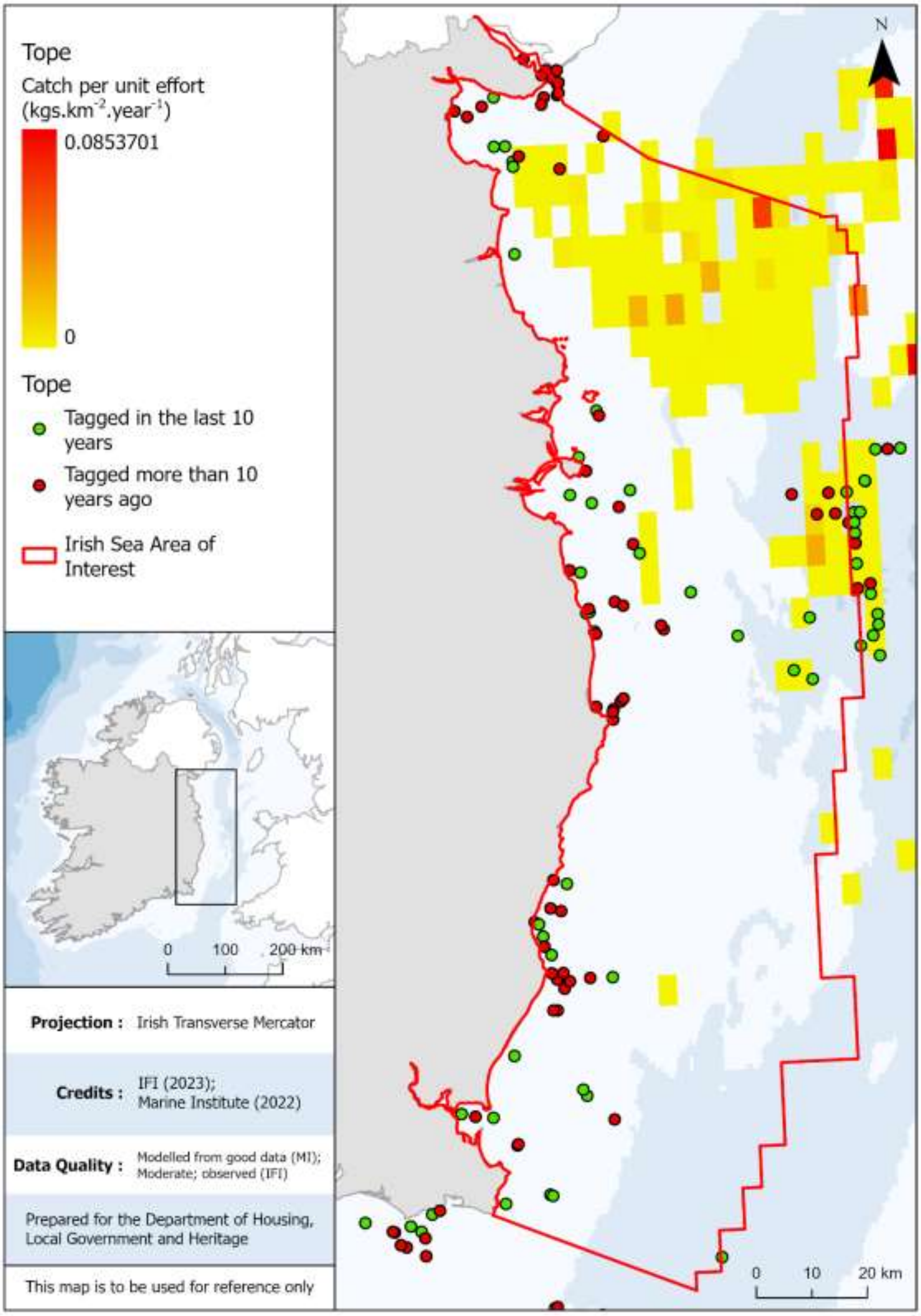

Figure 3. Data available for tope shark, *Galeorhinus galeus* in the western Irish Sea. Points show Inland Fisheries Ireland Tag and Recapture data and shaded areas indicate ICES internationship fishing effort and swept area ratios.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
Inland Fisheries Ireland Tag and Recapture	Inland Fisheries Ireland	Moderate; observed		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	Data is sparse for this species

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17. Turbot (*Scophthalmus maximus*)

Irish name: Turbard

Figure 1. Turbot, *Scophthalmus maximus* (Linnaeus, 1758), By I, Luc Viatour, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=6519726

Background

Turbot is a large left-eyed flatfish found primarily in shallow waters throughout the Mediterranean, the Baltic Sea, the Black Sea, and the North Atlantic (Figure 2). Adults live on sandy, rocky or mixed bottoms; rather common in brackish waters. Feed mainly on other bottom-living fishes (sand-eels, gobies, *etc*.), and also, to a lesser extent, on larger crustaceans and bivalves. Batch spawner with spawning season between May and July; pelagic eggs. May reach 25 kg with females becoming much larger than males. Highly esteemed food fish (Source: Fishbase).

Turbot displays high fidelity to spawning sites and is relatively sedentary. The principal threat to turbot is over-exploitation. Population declines have been documented throughout this species' range. Across Europe, turbot is a valuable bycatch species that is taken in various fisheries such as those targeting flatfishes like sole and plaice. This species is caught with beam trawls, seines, trammel nets, longlines, gillnets and otter trawls. Turbot is bred in captivity and is thought to be an excellent candidate for aquaculture in Europe (source: IUCN European Red List Assessment, 2013 and references therein).

Rationale for spatial protection in the western Irish Sea

Turbot is nominated for inclusion with particular reference to its listing as Vulnerable by the European IUCN Red List. The latest Global IUCN Red List places turbot in the Least Concern category (Cardinale et al., 2021). Nevertheless, turbot is not subject to stock assessment or individual management in the western Irish Sea and there are no fishing restrictions in place under the Common Fisheries Policy (2015) so the precautionary principle was applied and spatial management is considered.

The western Irish Sea is a significant part of its range. Data on the distribution of this species in the Irish Sea is comprehensive with the exception of shallow areas; catch and positional data are available from the fishery (logbooks and VMS) and the IBTS survey reports CPUE, length, weight, age, sex and maturity from scientific hauls spread across the area in a stratified design.

Turbot are amenable to spatial protection owing to the fact they have high spawning site fidelity, generally do not undertake extensive movements (Cardinale et al. 2021 and references therein). Although larval dispersal is relatively low, Florin et al. (2013) found a high potential for larval export from a marine reserve in Sweden, showing that it may be important for maintaining a viable turbot stock.

Sensitivity assessment

No existing MarESA or FeAST sensitivity assessments were available for turbot. A full literature search (terms below) produced greater than 3000 results, partially due to the use of turbot in aquaculture. It was not possible to review the full set of resulting papers in the time available so the following sensitivity assessment is based on selected papers, the IUCN assessments, and sensitivity assessments for similar flatfish (witch and American plaice).

The highest associated sensitivity scoring for American plaice was in relation to targeted and non-targeted (bycatch) removals by all fishing sub-sectors (medium sensitivity, high confidence). Physical loss or alteration of its habitat were deemed a medium sensitivity (with medium confidence). Due to its close association with certain shallow sediments, resistance to physical loss and change of sediment type were scored as low but, as they are mobile, have pelagic eggs and larvae, and have a long association with fisheries-related abrasion, resilience was scored medium.

Turbot were assessed as not sensitive to waterflow changes but it should be noted that the transport and retention of their eggs and larvae to suitable areas of habitats may rely on the Irish Sea gyre (Dickey-Collas et al. 1996) and large-scale disruption of such features could disrupt settlement of larvae.

Further research needs

Existing data on the shallow water distribution of turbot in the western Irish Sea (e.g. from beach seine or inshore surveys) needs to be combined with the offshore data described below.

Figure 2. Global geographic distribution of Turbot, *Scophthalmus maximus,* from www.aquamap.org.

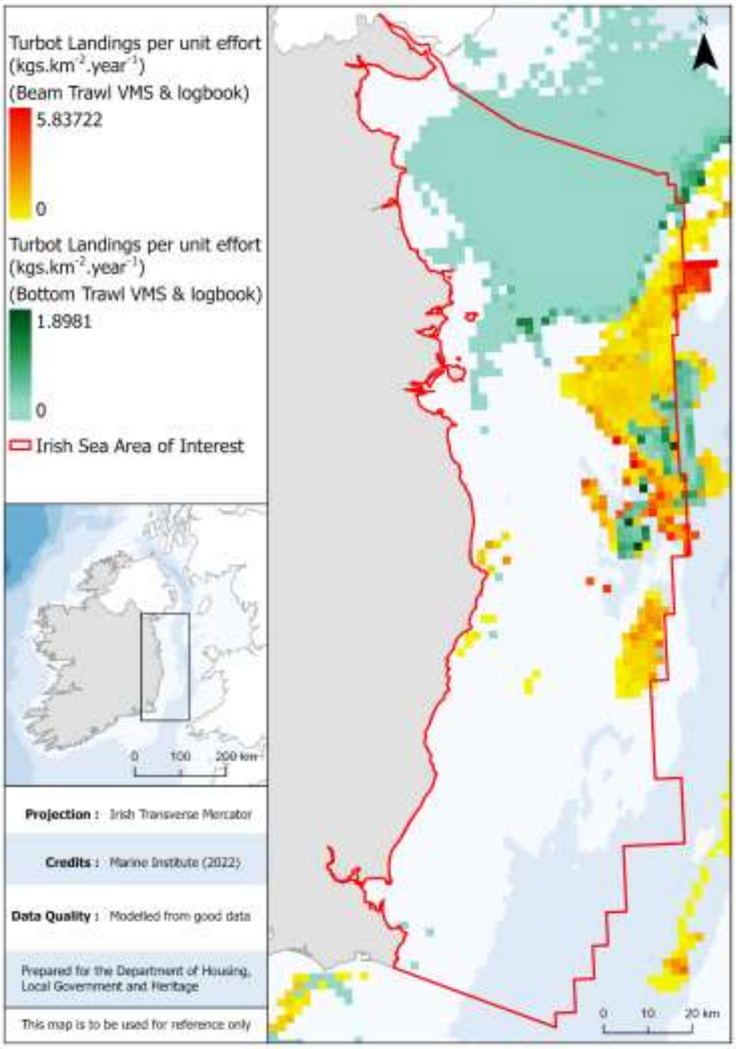

Figure 3. Data available for Turbot, *Scophthalmus maximus,* in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	
Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data		

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18. Witch Flounder *(Glyptocephalus cynoglossus)*

Irish name: Leathóg bhán

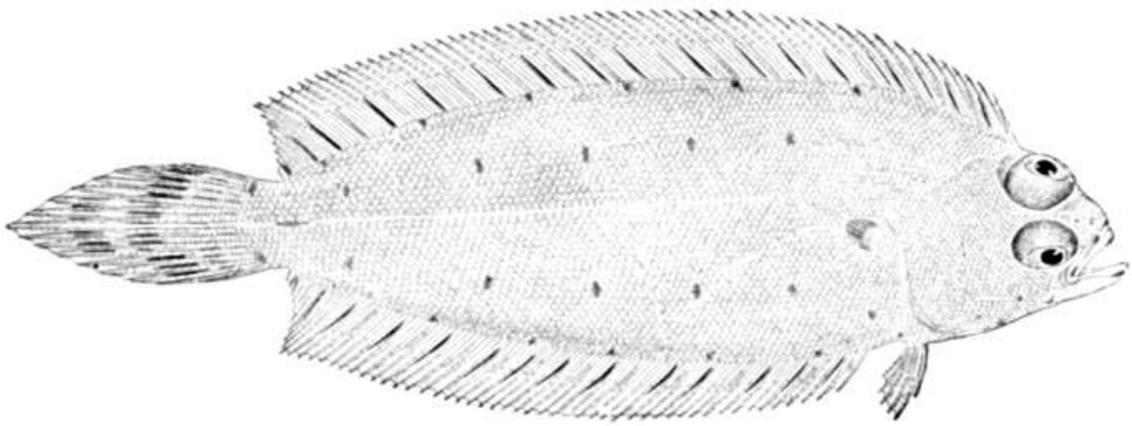

Figure 1. Witch flounder, *Glyptocephalus cynoglossus* (Linnaeus, 1758), Public Domain, https://commons.wikimedia.org/w/index.php?curid=677206

Background

Witch is a species of right-eye flounder from the family Pleuronectidae. It occurs on both sides of the North Atlantic Ocean on muddy sea beds in fairly deep water. It feeds primarily on crustaceans, polychaetes, and brittle stars. Eggs and larvae are pelagic and spawning occurs from May to September (Source: Fishbase).

There are very few directed fisheries for witch in European waters but due to its association with muddy substrates it is a by-catch species in the Nephrops and demersal trawl fisheries.

Rationale for spatial protection in the western Irish Sea

Witch flounder is nominated for inclusion with particular reference to its listing as Vulnerable by the global IUCN Red List. This is however a joint assessment of the western and eastern Atlantic populations and the western Atlantic stocks were weighted heavier when estimating global decline. The European Red List places witch in the Least Concern category. Nevertheless, witch is not subject to individual stock assessment or management in the western Irish Sea and there are no fishing restrictions in place under the Common Fisheries Policy (2015) so the precautionary principle was applied and spatial management is considered.

The western Irish Sea is a significant part of its range. Data on the distribution of this species in the Irish Sea is comprehensive; catch and positional data are available from the fishery (logbooks and VMS) and the IBTS survey reports CPUE, length, weight, age, sex and maturity from scientific hauls spread across the area in a stratified design.

Witch are amenable to spatial protection owing to its close association to fine-grained substrate types and the fact that tagging studies have shown little movement from resident areas (Bailey, 1997).

Sensitivity assessment

The highest associated sensitivity scoring for witch was in relation to physical loss or alteration of its habitat and its targeted and non-targeted removal (bycatch) by fishing. Elements of both of these pressure classification were deemed a medium sensitivity (with medium confidence). Due to its close association with fine-grained/muddy sediments, resistance to physical loss and change of sediment type were scored as low but, as witch are mobile and have pelagic eggs and larvae, resilience was scored medium.

One study in the western Atlantic found evidence to suggest the health of bottom-dwelling flatfish at three sites was impaired by chronic exposure to sediment contaminated with PAHs or PCBs. Overall however there was not enough literature to form an assessment of sensitivity.

Witch were assessed as not sensitive to waterflow changes but it should be noted that the transport and retention of their eggs and larvae to suitable areas of habitats in the Irish Sea relies on a certain ocean current and large scale disruption of that feature could disrupt settlement of larval witch.

Further research needs

Evidence to identify the potential effect of multiple pressures was insufficient to form an assessment. These pressures included chemical (transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances).

Figure 2. Global geographic distribution of witch flounder, *Glyptocephalus cynoglossus*, from IUCN Global Red List Assessment 2021.

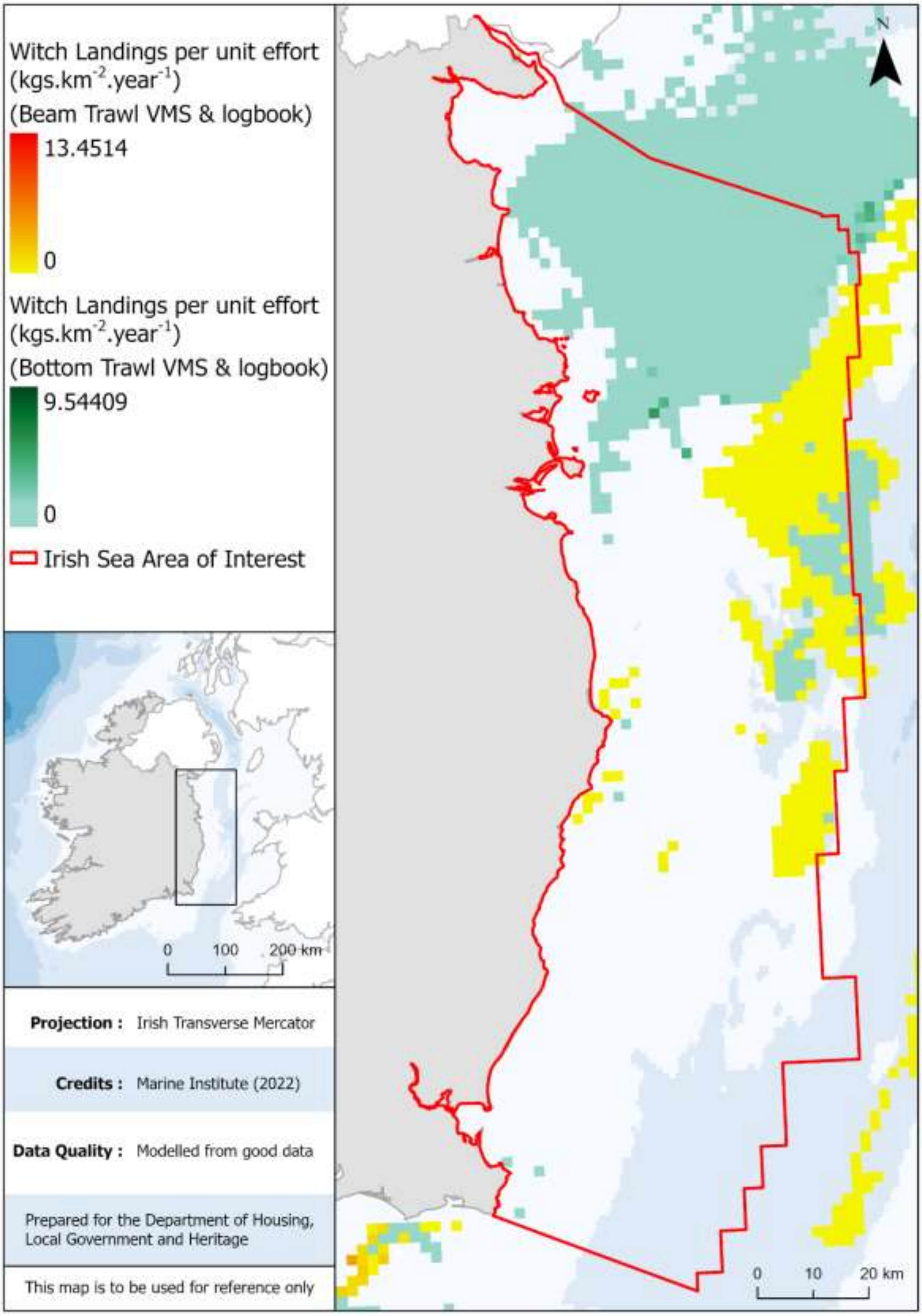

Figure 3. Data available for witch flounder, *Glyptocephalus cynoglossus*, in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
ICES international fishing effort and swept area ratios; VMS	International Council for the Exploration of the Seas	Modelled from good data		
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Good; observed	IE-IGFS and NIGFS	
Marine Institute VMS and logbook	Supplied to Marine Institute by Irish Naval Service and Sea Fisheries Protection Authority	Modelled from good data		

References

Bailey, K. (1997). Structural dynamics and ecology of flatfish populations. Journal of Sea Research, Volume 37, Issues 3–4, Pages 269-280, ISSN 1385-1101, https://doi.org/10.1016/S1385-1101(97)00018-X.

Cadrin, S., González Troncoso, D., Nimmegeers, S., Vansteenbrugge, L., Wheeland, L. & Munroe, T.A. 2022. *Glyptocephalus cynoglossus*. *The IUCN Red List of Threatened Species* 2022: e.T18214757A162704857.

19. Ross Worm Reefs *Sabellaria spinulosa*

Figure 1: Ross worm, *Sabellaria spinulosa* © Joint Nature Conservation Committee (JNCC)

Background

Sabellaria spinulosa is a small, tube-building polychaete worm found in the subtidal and lower intertidal/sublittoral fringe. In most parts of its geographic range, it does not form reefs but is solitary or found in small groups, encrusting pebbles, shell, kelp holdfasts and bedrock. When conditions are favourable dense aggregations may be found, forming reefs up to about 60cms high and extending over several hectares; these are often raised above the surrounding seabed. The reef infauna typically comprises polychaete species such as *Protodorvillea kefersteini*, *Scoloplos armiger*, *Harmothoe* spp., *Mediomastus fragilis*, *Lanice conchilega* and cirratulids together with the bivalves *Abra alba* and *Nucula* spp. and tube-building amphipods such as *Ampelisca* spp. Epifauna comprise calcareous tubeworms, pycnogonids, hermit crabs, amphipods, hydroids, bryozoans, sponges, and ascidians (OSPAR Commission, 2008).

Rationale for spatial protection in the western Irish Sea

Sabellaria spinulosa reefs are listed by OSPAR with reference to its sensitivity, rarity, ecological significance, and decline. The reefs provide biogenic habitat and are host to a wide range of associated species. This biotope is not currently protected or conserved in the western Irish Sea but is amenable to spatial protection.

Sensitivity assessment

***Sabellaria spinulosa* reefs are moderately and highly sensitive to pressures associated with the construction and operation of offshore wind farms (low confidence).** All marine habitats and benthic species are considered to have a resistance of ‘None’ to physical loss (to land or freshwater habitat) and to be unable to recover from a permanent loss of habitat (resilience is ‘very low’) (Tyler-Walters et al., 2018). This habitat was assessed as moderately sensitive to removal of substratum (high confidence). The removal of sediment or substratum down to 30 cm depth is likely to remove the whole *Sabellaria spinulosa* reef within the extraction footprint. Therefore, resistance to this pressure is assessed as 'none'. However, if suitable substrata were to remain, recruitment rates are high and recovery could be quite rapid, therefore resilience is considered to be 'medium' (Tillin et al., 2022).

***Sabellaria spinulosa* reefs have a high sensitivity to bottom trawling and dredging/beam trawling and a medium sensitivity to pelagic and static gear fishing (low confidence).** The reef is highly sensitive to the physical change to another sediment type (low confidence). Where the reef occurs on mixed sediments an increase in fine sediments to the degree that sediments are re-classified as mud or sandy mud would severely reduce habitat suitability. Sensitivity to abrasion (low confidence) and penetration (medium confidence) of the substratum were assessed as medium for this habitat. Abrasion at the surface of *Sabellaria spinulosa* reefs is considered likely to damage the tubes and result in sub-lethal and lethal damage to the worms while structural damage to the seabed sub-surface is likely to damage and break-up tube aggregations leading to the loss of reef within the footprint of direct impact. However, depending on the level of impact recovery is likely to be quick (Tillin et al., 2022).

Sabellaria spinulosa has been scored as not sensitive to shipping related activities (low confidence). However, a number of pressures associated with the shipping sector have not been assessed for this reef habitat. Further research could determine this habitat as sensitive to shipping activities.

Further research needs

There is insufficient evidence on the effects of chemical pressures on S. sabellaria reefs. These include transition elements & organo-metal contamination, hydrocarbon & PAH contamination, synthetic compound contamination, introduction of other substances and deoxygenation**.** As previously mentioned, further research could determine this reef habitat sensitive to shipping activities as well as increase the sensitivity to pelagic and static fishing gear.

Figure 2. Global distribution of *Sabellaria spinulosa*, Source: https://mapper.obis.org/?taxonid=130867

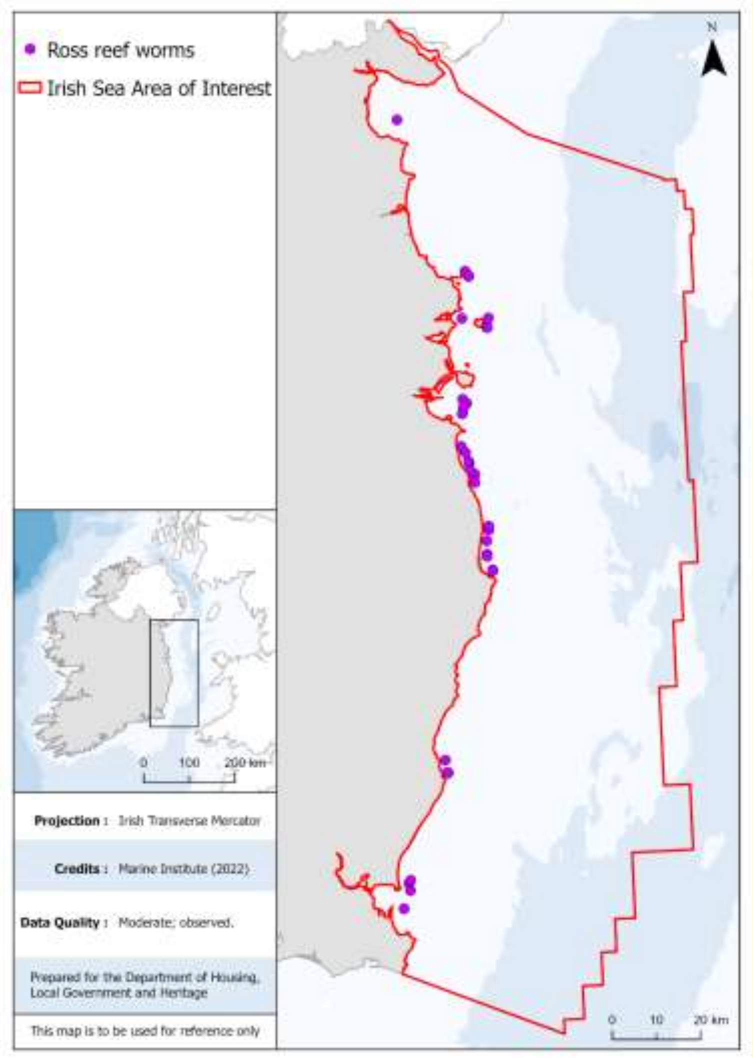

Figure 3. Data available for Ross worm reef, *Sabellaria spinulosa* in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Marine Institute Water Framework Directive Benthic Data	Marine Institute	Moderate; observed		

References

OSPAR Commission (2009) Background document on Sabellaria spinulosa reefs. OSPAR Commission, United Kingdom.

Tillin, H.M., Marshall, C., Gibb, N. & Garrard, S. L. 2022. *Sabellaria spinulosa* on stable circalittoral mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 26-04-2023]. Available from: https://www.marlin.ac.uk/habitat/detail/377

Tyler-Walters, H., Tillin, H.M., d'Avack, E.A.S., Perry, F., & Stamp, T. (2018). *Marine Evidence-based Sensitivity Assessment (MarESA) – A Guide*. Marine Life Information Network (MarLIN). Marine Biological Association of the UK, Plymouth. https://www.marlin.ac.uk/assets/pdf/MarESA-Sensitivity-Assessment-Guidance-Rpt-Dec2018.pdf

20. Seapens and Burrowing Megafauna

Figure 1: *Pennatula phosphorea and Turritella communis* © Joint Nature Conservation Committee (JNCC)

Background

Plains of fine mud, at water depths ranging from 15- 200m or more, which are heavily bioturbated by burrowing megafauna with burrows and mounds typically forming a prominent feature of the sediment surface. The habitat may include conspicuous populations of seapens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. The burrowing crustaceans present may include *Nephrops norvegicus*, *Calocaris macandreae* or *Callianassa subterranea*. The burrowing activity of megafauna creates a complex habitat, providing deep oxygen penetration (OSPAR Commission, 2010).

Rationale for spatial protection in the western Irish Sea

Seapens and burrowing megafauna communities were nominated for inclusion with particular reference to its listing under OSPAR. This biotope is considered to be in decline and/or threatened in OSPAR regions II and III. This biotope is not currently protected or conserved in the western Irish Sea but is amenable to spatial protection.

Sensitivity assessment

Seapens and burrowing megafauna are highly sensitive to pressures associated with the construction and operation of ORE (high confidence). All marine habitats and benthic species are considered to have a resistance of 'None' to physical loss (to land or freshwater habitat) and to be unable to recover from a permanent loss of habitat (resilience is 'Very Low')(high confidence)(Tyler-Walters et al., 2018). This biotope also has a high sensitivity to physical change to the seabed (high confidence) and sediment type (medium confidence).

If sedimentary substrata were replaced with rock substrata the biotope would be lost, as it would no longer be a sedimentary habitat and would no longer support seapens and burrowing megafauna. Additionally, seapens have a narrow range of sediment type preferences and given that this pressure is a permanent change, resilience is very low (Hill et al., 2022).

Seapens and burrowing megafauna have a high sensitivity to bottom trawling and dredging/beam trawling (high confidence) and a medium sensitivity to pelagic and static gear fishing (low confidence). As mentioned above, this biotope also has a high sensitivity to physical change to the seabed (high confidence) and sediment type (medium confidence). This biotope has a medium sensitivity to abrasion (low confidence) but a high sensitivity to penetration of the substratum (low confidence). *Virgularia mirabilis* and *Pennatula phosphorea* can avoid abrasion by withdrawing into the sediment, but a frequent disturbance will probably reduce feeding time and hence viability. Penetrative gear is likely to remove a greater proportion of the seapen population, as it may remove them from their burrows, within the footprint of the activity (Hill et al., 2022).

Pressures associated with **Shipping** were ‘Not Assessed’ and further information is needed on the sensitivity of Seapens and burrowing megafauna to these pressures.

Further research needs

There is insufficient evidence on the effects of chemical pressures on seapens and burrowing megafauna to form an assessment. The pressures requiring more research include transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances. No direct evidence on the effect of non-native species on seapen and burrowing megafauna communities was found but further research is required.

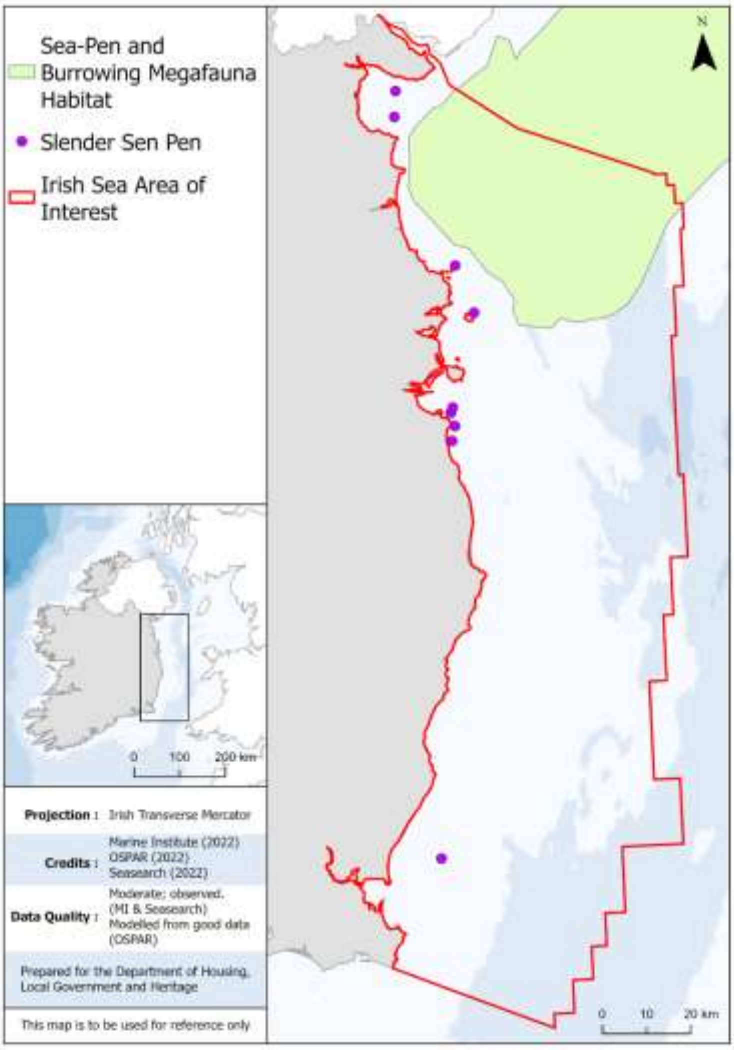

Figure 2. Data available for Seapens and burrowing megafauna in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
OSPAR Seapens and Burrowing Communities	OSPAR	Modelled from good data		

References

Hill, J.M., Tyler-Walters, H. & Garrard, S. L. 2022. Seapens and burrowing megafauna in circalittoral fine mud. In Tyler-Walters H. *Marine Life Information Network: Biology and*

Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 26-04-2023]. Available from: https://www.marlin.ac.uk/habitat/detail/131

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21. Barrel jellyfish *(Rhizostoma octopus)*

Irish name: Smugairle róin béalrufach

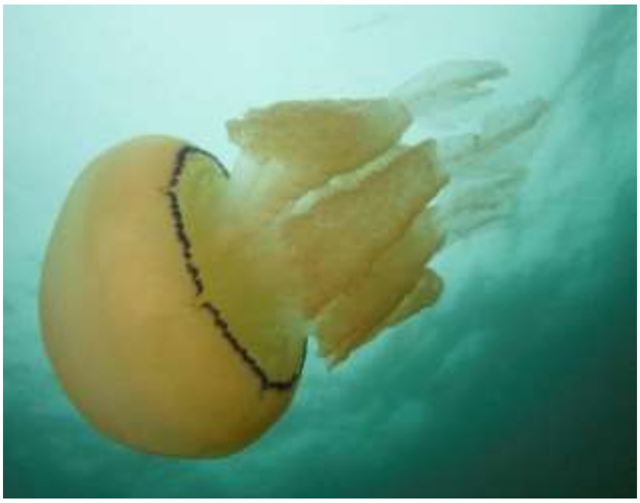

Figure 1. Barrel jellyfish, *Rhizostoma octopus* (Gmelin, 1791) © Ciaran O'Murchú

Background

Rhizostoma octopus (Gmelin, 1791) or the barrel jellyfish (also known as dustbin lid jellyfish) is one of the largest rhizostome jellyfishes, and can attain a bell diameter of ca. 90 cm and a wet weight of over 30 kg (Houghton et al. 2007; Doyle et al. 2012). It is the most northerly distributed rhizostome with a population located as far north as Solway Firth and Clyde Sea area in Scotland and as south as Arcachon and St. Jean de Luz in the Bay of Biscay (Houghton et al. 2006; Doyle, Georges and Houghton 2012). Populations are also known from the southern North Sea off the Belgium, Dutch and German coasts such as the Elbe estuary (Russell 1970; Holst et al. 2007; Thiel 1966). Within this broad geographical area, barrel jellyfish are mainly found in shallow bays (with riverine input) and as such have a punctuated distribution, with only a handful of areas known where populations regularly occur (Houghton et al. 2006; Lee et al. 2013; Van Walraven et al. 2015). Occasional records of individuals are known from many other localities but these may represent 'sinks' where individuals are transported and stranded on beaches from 'source' populations (Lee et al. 2013). Within the western Irish Sea, a large population of barrel jellyfish was identified off the Rosslare Harbour (and north along the coast of Curracloe beach) using aerial surveys (Houghton et al. 2006). 10,000s of individuals were observed over consecutive surveys during 2003 and 2004. Additional observations were made from ferry surveys out of Rosslare (Doyle et al. 2007) and juvenile barrel jellyfish were observed north of Rosslare ferry port in November 2004. In February to April 2023, large numbers of barrel jellyfish were recorded stranded on beaches in County Dublin and Meath. Aerial surveys in Carmarthen Bay revealed that there can be large interannual variation in the abundance of barrel jellyfish, from almost zero in 2005 to >590 tonnes in 2009 (Elliot, Hobson and Tang 2017). No aerial surveys of populations in the western Irish Sea have been carried out since Houghton et al. (2006).

Rationale for spatial protection in the western Irish Sea

Barrel jellyfish were nominated for inclusion because they are an ecologically important species in the pelagic environment. With 10,000s of individuals forming large blooms (aggregations), they represent an important food source for the migratory leatherback sea turtle (*Dermochelys coriacea*) which are known to feed on barrel jellyfish in the Wexford area. A retrospective analysis of a turtle sightings database (>100 years of sightings) revealed that leatherbacks are more likely to be sighted in bays where you have barrel jellyfish blooms than anywhere else (Houghton et al. 2006). As leatherbacks are an Annex IV species, it is important that these pelagic foraging areas are protected to ensure their favourable conservation status. Barrel jellyfish are also known to act as refugia or nurseries for many fish species including the Atlantic horse mackerel (*Trachurus trachurus*). Such refugia may play an important role in the protection of juvenile fish. Barrel jellyfish are not afforded any protection as they are not listed as a protected species under any legislation or red list.

The **western Irish Sea is considered a significant part of its range**. Within the entire Irish Sea only 3 other locations (Carmarthen Bay and Tremadoc Bay in Wales, and Solway Firth on the Scotland/England border) are known to have large populations of barrel jellyfish (Houghton et al. 2006). Strandings are known to occur along the Wicklow, Dublin, Meath and Louth coastlines but no significant population was identified in these areas which are more likely sinks for vagrant individuals (Lee et al. 2008).

Based on current knowledge barrel jellyfish are amenable to spatial protection as they only occur in very specific shallow bays, with only one known location identified in all Irish waters. As such the waters off Rosslare and north along the beaches of Curracloe provide a very unique habitat for this species. As there already exists a fishery for this species in Welsh waters, it is important to consider the ecological impacts that a fishery for barrel jellyfish in the western Irish Sea would have on the jellyfish population but also on other species that depend on it.

Sensitivity assessment

In terms of the sensitivity analysis, **the barrel jellyfish scored 'Low' for all pressures**. However, **for Resistance, barrel jellyfish scored a Medium for Removal of target species** and Removal of non-target species. Elliot, Hobson and Tang (2017) stated that during a low abundance year, two leatherbacks foraging and the extraction of 4.3 tonnes of jellyfish for the fishery (normal fishing levels) would be enough to completely deplete the population. However, barrel jellyfish have a benthic polyp stage in addition to the pelagic medusa stage. The **benthic polyp stage confers some resistance (and resilience) to the species** as polyps continuously release new medusae year after year. So provided there is a healthy benthic polyp population, the jellyfish phase can probably withstand a certain level of exploitation (removal of target species). However, it is important to remember that barrel jellyfish provide food for leatherbacks and shelter for juvenile fish species, so removal of large numbers will also impact on these species. Barrel jellyfish are not currently targeted by commercial fisheries in the western Irish Sea.

Under **Resistance, barrel jellyfish also scored a 'Medium' for Underwater noise** but because of the acute and localised nature of such noise (e.g. pile driving for ORE), it will not affect the entire jellyfish population which can be spread over many 10s km. Furthermore, the benthic polyps may act as a potential buffer to widespread damage of a population and therefore, the species **scored Low on sensitivity**. A recent study by Solé et al. (2016) found that *Rhizostoma pulmo*, a sister species to *R. octopus*, is sensitive to low frequency sounds. Scanning electron microscopy (SEM) revealed that marginal sense organs bearing statocysts (responsible for pulsing, swimming and orientation) were injured (significant hair cell extrusion and loss occurred to the sensory cells).

There was no evidence to suggest that jellyfish are sensitive to electromagnetic energy generated from ORE. **Jellyfish may actually benefit from the increase in new substrate** that will be provided by wind turbine platforms.

Further research needs

To establish the interannual variability in the abundance of barrel jellyfish it is important to conduct regular (annual) aerial surveys during the months of July-August. Boat surveys to quantify size distribution of individuals to inform aerial survey biomass estimates and to quantify associated juvenile fish are needed. Research is needed to determine if barrel jellyfish overwinter on the seabed and whether these individuals are responsible for the next recruitment of barrel jellyfish polyps. It is hugely important to identify where barrel jellyfish benthic polyps are located as any harvesting or removal of medusae, or impacts on the medusae from sound or other, are dependent on a healthy population of benthic polyps.

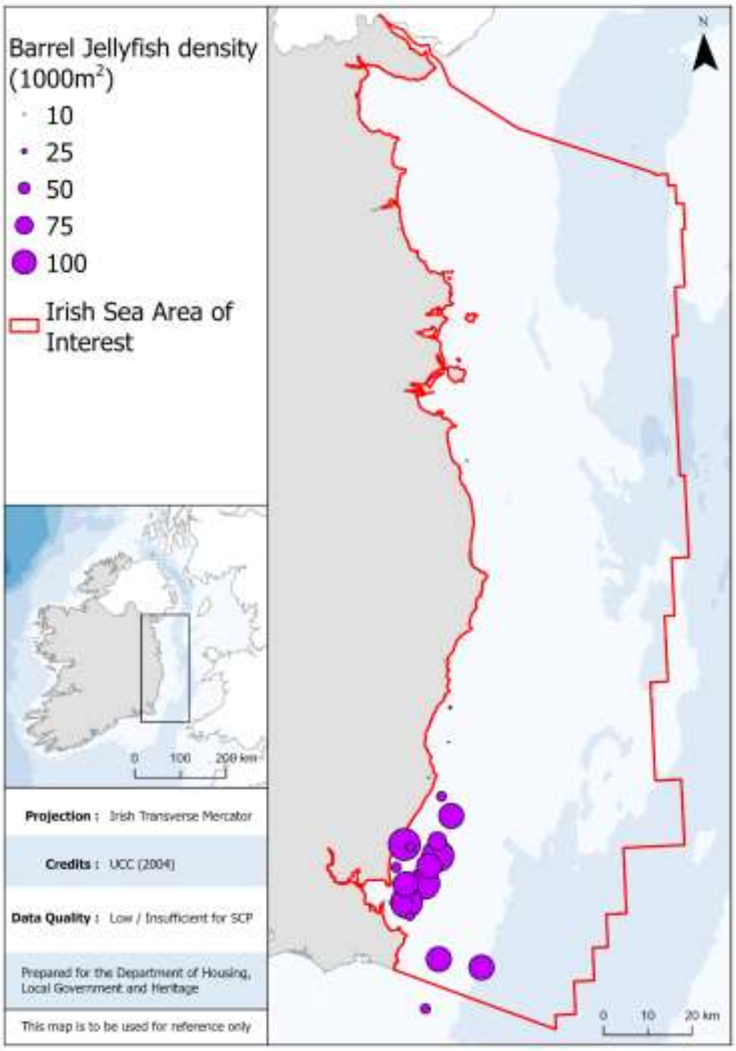

Figure 2. Data available for barrel jellyfish, *Rhizostoma octopus*, in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Irish Sea leatherback Turtle Project barrel jellyfish data	University College Cork	Sightings data from aerial surveys carried out in 2003 and 2004. Quality: Good data but older than 10 years		

References

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Doyle, T.K., Houghton, J.D.R., Buckley, S.M., Hays, G.C., Davenport, J. (2007). The broad-scale distribution of five jellyfish species across a temperate coastal environment. *Hydrobiologi*a 579, 29-39.

Doyle, T.K., Houghton, J.D.R., McDevitt, R., Davenport, J., Hays, G.C. (2007). The energy density of jellyfish: Estimates from bomb-calorimetry and proximate-composition. *Journal of Experimental Marine Biology and Ecology* 343, 239-252.

Houghton, J.D.R., Doyle, T.K., Davenport, J., Hays, G.C. (2006). Developing a simple, rapid method for identifying and monitoring jellyfish aggregations from the air. *Marine Ecology Progress Series* 314, 159-170.

Houghton, J.D.R., Doyle, T.K., Davenport, J., Lilley, M.K.S., Wilson, R.P., Hays, G.C. (2007). Stranding events provide indirect insights into the seasonality and persistence of jellyfish medusae (Cnidaria : Scyphozoa). *Hydrobiologia* 589, 1-13.

Houghton, J.D.R., Doyle, T.K., Wilson, M.W., Davenport, J., Hays, G.C. (2006). Jellyfish aggregations and leatherback turtle foraging patterns in a temperate coastal environment. *Ecology* 87, 1967-1972.

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Solé, M., Lenoir, M., Fortuño, J. M., Durfort, M., van der Schaar, M., André, M. (2016) Evidence of Cnidarians sensitivity to sound after exposure to low frequency underwater sources. Scientific Reports 6:37979. doi: 10.1038/srep37979

22. Herring Spawning Areas/Grounds/Beds

Irish name: Beitreach sceathraí scadán

Figure 1. Atlantic Herring, *Clupea harengus* (Linnaeus, 1758), Chile © Gervais et Boulart - Les poissons Gervais, H., Public Domain, https://commons.wikimedia.org/w/index.php?curid=18282630

Background

Herring are a vitally important part of the marine ecosystem, being prey for marine mammals, birds and many predatory fish. They are also a valuable fishery species. Irish Sea herring (CSH) is one of three herring stocks that occurs in Irish waters. The Irish Sea stock encompasses ICES area 7.a North and has been a key fishery for decades. Northern Ireland holds the vast majority of the yearly allowable catch for this stock. In recent years the biomass of the Irish Sea herring stock has been above all reference points. (Main source: Marine Institute Stockbook 2022; Molloy, 2006)

Unusually for a marine fish, herring eggs are deposited on the seabed in discrete gravel beds or flat stone. The herring are completely reliant on these spawning beds for reproduction and individuals return to their natal spawning ground each year. Nearby spawning gravel beds are generally grouped into “spawning grounds”, which may contain one or more beds. Spawning grounds are further grouped into “spawning areas”. The spawning areas, grounds and beds for herring around Ireland are well known and are located close to the coast. The Irish Sea herring population spawns in two areas: the Isle of Man and the Mourne (Dundalk bay), with the latter being the only herring spawning area inside the area of interest for the current study (Figure 3). (Main sources: O’Sullivan et al., 2013; Breslin, 1998; Frost and Diel, 2022)

Rationale for spatial protection in the western Irish Sea

Herring is not a species listed by OSPAR or IUCN. Fishing restrictions for herring are in place under the Common Fisheries Policy (2015) but these do not relate to the spawning habitat. The spawning areas/grounds/bed were included in the features list as they are an essential part of the life-cycle for this important forage fish species. The western Irish Sea is a significant part of the range of the Irish Sea herring population and the Mourne is the only spawning ground in the area of interest. Based on the discrete and well documented substrate requirements, herring spawning beds are highly amenable to spatial protection.

Sensitivity assessment

The highest associated sensitivity scoring for herring spawning grounds was in relation to physical loss or disturbance to the seabed. Herring spawning beds are vulnerable to anthropogenic disturbance of the seabed including but not limited to dredging, sand and gravel extraction, dumping of dredge spoil and waste from fish cages (high confidence). The International Council for the Exploration of the Seas advice for herring in the Irish Sea has consistently stated (e.g., ICES, 2021):

"*Activities that have a negative impact on the spawning habitat of herring, such as the dumping of dredge spoil, the extraction of marine aggregates (e.g., gravel and sand), and the erection of structures such as wind turbines in the vicinity of spawning grounds are a cause for concern*"

and advises that

"*Activities that have a negative impact on the spawning of herring should not occur unless the effects of these activities have been assessed and shown not to be detrimental to the productivity of the stock*"

Smothering of gravel spawning beds via sediment plumes and noise during works would also cause disruption to herring spawning behaviour (high confidence).

Further research needs

Evidence to identify the potential effect of multiple pressures was insufficient to form an assessment. The potential cumulative effect of multiple ORE installations between herring feeding grounds and spawning grounds (i.e., on the migration route) is poorly understood and could not be assessed. As well as being a possible physical barrier to movement, the effect of underwater noise on herring movement warrants further investigation. Other such pressures included transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances.

Figure 2. Global geographic distribution of Atlantic herring, *Clupea harengus*, from www.aquamaps.org.

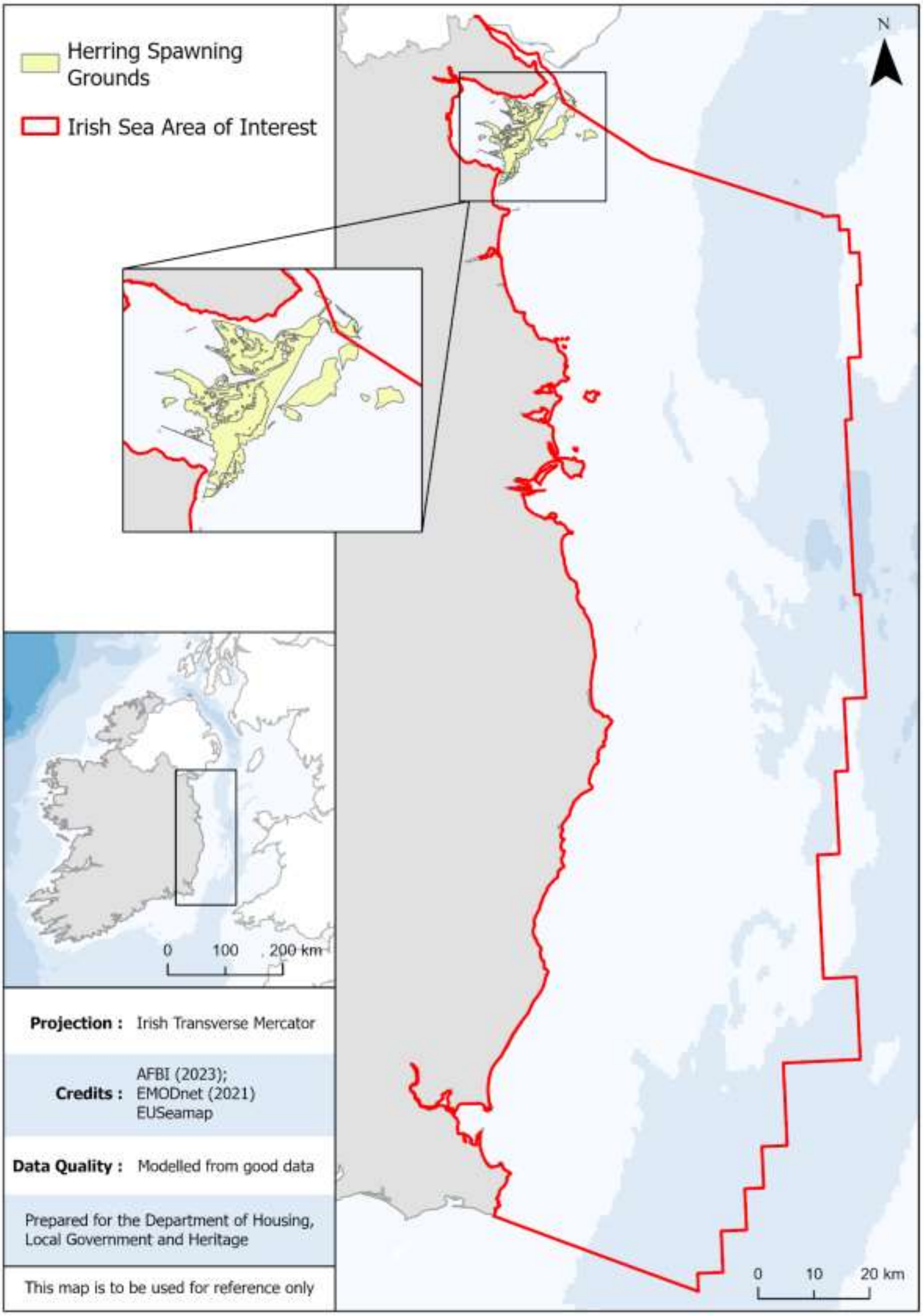

Figure 3. Data available for the course gravel substrate constituting the Mourne herring spawning ground in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	AFBI advised to select areas with coarse sediment as the benthic habitat in the Dundalk Bay area.

References

Breslin J.J. (1998) The location and extent of the main Herring (*Clupea harengus*) spawning grounds around the Irish coast. Masters Thesis: University College Dublin

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23. Forage and Juvenile Fish

Irish name: Salán/Stuifín

Figure 1. Sprat, *Sprattus sprattus* (Linnaeus, 1758), an example from the forage fish species assemblage
https://commons.wikimedia.org/w/index.php?curid=1531023

Background

Forage fish are an assemblage of generally small, pelagic, planktivorous, schooling fish species that hold a key position in marine food-webs. They form central links between lower and higher trophic levels, being prey for a number of different seabirds, marine mammals and piscivorous fish. Climate affects forage fish productivity. Commercial fisheries target certain forage fish species for both human consumption and fishmeal.

Typical forage fish species include herring, sprat, sand eel, and anchovy. Of these species in the western Irish Sea, herring and sprat have by far the greatest biomass. On sprat in Irish waters, the Marine Institute Stock Book (2022) states that:

"*Sprat is a pelagic schooling fish usually found inshore, with juveniles sometimes found in estuaries. The species is widely distributed from Morocco to the South of Norway and four different stocks are identified in European waters... Sprat perform seasonal migrations between winter–feeding and summer spawning grounds as well as diel vertical migrations. Sprat reach a total length of 18 cm, size–at–maturity has been estimated at 10.1 cm and is highly variable between areas. Spawning occurs in shallow waters (10–20 m) and egg production ranges 6,000–14,000. There is currently no evidence of spawning site fidelity (homing).*"

During the stakeholder engagement process, it was identified that juvenile whiting were an important prey item for listed elasmobranch species on certain sandbanks at certain times of the year, which justified their inclusion. The rationale for cod and haddock juveniles is covered below.

Norway pout has been identified as a key forage fish species in the North Sea (Engelhard *et al*. 2014) and has therefore been included.

Rationale for spatial protection in the western Irish Sea

Forage fish were included in the features list based on ecological importance, being a key food source for a wide range of species, including some protected species and some commercially fished species. Most species in the assemblage are not listed on OSPAR or IUCN threatened lists, with the exception of cod and haddock. Cod (OSPAR listed and European Red List: threatened) and haddock (Global IUSN: vulnerable) were included in the assemblage - **as juveniles only** - for the following reasons: While they are both listed, they are managed under the CFP are were therefore excluded from the features list in their own right. Further, any spatial protection for the primary purpose of commercial fisheries enhancement would not fall under the definition of an MPA, rather being considered an OECM. However, commercial species have other roles in the ecosystem, occupying certain niches, acting as competitors, predators and prey for the wider system. Including the juvenile stages of these listed species therefore acknowledges their importance in the ecosystem and could lead to benefits for the commercial stocks by protecting their nursery grounds.

Although ICES provides catch advice, there is no TAC set for sprat in the Celtic Seas (including the Irish Sea). The vast majority of sprat caught in the Celtic Seas are taken by Irish vessels. The Irish Sea is not a core area for the fishery, but catches are frequent along the eastern Irish coast. The Irish Sea herring stock is currently above all reference points and fished at MSY, mostly by Northern Irish vessels. There is no targeted fishery for sandeel. The Irish Sea cod stock is below all biomass reference points and has ICES advised zero catch for 2023 (Marine Institute Stockbook 2022).

The western Irish Sea is a significant part of the range of all the species in the assemblage. Data on the distribution of the species in the Irish Sea is available from the International Bottom Trawl Survey database (ICES DATRAS), which covers the western Irish Sea as well as its surrounds.

Based on current knowledge the species assemblage is amenable to spatial protection. Analysis of the bottom trawl survey data (described below) has identified regions in the western Irish Sea where the listed forage and juvenile fish are consistently caught.

Sensitivity assessment

Individual species in the assemblage had varying susceptibility to each pressure so the sensitivity scores were based on the most sensitive species for each pressure. The highest associated sensitivity scoring for forage and juvenile fish was in relation to its targeted and non-targeted removal (bycatch) by fishing (high confidence). High sensitivity to loss and disturbance of habitat was specifically related to sandeel. A precautionary approach was followed for chemical pollutants and therefore forage and juvenile fish were deemed sensitive to chemical pollutants including transition elements and organo-metal contamination, and hydrocarbon and PAH contamination. Again, this is made more relevant in the case of sandeel due to their association with the substrate.

Further research needs

Knowledge on the populations of sandeel in the western Irish Sea remains limited and requires further investigation. The stock structure of sprat in the western Irish Sea is unknown. Similarly the mixing of Irish Sea and Celtic Sea herring in the area is known but not yet accounted for in stock assessment. In addition, evidence to identify the potential effect of multiple pressures was insufficient to form an assessment. These pressures included chemical (transition elements and organo-metal contamination, hydrocarbon and PAH contamination, synthetic compound contamination and introduction of other substances) and physical pressures for species other than sandeels (abrasion/disturbance of substratum surface or seabed, penetration or disturbance of substratum subsurface and barriers to species movement).

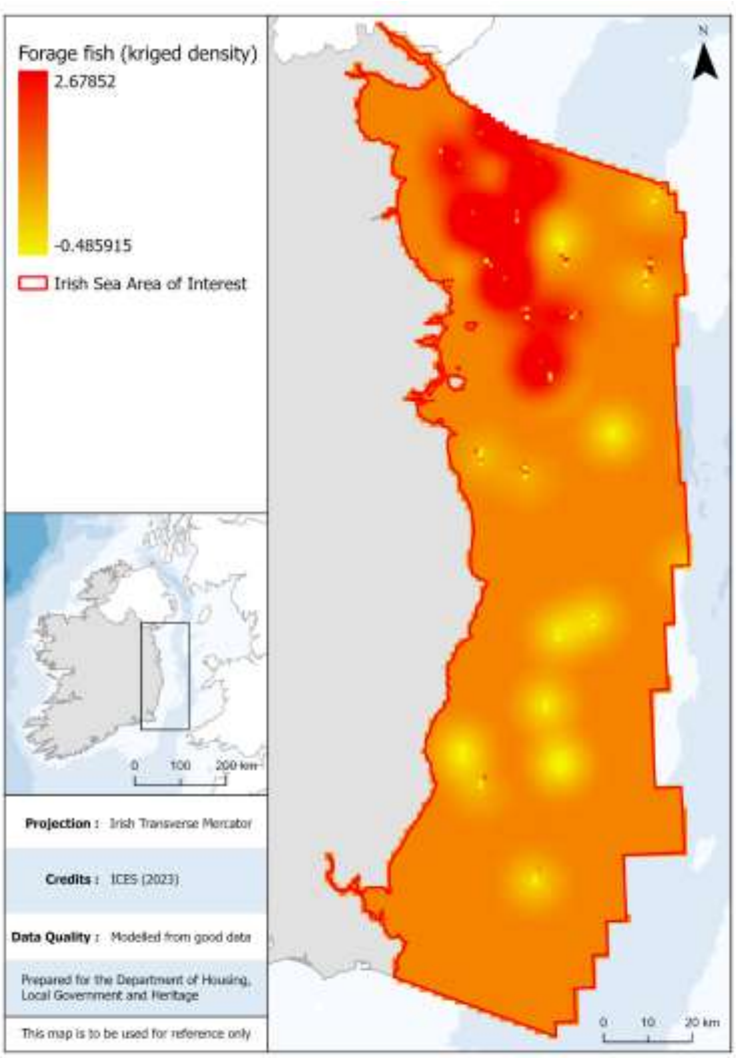

Figure 2. Density of the combined forage and juvenile fish species assemblage for the years 2011-2021 (using kriged CPUE from the International Bottom Trawl Survey [ICES DATRAS]).

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
International Bottom Trawl Survey (IBTS) Fisheries Database of Trawl Surveys (DATRAS)	International Council for the Exploration of the Seas	Modelled from good data	IE-IGFS and NIGFS	

Since the standard trawl used in the IBTS is more selective to smaller fish than the typical commercial trawl, the DATRAS survey data was deemed more representative of the spatial distribution of juvenile and forage fish than linked logbook/VMS data. To address the issue of the relatively large distances between survey hauls in some areas, the density was interpolated to fill in the blank areas (i.e., the catch per unit effort per haul was kriged over multiple years). The results were checked for consistency with other datasets (commercial catch), other surveys (AFBI acoustic survey) and similar studies (e.g., Ellis *et al*. 2012).

References

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Georg H. Engelhard, Myron A. Peck, Anna Rindorf, Sophie C. Smout, Mikael van Deurs, Kristina Raab, Ken H. Andersen, Stefan Garthe, Rebecca A.M. Lauerburg, Finlay Scott, Thomas Brunel, Geert Aarts, Tobias van Kooten, Mark Dickey-Collas, (2014) Forage fish, their fisheries, and their predators: who drives whom?, ICES Journal of Marine Science, Volume 71, Issue 1, January 2014, Pages 90–104, https://doi.org/10.1093/icesjms/fst087

Marine Institute Stock Book (2022) Report to the Minister for Agriculture, Food and the Marine. Annual Review of Fish Stocks in 2022 with Management Advice for 2023

24. Sub-tidal Mussel Beds *(Mytilus edulis)*

Irish name: Diúilicín

Figure 1: *Mytilus edulis* © Dr Keith Hiscock

Background

The shell of M. edulis is roughly triangular in outline, however, shell shape varies considerably with environmental conditions. It is smooth with a sculpturing of concentric lines but no radiating ribs and is usually purple or blue. Length varies, with specimens usually ranging from 5 -10 cm although some populations never attain more than 2-3 cm, and the largest specimens may reach 15 -20 cm (Tyler-Walters, H. 2008). Shallow sublittoral mixed sediment, in fully marine coastal habitats or sometimes in variable salinity conditions in the outer regions of estuaries, are characterised by beds of the common mussel *Mytilus edulis*. Other characterising infaunal species may include the amphipod *Gammarus salinus* and oligochaetes of the genus *Tubificoides*. The polychaetes *Harmothoe* spp., *Kefersteinia cirrata* and *Heteromastus filiformis* are also important. Epifaunal species include the whelks *Nucella lapillus* and *Buccinum undatum*, the common starfish *Asterias rubens*, the spider crab *Maja squinado* and the anemone *Urticina felina* (Tyler-Walters et al., 2022).

Rationale for spatial protection in the western Irish Sea

Sub-tidal mussel beds were nominated for inclusion on the features list with particular reference to its ecological importance. *Mytilus edulis* is an active suspension feeder on organic particulates and dissolved organic matter. The production of faeces and pseudofaeces enriches the underlying sediment providing a rich food source for infauna detritivores, deposit feeders, meiofauna and bacteria. Dense beds of suspension feeding bivalves are important in nutrient cycling in estuarine and coastal ecosystems, transferring phytoplankton primary production and nutrients to benthic secondary production (pelagic-benthic coupling)

(Dame, 1996). The organic rich 'mussel mud' provides a food source for deposit feeding polychaetes (e.g., *Scoloplos armiger* and *Capitella capitata* and oligochaetes (e.g. *Tubificoides* spp.) and surface deposit feeders (e.g., *Polydora* spp. and *Macoma baltica).* The interstices within the mussel matrix and mussel mud support epifaunal and infaunal predators such as scale worms (e.g., *Harmothoe* spp.), nereids (e.g. *Nephtys* spp.) and other polychaetes and nemerteans (Tyler-Walters et al., 2022).

Sub-tidal mussel beds are amenable to spatial protection and the western Irish Sea is a significant part of its distribution.

Sensitivity assessment

Although a wide range of species are associated with *Mytilus edulis* reef or bed biotopes these characterising species occur in a range of other biotopes and are therefore not considered to be obligate associates. *Mytilus edulis* beds are not dependent on associated species to create or modify habitat, provide food or other resources, although their loss would represent a loss of diversity. It should be noted that for attached organisms the sensitivity of the *Mytilus edulis* biotope would be of primary concern as removal of the reef would also lead to removal of the attached species. The sensitivity assessments are therefore based on *Mytilus edulis* and only consider the sensitivity of associated species where they might augment any impact or cause secondary impacts (Tyler-Walters et al., 2022).

Sub-tidal mussel beds are highly sensitive to the construction and operation of ORE (medium confidence). All marine habitats and benthic species are considered to have a resistance of ‘None’ to physical loss (to land or freshwater habitat) and to be unable to recover from a permanent loss of habitat (resilience is ‘Very Low’)(high confidence)(Tyler-Walters et al., 2018). Sub-tidal mussel beds have a high sensitivity to habitat structure change as the process of extraction will remove the entire mussel bed and the associated community(medium confidence). Additionally, *M. edulis* are highly sensitive to a number of the chemical pressures associated with the construction and operation of offshore wind farms (medium confidence). For example, Across the entire 'Transitional elements & organometal' contaminant group, there is evidence that several metals, one nanoparticulate metal, and some organometals have been reported to cause ‘severe’ (>75%) mortalities in adult and juvenile mussels.

Sub-tidal mussel beds are highly sensitive to pressures associated with the fishing sector (medium confidence). As mentioned above, M. edulis has a high sensitivity to chemical pressure, including hydrocarbon and PAH contamination, synthetic compound contaminants and Transition elements and organo-metals (medium confidence). This biotope is also moderately sensitive to abrasion and penetration of the substratum (medium confidence). *Mytilus edulis* lives on the surface of the seabed held by byssus threads attached to either the substratum or to other mussels in the bed. Activities resulting in abrasion and disturbance can either directly affect the mussel by crushing them, or indirectly affect them by the weakening or breaking of their byssus threads making them vulnerable to displacement (Denny, 1987). The activities that penetrate the seabed could result in removal of part of a bed and its associated fauna and flora.(Tyler-Walters et al., 2022).

Sub-tidal mussel beds are highly sensitive to shipping related pressures such as the chemical pressures previously mentioned and the introduction or spread of invasive non-indigenous species (medium confidence). As described by Tyler-Walters et al. (2022), a number of species have shown to negatively impact *M. edulis* by competing for space and food and reducing growth rates, potentially leading to reduced abundance of mussels.

Further research needs

Information on the effects of electromagnetic energy and the introduction of other substances were not assessed due to a lack of evidence.

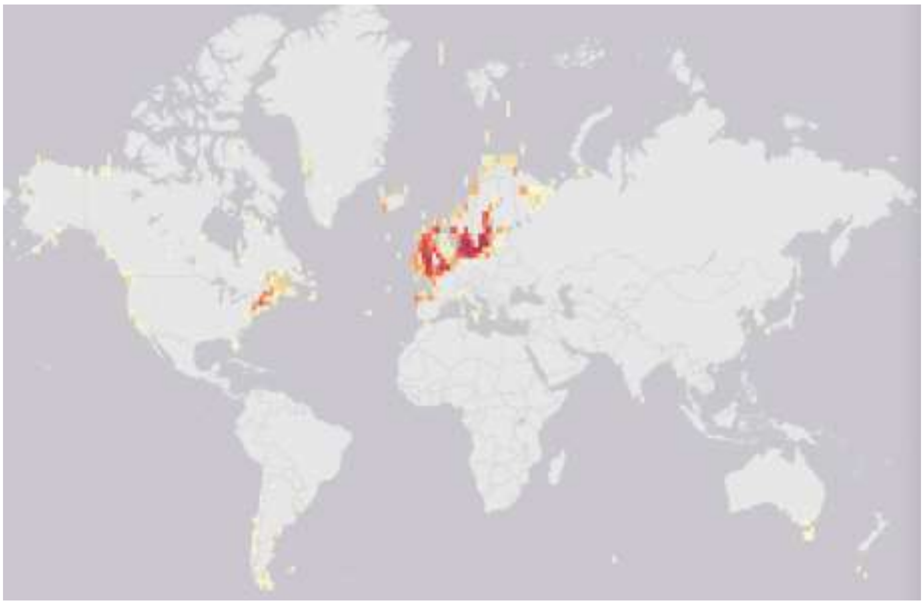

Figure 2. Global distribution of *Mytilus edulis*, Source:

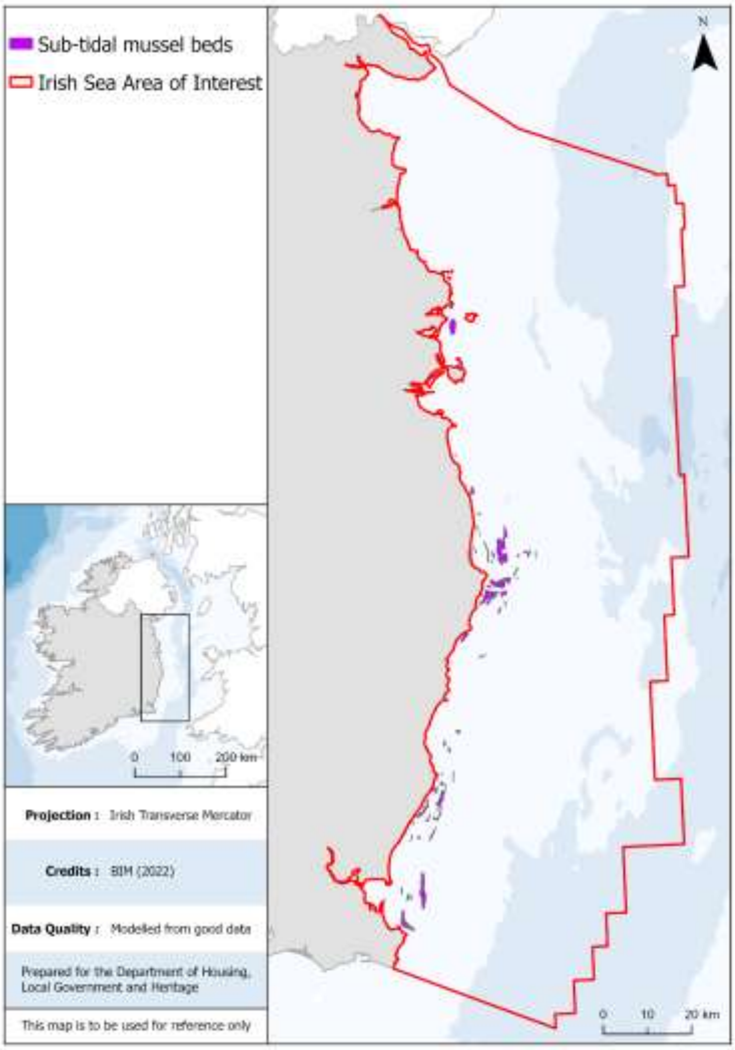

Figure 3. Data available for Sub-tidal mussel beds, *Mytilus edulis* in the western Irish Sea

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Bord Iascaigh Mhara (BIM) Seed Mussel Beds	Bord Iascaigh Mhara	Modelled from good data		

References

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Tyler-Walters, H., Tillin, H.M., Mainwaring, K., & Williams, E. (2022). *Mytilus edulis* beds on sublittoral sediment. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/36

25. Circalittoral Coarse Sediments

Background

Tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20m to a maximum depth of 50m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore. This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum* (JNCC, 2022).

Table 1. Circalittoral Coarse Sediments characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	**MarLIN link**
Group 1(d)	**Small epifaunal species with hard or protected bodies**	
	Bryozoa indet crusts	https://www.marlin.ac.uk/species/detail/1582
	Balanus Balanus	
	Balanus crenatus	https://www.marlin.ac.uk/species/detail/1381
	Pomatoceros triqueter	
Group 2	**Temporary or permanently attached surface dwelling or shallowly buried larger bivalves**	
	Pecten maximus	https://www.marlin.ac.uk/species/detail/1398
Group 3	**Mobile predators and scavengers**	
	Pagurus bernhardus	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Aonides paucibranchiata	
	Caulleriella zetlandica	
	Chaetopterus variopedatus	
	Lanice conchilega	https://www.marlin.ac.uk/species/detail/1642
	Mediomastus fragilis	
	Minuspio cirrifera	
	Owenia fusiformis	https://www.marlin.ac.uk/species/detail/1703
	Polygordius	
Group 6	**Predatory polychaetes**	

	Exogone verrugera	
	Glycera lapidum	
	Hesionura elongate	
	Lumbrineris gracilis	
	(Lumbrineris spp)	
	Pisione remota	
	Protodorvillea kefersteini	
Group 7	**Very small - small, short lived (<2 years) free-living species**	
	Ampelisca spp.	
Group 8(a)	**Subsurface dwelling Echinoids**	
	Echinocyamus pusillus	
Group 8(b)	**Surface dwelling Echinoids**	
	Echinus esculentus	https://www.marlin.ac.uk/species/detail/1311
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**	
	Ophiura albida	
Group 8(d)	**Large burrowing Holothuroidea**	
	Neopentadactyla mixta	
Group 10	**Burrowing, soft-bodied species**	
	Branchiostoma lanceolatum	

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Circalittoral Coarse sediment habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Circalittoral coarse sediments are highly sensitive to pressures associated with the construction and operation of offshore renewable infrastructure (medium confidence). Loss or change of the physical habitat could lead to a loss of biodiversity and lead to changes in the community structure associated with this biotope (low confidence). *Neopentadactyla mixta* is only characteristic of coarse gravel and maerl and only found in coarse gravel/maerl sediment. Therefore, a change in sediment type would result in a significant loss in abundance of this species, as well as major changes in the associated community (Tillin & Tyler-Walters, 2014).

Circalittoral coarse sediments are highly sensitive to pressures associated with the four fishing sub sectors (medium confidence). As with ORE a physical change to the seabed or sediment type can occur with surface and subsurface fishing, leading to a loss of biodiversity within this biotope (low confidence). In addition, this habitat type has a high sensitivity to removal of target species (low confidence). Species within the sensitive ecological group (group 8(d)) are not targeted by commercial fisheries and hence are not directly affected by this pressure. However, maerl extraction for the coralline algae itself can result in complete destruction of maerl beds. For example, in Brittany, the clean maerl gravel of the Glenan maerl bank described in 1969, was degraded to muddy sand dominated by deposit feeders and omnivores within 30 years (Grall & Hall- Spencer 2003). Whereas Birkett *et al* (1998) noted that although maerl beds subject to extraction in the Fal estuary exhibit a diverse flora and fauna, they were less species-rich than those in Galway Bay, although direct correlation with dredging was unclear (Grall & Hall-Spencer 2003). Grall and Glemarec (1997, cited in Birkett *et al* 1998) reported few differences in biological composition between exploited and control beds in Brittany. The degree of impact therefore depends on the intensity of extraction and/or on the context (Tillin & Tyler-Walters, 2014).

Circalittoral coarse sediments are highly sensitive to shipping related pressures (medium confidence). This includes the introduction or spread of invasive non-indigenous species (medium confidence). No information on the direct effects of non-native species on the characterising species *Neopentadactyla mixta* was found. Yet *Crepidula fornicata* beds may form on sedimentary habitats. Grall and Hall-Spencer (2003) note that beds of invasive slipper limpet *Crepidula fornicata* grew across maerl beds in Brittany. As a result, the maerl thalli were killed, and the bed clogged with silt and pseudo-faeces, so that the associated community was drastically changed (Tillin & Tyler-Walters, 2014).

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

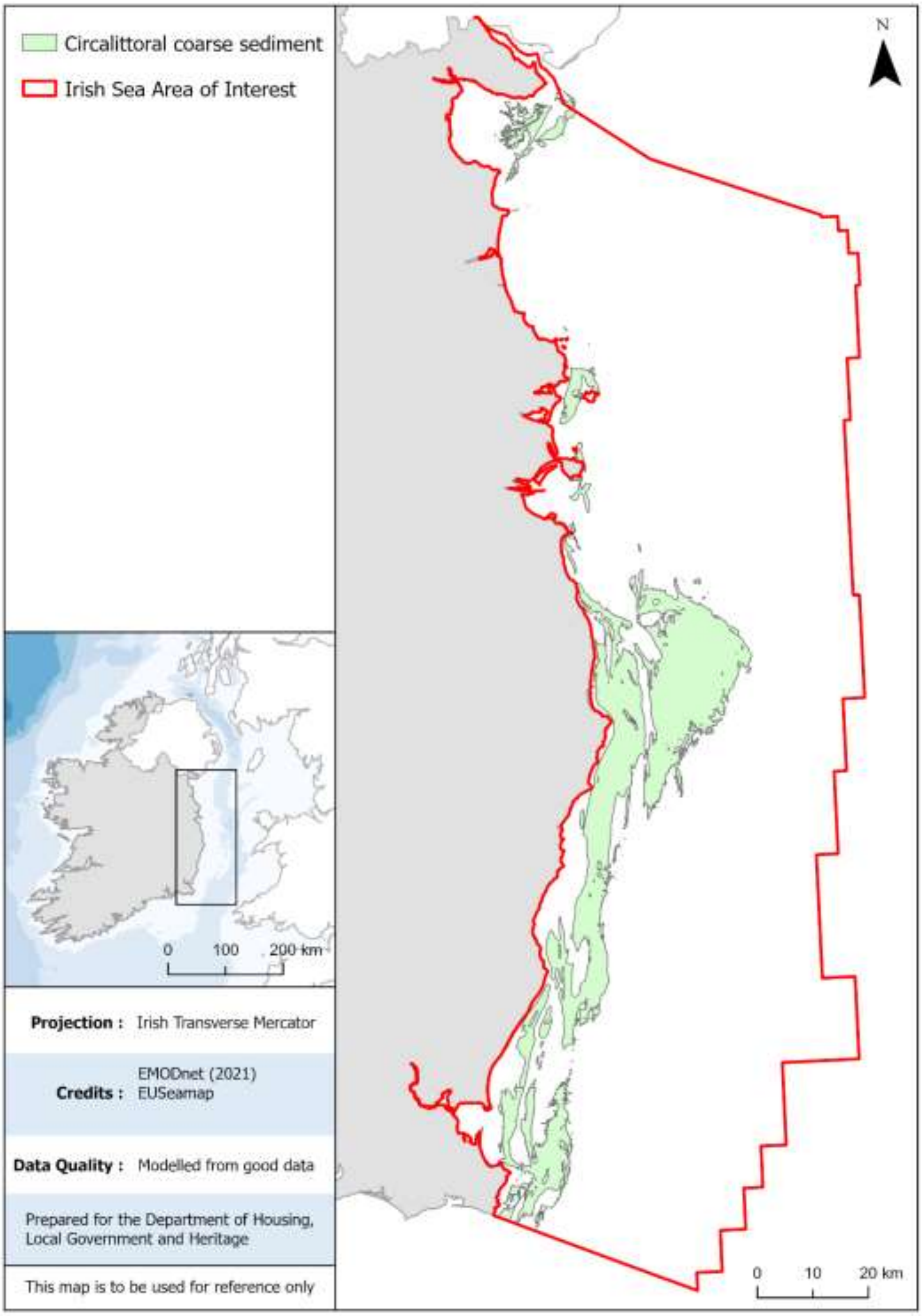

Figure 1. Data available for circalittoral coarse sediments in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

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Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

26. Circalittoral Mixed Sediments

Background

Mixed (heterogeneous) sediment habitats in the circalittoral zone (generally below 15-20m to a maximum depth of 50m) including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel. Due to the variable nature of the seabed a variety of communities can develop which are often very diverse. A wide range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones such as *Cerianthus lloydii* are often present in such habitats and the presence of hard substrata (shells and stones) on the surface enables epifaunal species to become established, particularly hydroids such as *Nemertesia* spp. and *Hydrallmania falcata*. The combination of epifauna and infauna can lead to species rich communities (JNCC, 2022).

Table 1. Circalittoral Mixed Sediments characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	MarLIN Link
Group 1(b)	**Erect, shorter lived epifaunal species**	
	Hydrallmania falcata	
	Flustra foliacea	
	Nemertesia antennina	
	Nemertesia ramose	
Group 1(c)	**Soft-bodied epifaunal species**	
	Alcyonium digitatum	https://www.marlin.ac.uk/species/detail/1187
	Urticina feline	https://www.marlin.ac.uk/species/detail/1392
Group 1(d)	**Small epifaunal species with hard or protected bodies**	
	Pomatoceros triqueter	
Group 2	**Temporary or permanently attached surface dwelling or shallowly buried larger bivalves**	
	Modiolus modiolus	
Group 3	***Mobile predators and scavengers***	
	Pagurus bernhardus	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**	
	Mysella bidentata	
	Thyasira flexuosa	

Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Chaetozone setosa	
	Owenia fusiformis	https://www.marlin.ac.uk/species/detail/1703
	Scalibregma inflatum	
	Spiophanes bombyx	https://www.marlin.ac.uk/species/detail/1705
	Scoloplos armiger	
Group 6	**Predatory polychaetes**	
	Hesionura elongate	
	Lumbrineris gracilis (Lumbrineris spp)	
	Nephtys hombergii	https://www.marlin.ac.uk/species/detail/1710
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**	
	Ophiocomina nigra	
	Ophiothrix fragilis	https://www.marlin.ac.uk/species/detail/1198
Group 10	**Burrowing, soft-bodied species**	
	Cerianthus lloydii	

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat associations expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Circalittoral Mixed sediment habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Circalittoral mixed sediments are moderately and highly sensitive to pressures associated with the construction and operation of offshore renewable infrastructure (medium confidence). Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). Ecological group 2 has a high sensitivity to removal of the substratum (medium confidence), surface abrasion and penetration of the substratum (low confidence). The process of extraction is considered to remove all members of this ecological group as they are either sessile or slow moving. Recovery will be mediated by the scale of the disturbance and the suitability of the sedimentary habitat remaining. This ecological group represents larger epifaunal bivalves or those that are shallowly buried with part of the shell projecting above the surface and are therefore directly exposed to abrasion and sub-surface damage. This ecological group is also highly sensitive to heavy smothering and siltation changes (low confidence). As the members of this ecological group are shallowly buried this ecological group would be buried by the deposit. The intensity and duration of siltation will be mediated by site-specific hydrodynamic conditions, such as water- flow and wave action. Based on the laboratory studies by Last *et al* (2011) and Szostek *et al* 2013, this ecological group was considered to be unable to vertically migrate through a layer of overburden at the pressure benchmark level, that is, 30cm of fine material and therefore has been assessed as highly sensitive (Tillin & Tyler-Walters, 2014).

Circalittoral mixed sediments are moderately and highly sensitive to pressures associated with the fishing sector (low confidence). As mentioned above, ecological group 2 is highly sensitive to abrasion and penetration of the substratum (medium confidence). Groups 2 and 4, which include suspension feeders, are moderately sensitive to a change in suspended solids (medium confidence). The change is chronic and sustained for a year and is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing and producing pseudofaeces for the filter feeders (Tillin & Tyler-Walters, 2014).

Circalittoral mixed sediments are moderately sensitive to pressure associated with the shipping sector (high confidence). A number of characterising species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). Asterias rubens, *Nephtys hombergii* and *Ophiothrix* fragilis have a medium sensitivity to hydrocarbon and PAH contamination while *Spiophanes bombyx* has a medium sensitivity to synthetic compound contamination. These pressures have been assessed based on a few characterising species where sensitivity analyses were already available. In addition, some pressures associated with shipping have not been assessed or no evidence is available for this biotope. Further research is needed to determine the true sensitivity of this biotope to shipping activities.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

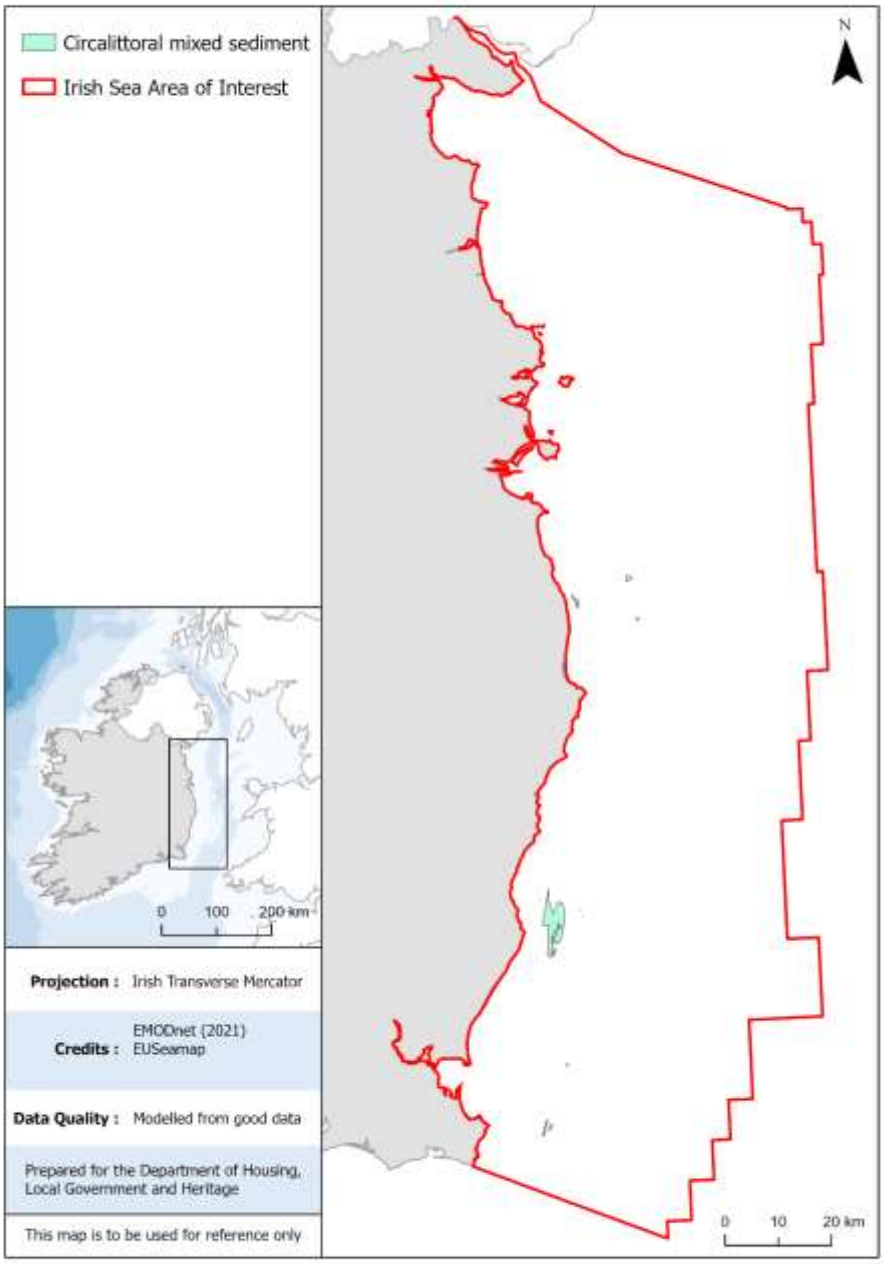

Figure 1. Data available for circalittoral mixed sediments in the western Irish Sea.

Data sources and quality

26. Circalittoral mixed sediments

Dataset Name	Data Owning	Dataset	Metadata	Comments

	Organisation	Quality	URL	
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

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JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

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Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

27. Circalittoral Mud

Background

Sublittoral muds occur below moderate depths of 15-20m and to a maximum depth of 50m, either on the open coast or in marine inlets such as sea lochs. The seapens *Virgularia mirabilis* and *Pennatula phosphorea* are characteristic of this biotope complex together with the burrowing anemone *Cerianthus lloydii* and the ophiuroid *Amphiura* spp. The relatively stable conditions often lead to the establishment of communities of burrowing megafaunal species, such as *Nephrops norvegicus* (JNCC, 2022).

Table 1. Circalittoral Mud characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	MarLIN Link
Group 1(a)	**Erect, longer-lived epifaunal species with some flexibility**	
	Pennatula phosphorea	
	Funiculina quadrangularis	https://www.marlin.ac.uk/species/detail/1154
	Virgularia mirabilis	https://www.marlin.ac.uk/species/detail/1396
Group 3	**Mobile predators and scavengers**	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Chaetozone setosa	
Group 6	**Predatory polychaetes**	
	Nephtys hystricis	
Group 8(a)	**Subsurface dwelling Echinoids**	
	Brissopsis lyrifera	https://www.marlin.ac.uk/species/detail/1654
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**	
	Amphiura brachiate	
	Amphiura filiformis	https://www.marlin.ac.uk/species/detail/1400
	Amphiura chiajei	https://www.marlin.ac.uk/species/detail/1657
	Ophiura ophiura	
Group 9	**Burrowing, hard-bodied species**	
	Nephrops norvegicus	https://www.marlin.ac.uk/species/detail/1672
	Calocaris macandrae	
Group 10	**Burrowing, soft-bodied species**	
	Cerianthus lloydii	

	Maxmuelleria lankesteri	

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Circalittoral Mud habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Circalittoral mud is highly sensitive to pressures associated with the construction and operation of offshore renewable infrastructure (medium confidence). Loss or change of the physical habitat could lead to a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). A change in sediment type will adversely affect the seapens. Based on their reported distribution a change of 'mud' to 'sandy mud' or 'slightly gravelly mud' will probably exclude *P. phosphorea* and *F. quadrangularis* (medium confidence)(Tillin & Tyler-Walters, 2014). In addition, characterising species within group 1(a) have a high sensitivity to a change in habitat structure through extraction of the substratum (medium confidence). An extraction of sediment to 30cm (the benchmark) will remove most of the resident seapens present and recovery is expected to be low (Tillin & Tyler-Walters, 2014).

Circalittoral mud is highly sensitive to pressures associated with the fishing sector (medium confidence). The ecological group 1(a), present in circalittoral muds have a high sensitivity to each of the four fishing sectors (low confidence). Overall, surface abrasion is unlikely to adversely affect the three seapen species within the group. Towed gear is likely to remove a proportion of sea pens from the sediment, and if damaged they are likely to die, but if undamaged displaced and/or returned to suitable sediment they can recover relatively quickly. *V. mirabilis* and *P. phosphorea* can avoid abrasion by withdrawing into the sediment, but frequent disturbance will probably reduce feeding time and hence viability. However, *F. quadrangularis* cannot withdraw and is the tallest of all three of the seapens (up to 2m) and is the most likely to be displaced or removed by surface abrasion and towed gear (Tillin & Tyler-Walters, 2014). Hence, a sensitivity score of **'High**' has been assigned to this ecological group for abrasion and penetration of the substratum (low confidence).

Circalittoral muds are moderately sensitive to pressures associated with the shipping sector (high confidence). A small number of characterising species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). Asterias rubens, *Amphiura chiajei and Amphiura filiformis* have a medium sensitivity to hydrocarbon and PAH contamination while *Brissopsis lyrifera* and *Amphiura filiformis* have a medium sensitivity to synthetic compound contamination. These pressures have been assessed based on a few characterising species where sensitivity analyses were already available. In addition, some pressures associated with shipping have not been assessed or no evidence is available for this biotope. Further research is needed to determine the true sensitivity of this biotope to shipping activities.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

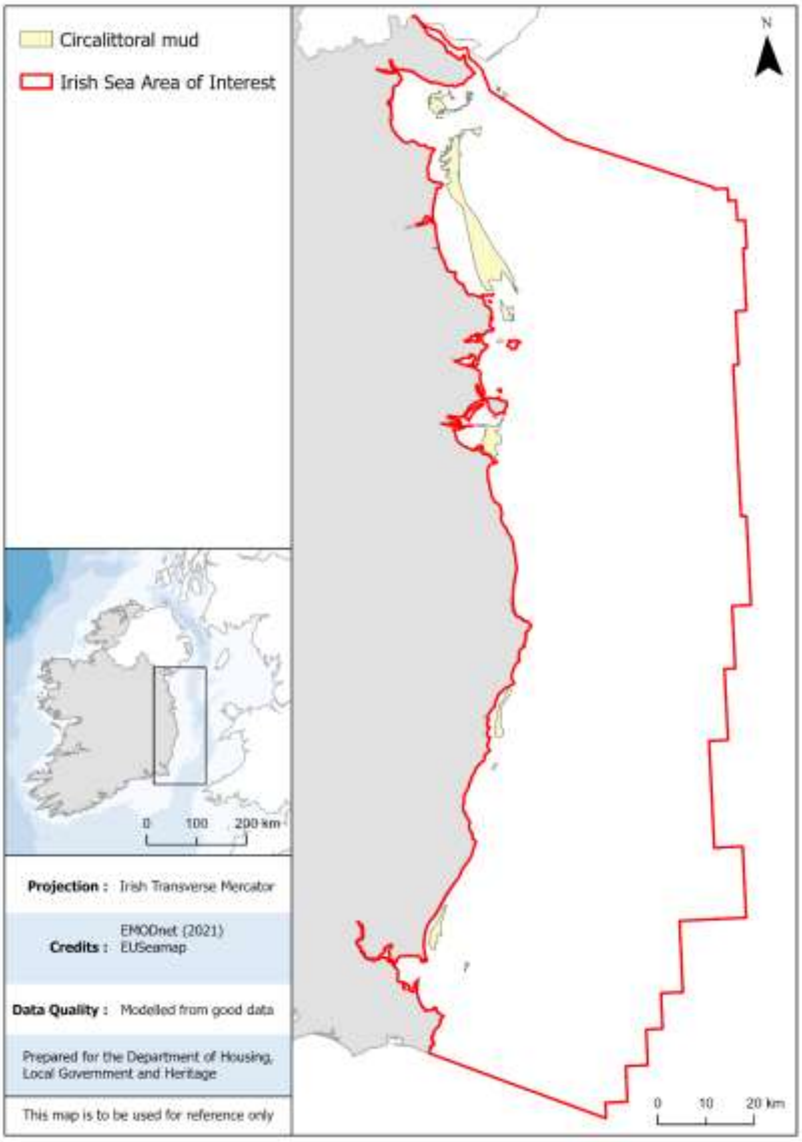

Figure 1. Data available for circalittoral mud in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and

sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

28. Circalittoral Sand

Background

Clean fine sands with less than 5% silt/clay in deeper water, either on the open coast or in tide-swept channels of marine inlets in depths of over 15-20m to a max depth of 50m. The habitat may also extend offshore and is characterised by a wide range of echinoderms (in some areas including the pea urchin *Echinocyamus pusillus*), polychaetes and bivalves. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community (JNCC, 2022).

Table 1. Circalittoral Sand characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	MarLIN Link
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**	
	Abra prismatica	
	Moerella pygmaea	
	Spisula elliptica	
	Timoclea ovata	
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Aonides paucibranchiata	
	Chaetozone setosa	
	Ophelia borealis	
	Owenia fusiformis	https://www.marlin.ac.uk/species/detail/1703
	Scoloplos armiger	
	Spiophanes bombyx	https://www.marlin.ac.uk/species/detail/1705
Group 6	**Predatory polychaetes**	
	Exogone verrugera	
	Glycera lapidum	
	Lumbrineris gracilis (Lumbrineris spp)	
Group 7	**Very small-small, short lived (<2 years) free-living species**	
	Bathyporeia elegans	
	Eudorellopsis deformis	
Group 8(a)	**Subsurface dwelling Echinoids**	
	Echinocyamus pusillus	

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the western Irish Sea

Circalittoral Sand habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Circalittoral sands are highly sensitive to pressures associated with the construction (high confidence) and moderately sensitive to pressures associated with the operation (low confidence) of offshore renewable infrastructure. Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). Pressures associated with the operation of ORE, including the physical change of the sediment type and removal of substratum, have a medium sensitivity (low confidence). Species within ecological group 8(a) vary in environmental requirements but each appears to occur in a relatively restricted range of sediment types, related to burrowing, feeding and other characteristics. The species are therefore considered to have **'Low' resistance** to a change in sediment type (low confidence) but resilience is assessed as **'Medium'** (recovery within 2-10 years) (medium confidence). It is also noted that this ecological group is not able to colonise artificial hard substratum and the introduction of this would reduce the extent of suitable habitat (Tillin & Tyler-Walters, 2014). In addition, a number of the ecological groups (4, 5, 6 & 8(a)) consists of shallowly buried species and removal of substratum would result in all individuals within the extraction footprint being removed (Tillin & Tyler-Walters, 2014).

Circalittoral sands are moderately sensitive to pressures associated with the fishing sector (low confidence). Species of ecological group 4 are infauna found close to the sediment surface. This life habit provides some protection from abrasion at the surface only, however it was considered that surface abrasion may damage and kill a proportion of the population. Members of this ecological group will also be directly impacted by penetration and disturbance of the substratum below the surface. However, the small size of members of this ecological group will confer some level of resistance. Gilkinson *et al* (1998) simulated the physical interaction of otter trawl doors with the seabed and between 58% and 70% of the bivalves in the scour path that were originally buried were completely or partially exposed at the test bed surface. However, only two out of a total of 42 specimens showed major damage. The pressure wave associated with the otter door pushes small bivalves out of the way without damaging them. Where species can rapidly burrow and reposition (typically within species occurring in unstable habitats) before predation mortality rates will be relatively low

(Tillin & Tyler-Walters, 2014). Sensitivity to changes in suspended solids is also assessed as medium for group 4 (low confidence). This ecological group is not predicted to be sensitive to acute changes in turbidity. However at the pressure benchmark the change is chronic and sustained for a year. This is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing and producing pseudofaeces for the filter feeders (Tillin & Tyler-Walters, 2014).

Circalittoral sands are moderately sensitive to pressures associated with the shipping sector (low confidence). It must be stressed that this assessment is based on one characterising species only due to a lack of evidence on the remaining species. Ager (2005) found the characterising species *Spiophanes bombyx* to have a medium sensitivity to synthetic compound contamination. However, no information was found directly relating to the effects of synthetic chemicals on *Spiophanes bombyx and* the assessment is inferred based on evidence on other polychaete species. This highlights the need for further research on the effects of sectoral activities on characterising species within the MSFD broadscale habitats.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Within the list of characterising species for this biotope only two species have been assessed for sensitivity by MarLIN. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

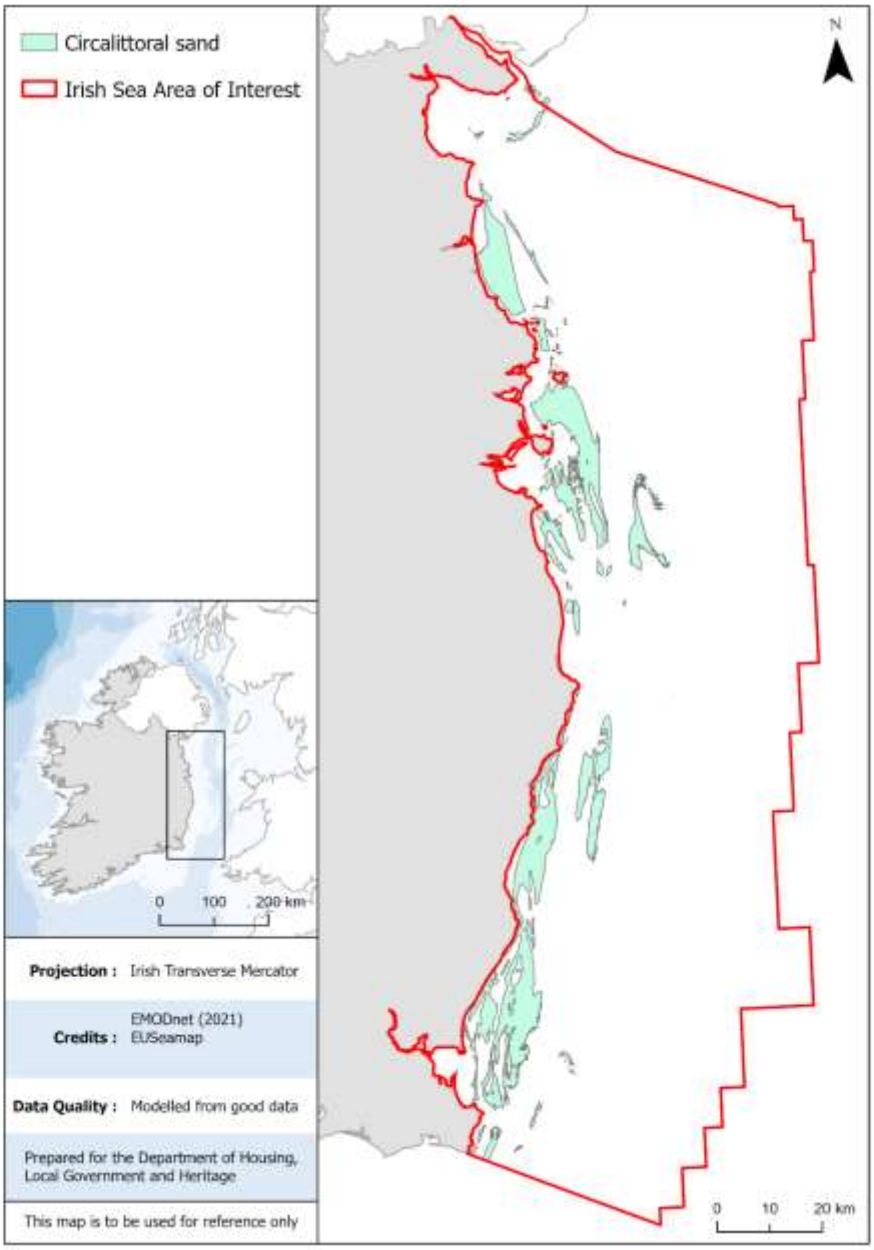

Figure 1. Data available for circalittoral sand in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	[EUSeamap (2021)]	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

Ager, O.E.D. (2005). *Spiophanes bombyx* A bristleworm. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 22-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1705

Gilkinson, K., Paulin, M., Hurley, S. & Schwinghamer, P. (1998). Impacts of trawl door scouring on infaunal bivalves: results of a physical trawl door model/dense sand interaction. *Journal of Experimental Marine Biology and Ecology*, **224**, 291 - 312.

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Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

29. Infralittoral Coarse Sediments

Background

These habitats occur at depths between 5 and 50 metres. They are moderately exposed habitats with coarse sand, gravelly sand, shingle and gravel in the infralittoral, and are subject to disturbance by tidal streams and wave action. Such habitats found on the open coast or in tide-swept marine inlets are characterised by a robust fauna of infaunal polychaetes such as *Chaetozone setosa* and *Lanice conchilega*, cumaceans such as *Iphinoe trispinosa* and *Diastylis bradyi*, and venerid bivalves (JNCC, 2022).

Table 1. **Infralittoral Coarse Sediments characterising species defined by Tillin & Tyler-Walters (2013).**

	Characterising species	MarLIN Link
Group 2	**Temporary or permanently attached surface dwelling or shallowly buried larger bivalves**	
	Ensis ensis	https://www.marlin.ac.uk/species/detail/1419
Group 3	**Mobile predators and scavengers**	
	Pagurus bernhardus	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
	Carcinus maenas	https://www.marlin.ac.uk/species/detail/1497
	Liocarcinus depurator	https://www.marlin.ac.uk/species/detail/1175
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**	
	Nucula nitidosa	
	Abra alba	https://www.marlin.ac.uk/species/detail/1722
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Lanice conchilega	https://www.marlin.ac.uk/species/detail/1642
	Chaetozone setosa	
	Spio martinensis	
	Scoloplos armiger	
	Spiophanes bombyx	https://www.marlin.ac.uk/species/detail/1705
	Magelona mirabilis	

	Mediomastus fragilis	
Group 6	**Predatory polychaetes**	
	Glycera lapidum	
	Nephtys cirrose	
	Phyllodoce maculata	
	Eteone longa	
	Nephtys hombergii	https://www.marlin.ac.uk/species/detail/1710
Group 7	**Very small-small, short lived (<2 years) free-living species**	
	Diastylis bradyi	
	Iphinoe trispinosa	
Group 8(a)	**Subsurface dwelling Echinoids**	
	Echinocardium cordatum	https://www.marlin.ac.uk/species/detail/1417

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Infralittoral Coarse Sediments habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Infralittoral coarse sediments are highly sensitive to pressures associated with the construction of offshore renewable infrastructure (high confidence). Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). Pressures associated with the operation of ORE, including the physical change of the sediment type and removal of substratum, have a medium sensitivity (medium confidence). Species within ecological group 8(a) vary in environmental requirements but each appears to occur in a relatively restricted range of sediment types, related to burrowing, feeding and other characteristics. The species are therefore considered to have **'Low' resistance** to a change in sediment type (low confidence) but resilience is assessed as **'Medium'** (recovery within 2-10 years) (medium confidence). It is also noted that this ecological group is not able to colonise artificial hard substratum and the introduction of this would reduce the extent of suitable habitat (Tillin & Tyler-Walters, 2014). In addition, a number of the ecological groups (2, 3, 4, 5, 6 & 8(a)) consists of surface dwelling or shallowly buried species and removal of substratum would result in all individuals within the extraction footprint being removed (Tillin & Tyler-Walters, 2014). Lastly, groups 2, 4, 5 and 8(a) are moderately sensitive to heavy smothering and siltation changes (Low confidence). As the members of these ecological groups are shallowly buried they would be buried by the deposit. Some species are considered to be unable to vertically migrate through a layer of overburden at the pressure benchmark level, that is, 30cm of fine material. For mobile species, the character of the overburden is an important factor determining the degree of vertical migration of buried bivalves. Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type (Tillin & Tyler-Walters, 2014).

Infralittoral coarse sediments are moderately sensitive to pressures associated with the fishing sector (high confidence). Ecological groups 2 and 4 are moderately sensitive to surface abrasion (medium confidence), while groups 2, 4 and 8(a) are moderately sensitive to penetration of the substratum (medium confidence). Species of ecological group 4, for example, are infauna found close to the sediment surface. This life habit provides some protection from abrasion at the surface only, however it was considered that surface abrasion may damage and kill a proportion of the population. Members of this ecological group will also be directly impacted by penetration and disturbance of the substratum below the surface. Ecological group 8(a) represents infaunal sea urchins that are shallowly buried and the fragility of the tests means that these species have little protection from abrasion that is coupled with penetration and disturbance of the seabed. Groups 2 and 4, which include suspension feeders, are also moderately sensitive to a change in suspended solids (medium confidence). The change in suspended solids is chronic and sustained for a year and is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency (Tillin & Tyler-Walters, 2014).

Infralittoral coarse sediments are moderately sensitive to pressures associated with shipping activities (high confidence). MarLIN has carried out sensitivity analyses for a number of characterising species found in this habitat type. Many of the species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). For example, Smith (1968) found synthetic compound contamination caused mass mortalities of *Echinocardium cordatum* and *Ensis spp.* when detergents were used to disperse oil from the Torrey Canyon oil (Hill, 2006 & Hill, 2008). The same species were also found to be highly intolerant of hydrocarbons. A number of oil spills has resulted in reduced abundance of both *Echinocardium cordatum* and *Ensis spp.*, however recovery is assessed as 'high' resulting in a medium sensitivity.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

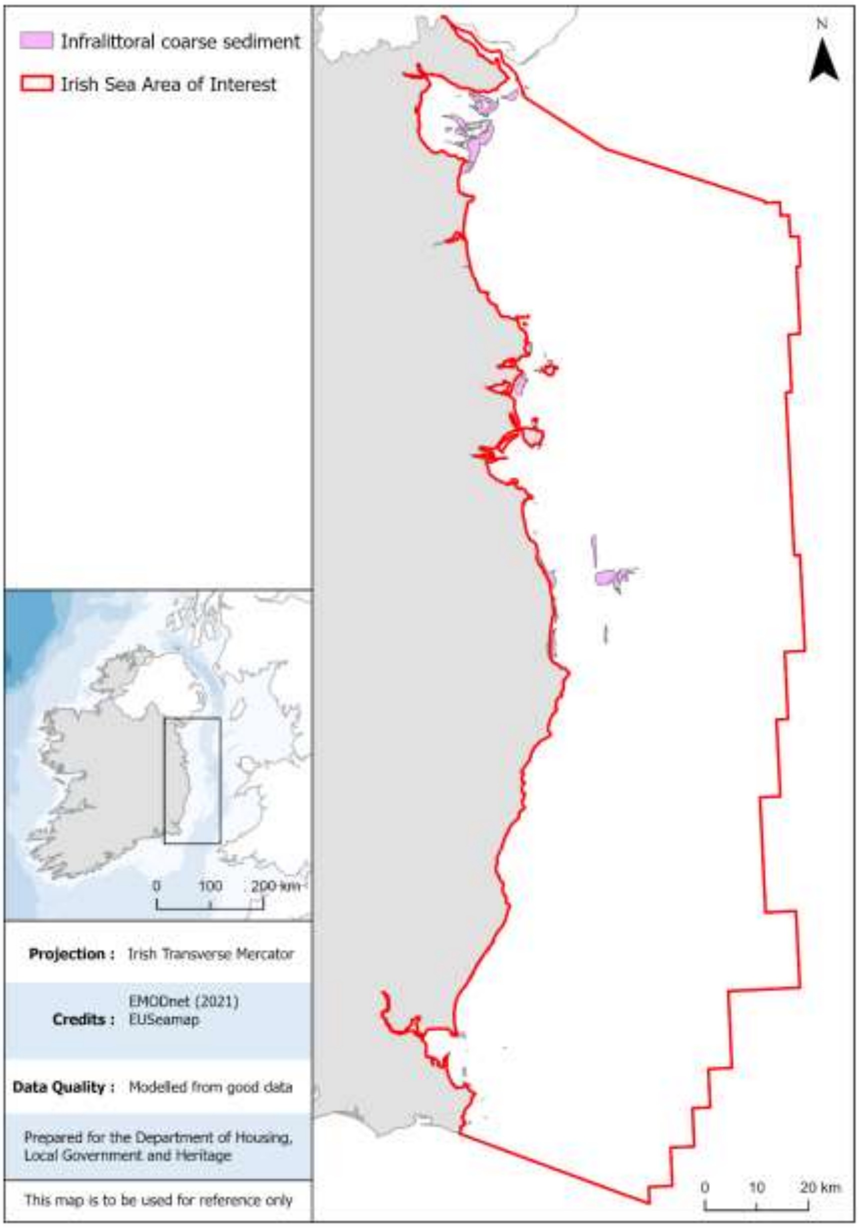

Figure 1. Data available for infralittoral coarse sediments in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments

EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

Hill, J.M. (2006). *Ensis ensis* Common razor shell. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 22-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1419

Hill, J.M. (2008). *Echinocardium cordatum* Sea potato. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 22-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1417

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Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

30. Infralittoral Mixed Sediments

Background

Shallow mixed (heterogeneous) sediments in fully marine or near fully marine conditions, supporting various animal-dominated communities, with relatively low proportions of seaweeds. This habitat may include well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in mud, sand or gravel. Due to the quite variable nature of the sediment type, a widely variable array of communities may be found, including those characterised by bivalves, polychaetes and file shells. This has resulted in many species being described as characteristic of this biotope complex all contributing only a small percentage to the overall similarity (JNCC, 2022).

Table 1. Infralittoral Mixed Sediments characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	**MarLIN Link**
Group 1(b)	**Erect, shorter lived epifaunal species**	
	Hydrallmania falcata	
Group 1(c)	**Soft-bodied epifaunal species**	
	Styela clava	
	Alcyonium digitatum	https://www.marlin.ac.uk/species/detail/1187
	Urticina feline	https://www.marlin.ac.uk/species/detail/1392
Group 1(d)	**Small epifaunal species with hard or protected bodies**	
	Spirobranchus triqueter	
	Crepidula fornicate	
	Calyptraea chinensis	
	Calliostoma zizyphinum	
	Spirobranchus lamarcki	
Group 2	**Temporary or permanently attached surface dwelling or shallowly buried larger bivalves**	
	Limaria hians	
	Ostrea edulis	https://www.marlin.ac.uk/species/detail/1146
	Venerupis corrugate	https://www.marlin.ac.uk/species/detail/1558
Group 3	**Mobile predators and scavengers**	
	Necora puber	

	Buccinum undatum	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
	Paguridae	
	Pagurus bernhardus	
	Cancer pagurus	https://www.marlin.ac.uk/species/detail/1179
	Carcinus maenas	https://www.marlin.ac.uk/species/detail/1497
	Hyas Araneus	
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**	
	Tellimya ferruginosa	
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Sphaerosyllis hystrix	
	Notomastus latericeus	
	Tubificoides swirencoides	
	Tubificoides benedii	
	Caulleriella alata	
	Sabella pavonine	
	Mediomastus fragilis	
	Aphelochaeta marioni	https://www.marlin.ac.uk/species/detail/1556
	Lanice conchilega	https://www.marlin.ac.uk/species/detail/1642
	Melinna palmata	
	Chaetozone gibber	
	Amphicteis gunneri	
Group 6	**Predatory polychaetes**	
	Syllidia armata	
	Phyllodoce mucosa	
Group 7	**Very small-small, short lived (<2 years) free-living species**	
	Monocorophium sextonae	
	Apseudopsis latreillii	
	Maera grossimana	

	Gammarella fucicola	
	Abludomelita gladiosa	
	Janira maculosa	
	Metaphoxus simplex	
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**	
	Ophiothrix fragilis	https://www.marlin.ac.uk/species/detail/1198
Group 10	**Burrowing, soft-bodied species**	
	Cerianthus lloydii	

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Infralittoral Mixed Sediments habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Infralittoral mixed sediments are highly sensitive to pressures associated with the construction of offshore renewable infrastructure (high confidence). Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). This biotope has a moderate sensitivity to the operation of ORE (high confidence). Species within ecological group 10 appear to occur in a relatively restricted range of sediment types, related to burrowing, feeding and other characteristics. The species are therefore considered to have **'Low' resistance** (loss of 25-75% of population)(low confidence) to a change in sediment type. **Resilience** is assessed as **'Medium'** (**2-10 years** following habitat recovery)(low confidence). In addition, a number of the ecological groups (1(b), 1(c), 1(d), 2, 3, 4, 5, 6, 8(c) & 10) consists of surface dwelling or shallowly buried species and removal of substratum would result in all individuals within the extraction footprint being removed (Tillin & Tyler-Walters, 2014).

Infralittoral mixed sediments are moderately sensitive to pressures associated with the fishing sector (high confidence). A number of the ecological groups present in this habitat were assessed as moderately sensitive to abrasion and penetration of the substratum including group 1(c): Soft-bodied epifaunal species (medium confidence). As erect epifauna, the growth form of members of this ecological group means they are exposed to direct physical damage from abrasion and sub-surface damage. Individuals may be directly displaced, damaged or removed as by-catch. Fishing may move the boulders and cobbles that these species are attached to. If these are turned over, species may die from physical damage or prevention of feeding (Tillin & Tyler-Walters, 2014). Sensitivity to a change in suspended solids was deemed moderately sensitive for ecological groups 2 and 4 (medium confidence). The groups are not predicted to be sensitive to acute changes in turbidity. However at the pressure benchmark the change is chronic and sustained for a year. This is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing and producing pseudofaeces for the filter feeders (Rayment, 2007; Tillin & Tyler-Walters, 2014).

Infralittoral mixed sediments are moderately sensitive to pressures associated with shipping related activities (high confidence). MarLIN has carried out sensitivity analyses for a number of characterising species found in this habitat type. Many of the species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). Asterias rubens, Ophiothrix fragilis and Carcinus maenas have a medium sensitivity to hydrocarbon and PAH contamination while Lanice conchilega, Urticina felina, Cancer pagurus, Aphelochaeta marioni and Venerupis corrugata have a medium sensitivity to synthetic compound contamination.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

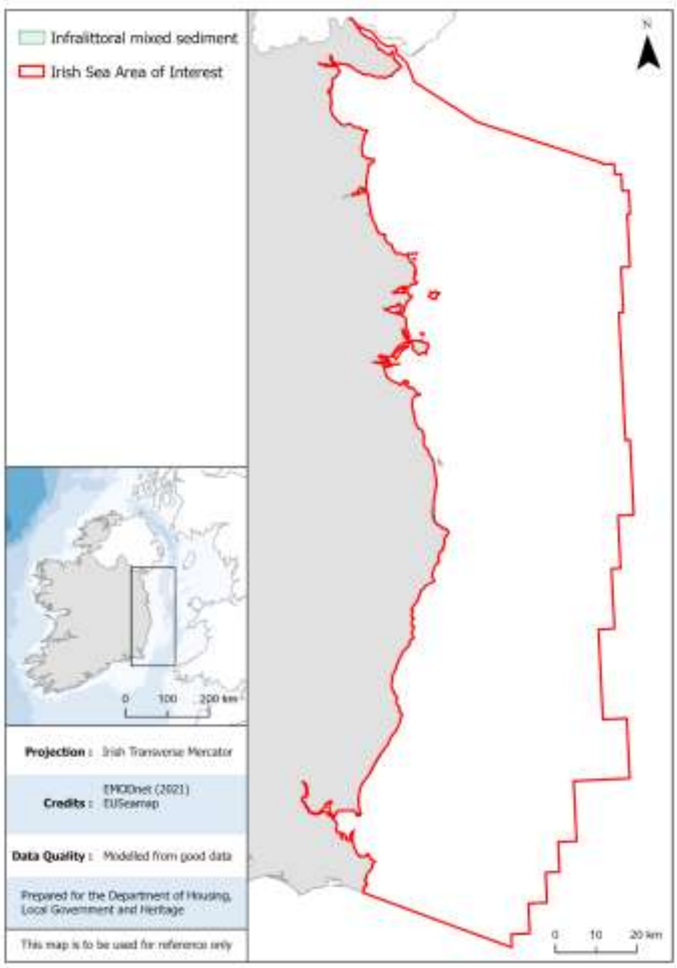

Figure 1. Data available for infralittoral mixed sediments in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	[EUSeamap (2021)]()	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Rayment, W.J. (2007). *Venerupis corrugata* Pullet carpet shell. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1558

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

31. Infralittoral Mud

Background

Shallow sublittoral muds, extending from the extreme lower shore to about 15-20 m depth in fully marine or near marine conditions, predominantly in extremely sheltered areas with very weak tidal currents. Such habitats are found in sea lochs and some rias and harbours. Populations of the lugworm *Arenicola marina* may be dense, with anemones, the opisthobranch *Philine aperta* and synaptid holothurians also characteristic in some areas. The extent of the oxidised layer may be shallow with some areas being periodically or permanently anoxic. In these areas bacterial mats may develop on the sediment surface. Infaunal records for this biotope complex are limited encompassing only one biotope. They are therefore not representative of the full suite of infaunal species found in this biotope (JNCC, 2022).

Table 1. Infralittoral Mud characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	MarLIN Link
Group 1(b)	**Erect, shorter lived epifaunal species**	
	Hydractinia echinate	
Group 2	**Temporary or permanently attached surface dwelling or shallowly buried larger bivalves**	
	Cerastoderma edule	https://www.marlin.ac.uk/species/detail/1384
Group 3	**Mobile predators and scavengers**	
	Carcinus maenas	https://www.marlin.ac.uk/species/detail/1497
	Pagurus bernhardus	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
	Liocarcinus depurator	https://www.marlin.ac.uk/species/detail/1175
	Philine aperta	https://www.marlin.ac.uk/species/detail/1412
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**	
	Abra nitida	
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Arenicola marina	https://www.marlin.ac.uk/species/detail/1402
	Aphelochaeta marioni	https://www.marlin.ac.uk/species/detail/155

		6
	Polydora ciliata	https://www.marlin.ac.uk/species/detail/1410
	Chaetozone caputesocis	
Group 6	**Predatory polychaetes**	
	Hediste diversicolor	https://www.marlin.ac.uk/species/detail/1426
Group 10	**Burrowing, soft-bodied species**	
	Cerianthus lloydii	

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Infralittoral Mud habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Infralittoral muds are highly sensitive to pressures associated with the construction of ORE (high confidence). Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). This biotope has a moderate sensitivity to the operation of ORE (high confidence). Species within ecological group 10 appear to occur in a relatively restricted range of sediment types, related to burrowing, feeding and other characteristics. The species are therefore considered to have **'Low' resistance** (loss of 25-75% of population)(low confidence) to a change in sediment type. **Resilience** is assessed as **'Medium'** (**2-10 years** following habitat recovery)(low confidence). In addition, a number of the ecological groups (1(b), 1(c), 1(d), 2, 3, 4, 5, 6, 8(a), 8(b), 8(c) & 10) consists of surface dwelling or shallowly buried species and removal of substratum would result in all individuals within the extraction footprint being removed (Tillin & Tyler-Walters, 2014).

Infralittoral muds are moderately sensitive to pressures associated with the fishing sector (high confidence). Species of ecological groups 2, 4 and 10 are found close to the sediment surface. This life habit provides some protection from abrasion at the surface only, however it was considered that surface abrasion may damage and kill a proportion of the population. Members of these ecological groups will also be directly impacted by penetration and disturbance of the substratum below the surface. Sensitivity to a change in suspended solids was deemed moderately sensitive for ecological groups 2 and 4 (medium confidence). The groups are not predicted to be sensitive to acute changes in turbidity. However at the pressure benchmark the change is chronic and sustained for a year. This is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing and producing pseudofaeces for the filter feeders (Rayment, 2007; Tillin & Tyler-Walters, 2014).

Infralittoral muds are moderately sensitive to pressures associated with shipping related activities (high confidence). MarLIN has carried out sensitivity analyses for a number of characterising species found in this habitat type. Many of the species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). *Asterias rubens* and *Carcinus maenas* have a medium sensitivity to hydrocarbon and PAH contamination while *Hediste diversicolor, Aphelochaeta marioni and Arenicola marina* have a medium sensitivity to synthetic compound contamination.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

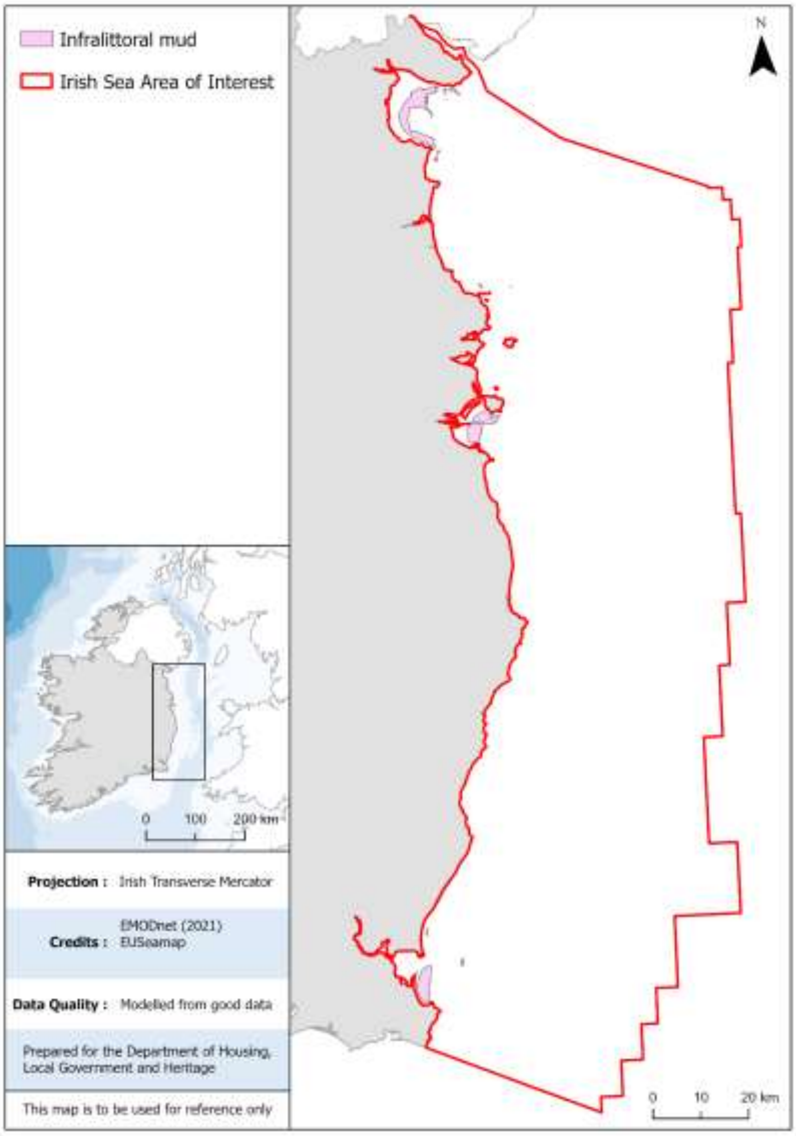

Figure 1. Data available for infralittoral mud in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and

sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Rayment, W.J. (2007). *Venerupis corrugata* Pullet carpet shell. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1558

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

32. Infralittoral Sand

Background

Clean sands which occur in shallow water (5m-20m), either on the open coast or in tide-swept channels of marine inlets. The habitat typically lacks a significant seaweed component and is characterised by robust fauna, particularly amphipods (*Bathyporeia*) and robust polychaetes including *Nephtys cirrosa* and *Lanice conchilega* (JNCC, 2022).

Table 1. **Infralittoral Sand characterising species defined by Tillin & Tyler-Walters (2013).**

	Characterising species	MarLIN Link
Group 1(b)	**Erect, shorter lived epifaunal species**	
	Hydrallmania falcata	
	Sertularia cupressina	
Group 1(c)	**Soft-bodied epifaunal species**	
	Alcyonidium diaphanum	
	Urticina feline	*https://www.marlin.ac.uk/species/detail/1392*
Group 1(d)	**Small epifaunal species with hard or protected bodies**	
	Balanus crenatus	https://www.marlin.ac.uk/species/detail/1381
Group 3	**Mobile predators and scavengers**	
	Cancer pagurus	https://www.marlin.ac.uk/species/detail/1179
	Pagurus bernhardus	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
	Liocarcinus depurator	https://www.marlin.ac.uk/species/detail/1175
	Carcinus maenas	https://www.marlin.ac.uk/species/detail/1497
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Spio filicornis	https://www.marlin.ac.uk/species/detail/1698
	Scoloplos armiger	
	Spiophanes bombyx	https://www.marlin.ac.uk/species/detail/1705
	Lanice conchilega	https://www.marlin.ac.uk/species/detail/1642
	Magelona mirabilis	https://www.marlin.ac.uk/species/detail/1630
	Chaetozone setosa	
Group 6	**Predatory polychaetes**	
	Nephtys cirrose	
Group 7	**Very small-small, short lived (<2 years) free-living species**	

	Bathyporeia elegans	
	Bathyporeia guilliamsoniana	

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Infralittoral sand habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Infralittoral sands are highly sensitive to pressures associated with the construction (high confidence) and moderately sensitive to pressures associated with the operation (high confidence) of offshore renewable infrastructure. Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). This biotope has a medium sensitivity to removal of the substratum (medium confidence). A number of the ecological groups (1(b), 1(c), 1(d), 3, 5, 6) consists of surface dwelling or shallowly buried species and removal of substratum would result in all individuals within the extraction footprint being removed. Ecological groups 1(c), 1(d), 4, and 5 were also moderately sensitive to heavy smothering and siltation changes (low confidence). Groups 1(c) and 1(d) are considered likely to express little resistance to this pressure as individuals are attached to the substratum and are likely to exhibit no or little vertical mobility. Groups 4 and 5 are shallowly buried and they would be buried by the deposit. Some species are considered to be unable to vertically migrate through a layer of overburden at the pressure benchmark level, that is, 30cm of fine material. For mobile species, the character of the overburden is an important factor determining the degree of vertical migration of buried bivalves. Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type (Tillin & Tyler-Walters, 2014).

Infralittoral sands are moderately sensitive to pressures associated with the fishing sector (high confidence). Species of ecological group 4 are infauna found close to the sediment surface. This life habit provides some protection from abrasion at the surface only, however it was considered that surface abrasion may damage and kill a proportion of the population. As erect epifauna, the growth form of members of group 1(c) means they are exposed to direct physical damage from abrasion and sub-surface damage. Individuals may be directly displaced, damaged or removed

Members of these ecological groups will also be directly impacted by penetration and disturbance of the substratum below the surface (Tillin & Tyler-Walters, 2014). In addition, species within ecological group 4 are moderately sensitive to a change in suspended solids (low confidence). It is not predicted to be sensitive to acute changes in turbidity. However at the pressure benchmark the change is chronic and sustained for a year. This is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing and producing pseudofaeces for the filter feeders (Tillin & Tyler-Walters, 2014).

Infralittoral sands are moderately sensitive to pressures associated with shipping related activities (high confidence). MarLIN has carried out sensitivity analyses for a number of characterising species found in this habitat type. Many of the species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). Asterias rubens and Carcinus maenas have a medium sensitivity to hydrocarbon and PAH contamination while *Spiophanes bombyx, Spio filicornis, Lanice conchilega, Urticina felina*, *Cancer pagurus and Balanus crenatus* have a medium sensitivity to synthetic compound contamination.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

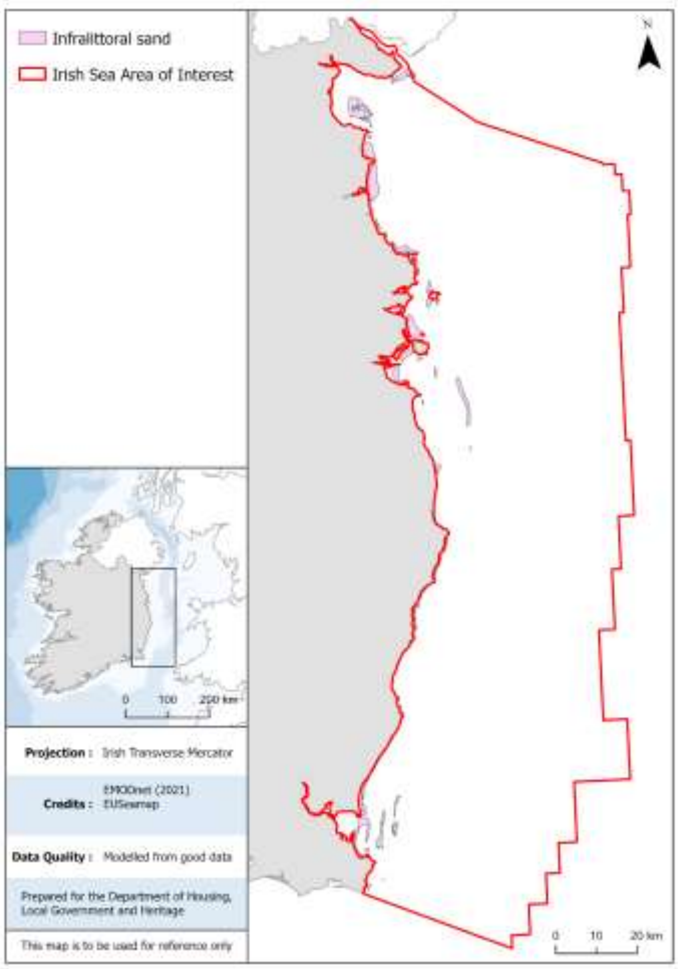

Figure 1. Data available for infralittoral sand in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	[EUSeamap (2021)]	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes. JNCC Report 512B

33. Offshore Circalittoral Coarse Sediments

Background

Offshore (deep) circalittoral habitats with coarse sands and gravel or shell occur between depths of 20m to 200m. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some areas settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus*. In areas where the mussels reach maturity their byssus threads bind the sediment together, increasing stability and allowing an increased deposition of silt (JNCC, 2022).

Table 1. Offshore Circalittoral Coarse Sediments characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species
Group 2	**Temporary or permanently attached surface dwelling or shallowly buried larger bivalves**
	Limatula subauriculata
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**
	Moerella pygmaea
	Thyasira flexuosa
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**
	Amythasides macroglossus
Group 6	**Predatory polychaetes**
	Glycera lapidum
	Hesionura elongate
	Protodorvillea kefersteini

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Offshore Circalittoral Coarse Sediment habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Offshore circalittoral coarse sediments are highly sensitive to pressures associated with the construction of offshore wind farms (high confidence). Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). This biotope has a moderate sensitivity to the operation of ORE (medium confidence). Ecological groups 2, 4, 5 and 6 scored a medium sensitivity to habitat structure change (low confidence). The process of extraction is considered to remove all members of these ecological groups as they are either shallowly buried, sessile or slow moving. Recovery will be mediated by the scale of the disturbance and the suitability of the sedimentary habitat remaining. Ecological groups 2 and 4, which include suspension feeders, are moderately sensitive to a change in suspended solids (medium confidence). The change is chronic and sustained for a year and is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing and producing pseudofaeces for the filter feeders. These ecological groups are also moderately sensitive to heavy smothering and siltation changes (low confidence) The ecological groups are on the seabed or shallowly buried and would be buried with heavy siltation changes. The intensity and duration of siltation will be mediated by site-specific hydrodynamic conditions, such as water- flow and wave action. Based on the laboratory studies by Last *et al* (2011) and Szostek *et al* 2013, species in ecological group 2 were considered to be unable to vertically migrate through a layer of overburden at the pressure benchmark level, that is, 30cm of fine material and therefore has been assessed as highly sensitive (Tillin & Tyler-Walters, 2014).

Offshore circalittoral coarse sediments are moderately sensitive to pressures associated with the fishing sector (medium confidence). Ecological groups 2, 4 and 5 have a medium sensitivity to abrasion or the surface and penetration of the subsurface (medium confidence). Species of group 4 and 5 are infauna found close to the sediment surface. This life habit provides some protection from abrasion at the surface only, however it was considered that surface abrasion may damage and kill a proportion of the population. Members of these ecological groups will also be directly impacted by penetration and disturbance of the substratum below the surface. As mentioned previously, this biotope is also moderately sensitive to a change in suspended solids (medium confidence) (Tillin & Tyler-Walters, 2014).

Pressures associated with the shipping sector were not assessed for offshore circalittoral coarse sediments due to a lack of evidence. These include chemical pressures (Transition elements & organo-metal contamination, Hydrocarbon & PAH contamination, Synthetic compound contamination, introduction of other substances) biological pressures (introduction or spread of invasive non-indigenous species) and physical pressures (underwater noise). Further research is needed on the sensitivity of this biotope to these pressures and the shipping sector.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. There were no characterising species with sensitivity analyses already carried out for this offshore circalittoral coarse sediments. Therefore, multiple pressures are not assessed for this biotope. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

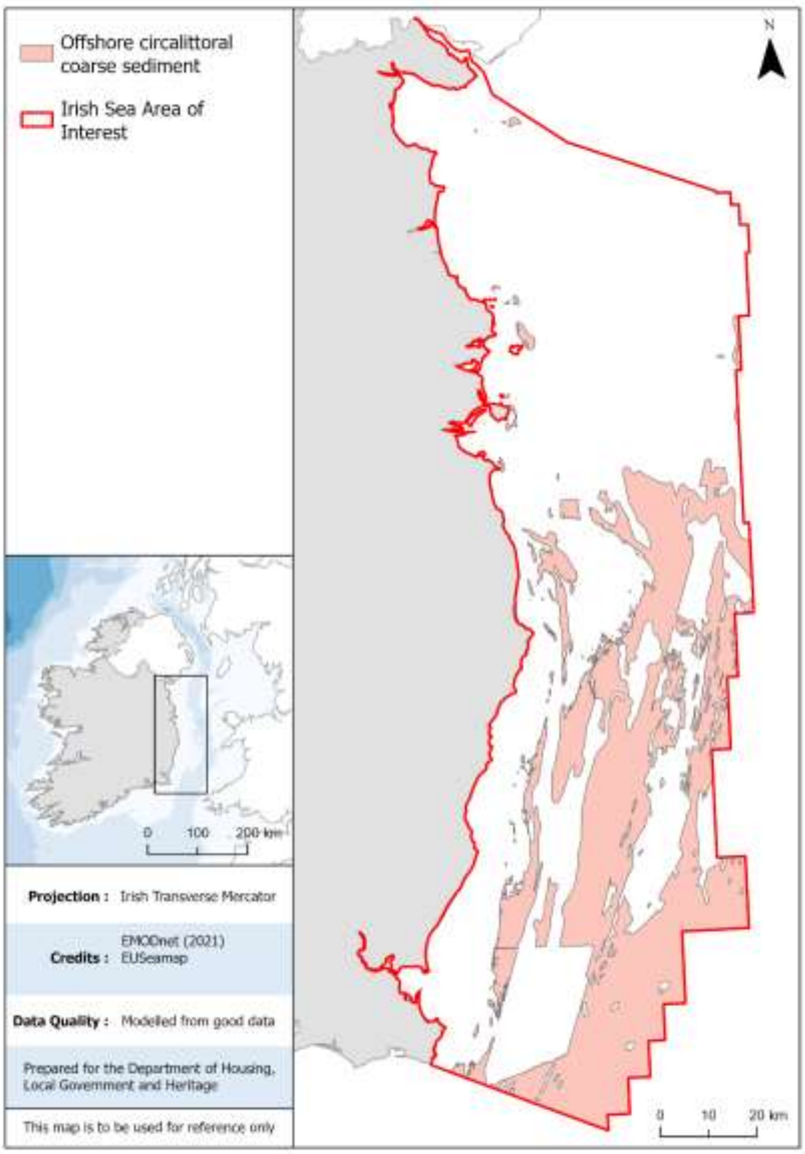

Figure 1. Data available for offshore circalittoral coarse sediments in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Last, K.S., Hendrick, V.J., Beveridge, C.M. & Davies, A.J. (2011). Measuring the effects of suspended particulate matter and smothering on the behaviour, growth and survival of key species found in areas associated with aggregate dredging. *Report for the Marine Aggregate Levy Sustainability Fund. Project MEPF 08/P76*. 69 pp. Available from: www.alsf-mepf.org.uk

Szostek, C.L., Davies, A.J. & Hinz, H. (2013). Effects of elevated levels of suspended particulate matter and burial on juvenile king scallops Pecten maximus. *Marine Ecology Progress Series*, **474**, 155-165.

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

34. Offshore Circalittoral Mixed Sediments

Background

Offshore (deep) circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell occur at depths between 50m and 200m. This habitat may cover large areas of the offshore continental shelf although there is relatively little data available. Such habitats are often highly diverse with a high number of infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore gravels and coarse sands and in some areas populations of the horse mussel *Modiolus modiolus* may develop in these habitats (JNCC, 2022).

Table 1. Offshore Circalittoral Mixed Sediments characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**
	Spisula elliptica
	Timoclea ovata
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**
	Aonides paucibranchiata
	Caulleriella zetlandica
	Laonice bahuiensis
	Mediomastus fragilis
	Polycirrus
	Polydora caulleryi
	Scalibregma inflatum
Group 6	**Predatory polychaetes**
	Eumida sanguinea
	Glycera lapidum
	Harmothoe
	Hesionura elongata
	Lumbrineris gracilis (Lumbrineris spp)
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**
	Amphipholis squamata

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Offshore Circalittoral Mixed Sediment habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Offshore circalittoral mixed sediments are highly sensitive to pressures associated with the construction (high confidence) and operation (low confidence) of offshore wind farms. Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). Species in ecological group 5 were assessed as highly sensitive to habitat structure change and heavy smothering and siltation changes (low confidence). Extraction would remove all individuals within the extraction footprint and hence resistance is assessed as **'None'**. Resilience is predicted to be '**Low'** for *C. zetlandica and* sensitivity is therefore assessed as **'High'.** For heavy siltation changes Richardson *et al* (1977) reported that the species most affected by dredged material disposal were tube-dwelling polychaetes. Therefore, within this ecological group the tube dwelling polychaetes *Lanice conchilega*, *Ampharete falcata*, *Polydora caulleryi* and *Caulleriella zetlandica* were considered to have a resistance of **'None'.** The resilience of *C. zetlandica* is assessed as '**Low**', and sensitivity is therefore, '**High**' (Tillin & Tyler-Walters, 2014).

Offshore circalittoral mixed sediments are moderately sensitive to pressures associated with the fishing sector (medium confidence). Ecological groups 4, 5 and 8(c) have a medium sensitivity to surface abrasion and penetration of the substratum (medium confidence). Species of group 4 and 5 are infauna found close to the sediment surface. This life habit provides some protection from abrasion at the surface only, however it was considered that surface abrasion may damage and kill a proportion of the population. Members of these ecological groups will also be directly impacted by penetration and disturbance of the substratum below the surface. Abrasion at the surface of the sediment has the potential to directly impact ecological group 8(c). Many of the species represented by this group are epifaunal and would be directly exposed to any source of abrasion and subsurface penetration. *Amphiura* species are shallow burrowers but extend arms above the surface to feed, these would be directly exposed. In some structurally complex habitats, individuals beneath stones or in crevices may avoid this pressure (Tillin & Tyler-Walters, 2014).

Pressures associated with the shipping sector were not assessed for offshore circalittoral mixed sediments due to a lack of evidence. These include chemical pressures (Transition elements & organo-metal contamination, Hydrocarbon & PAH contamination, Synthetic compound contamination, introduction of other substances) biological pressures (introduction or spread of invasive non-indigenous species) and physical pressures (underwater noise). Further research is needed on the sensitivity of this biotope to these pressures and the shipping sector.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. There were no characterising species with sensitivity analyses already carried out for this offshore circalittoral mixed sediments. Therefore multiple pressures are not assessed for this biotope. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

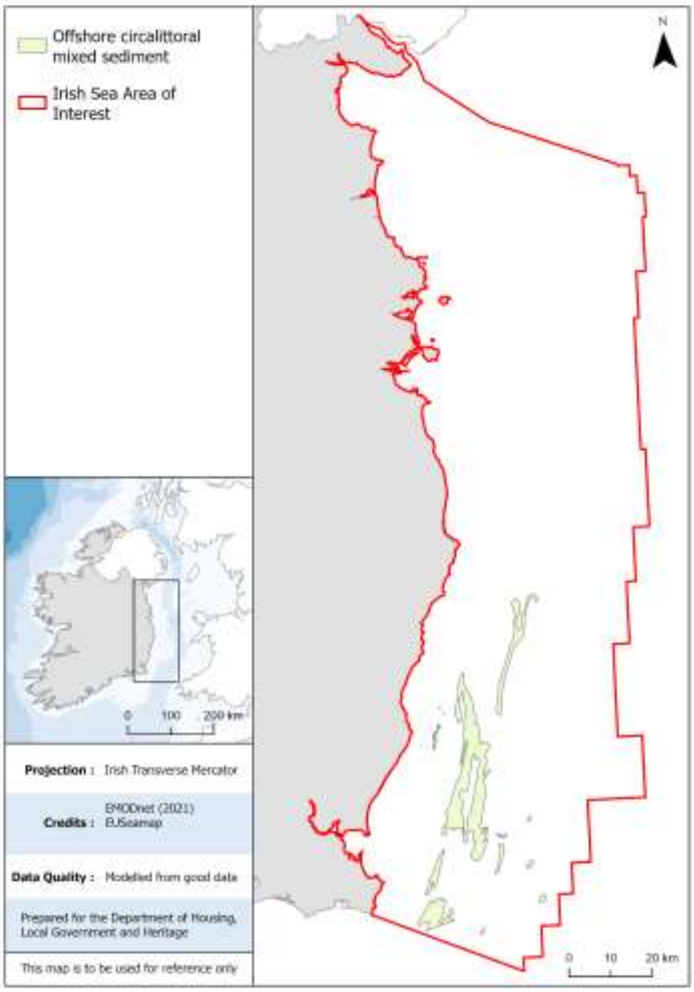

Figure 1. Data available for offshore circalittoral mixed sediments in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Richardson, M.D., Carey, A.G. & Colgate, W.A. (1977). Aquatic disposal field investigations Columbia River disposal site, Oregon Appendix C: The effects of dredged material disposal on benthic assemblages. *Dredged Material Research Programme Technical Report D-77-30*. 1-411 pp.

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A.

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B.

35. Offshore Circalittoral Mud

Background

In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera (JNCC, 2022).

Table 1. Offshore Circalittoral Mud characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	MarLIN Link
Group 1(a)	**Erect, longer-lived epifaunal species with some flexibility**	
	Pennatula phosphorea	
Group 1(c)	**Soft-bodied epifaunal species**	
	Ascidiella aspersa	
	Styela gelatinosa	
Group 2	**Temporary or permanently attached surface dwelling or shallowly buried larger bivalves**	
	Pseudamussium septemradiatum	
Group 3	**Mobile predators and scavengers**	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**	
	Abra alba	https://www.marlin.ac.uk/species/detail/1722
	Abra nitida	
	Myrtea spinifera	
	Parvicardium ovale	
	Thyasira flexuosa	
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Ampharete falcata	
	Chaetozone setosa	
	Heteromastus filiformis	
	Levinsenia gracilis	

	Sabella pavonina	
Group 6	**Predatory polychaetes**	
	Nephtys hystricis	
	Paramphinome jeffreysii	
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**	
	Amphiura filiformis	https://www.marlin.ac.uk/species/detail/1400

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Offshore Circalittoral Mud habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

Offshore circalittoral mud is highly sensitive to pressures associated with the construction (high confidence) and operation (medium confidence) of offshore renewable infrastructure. Loss or change of the physical habitat could lead to a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). A change in sediment type will adversely affect the seapens. Based on their reported distribution a change of 'mud' to 'sandy mud' or 'slightly gravelly mud' will probably exclude *P. phosphorea* (medium confidence)(Tillin & Tyler-Walters, 2014). In addition, characterising species within group 1(a) have a high sensitivity to a change in habitat structure through extraction of the substratum (medium confidence). An extraction of sediment to 30cm (the benchmark) will remove most of the resident seapens present and recovery is expected to be low (Tillin & Tyler-Walters, 2014).

Offshore circalittoral mud is highly sensitive to pressures associated with the fishing sector (medium confidence). The ecological group 1(a), present in circalittoral muds have a high sensitivity to each of the four fishing sectors (low confidence). Towed gear is likely to remove a proportion of sea pens from the sediment, and if damaged they are likely to die, but if undamaged displaced and/or returned to suitable sediment they can recover relatively quickly. *V. mirabilis* and *P. phosphorea* can avoid abrasion by withdrawing into the sediment, but frequent disturbance will probably reduce feeding time and hence viability.

Therefore, a sensitivity score of **'High**' has been assigned to this ecological group for abrasion and penetration of the substratum (low confidence) (Tillin & Tyler-Walters, 2014). Additionally, groups 2 and 4, which include suspension feeders, are also moderately sensitive to a change in suspended solids (medium confidence). The change in suspended solids is chronic and sustained for a year and is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency (Tillin & Tyler-Walters, 2014).

Offshore circalittoral muds are moderately sensitive to pressures associated with the shipping sector (high confidence). A small number of characterising species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). Asterias rubens *and Amphiura filiformis* have a medium sensitivity to hydrocarbon and PAH contamination while *Abra alba* and *Amphiura filiformis* have a medium sensitivity to synthetic compound contamination. These pressures have been assessed based on a few characterising species where sensitivity analyses were already available.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

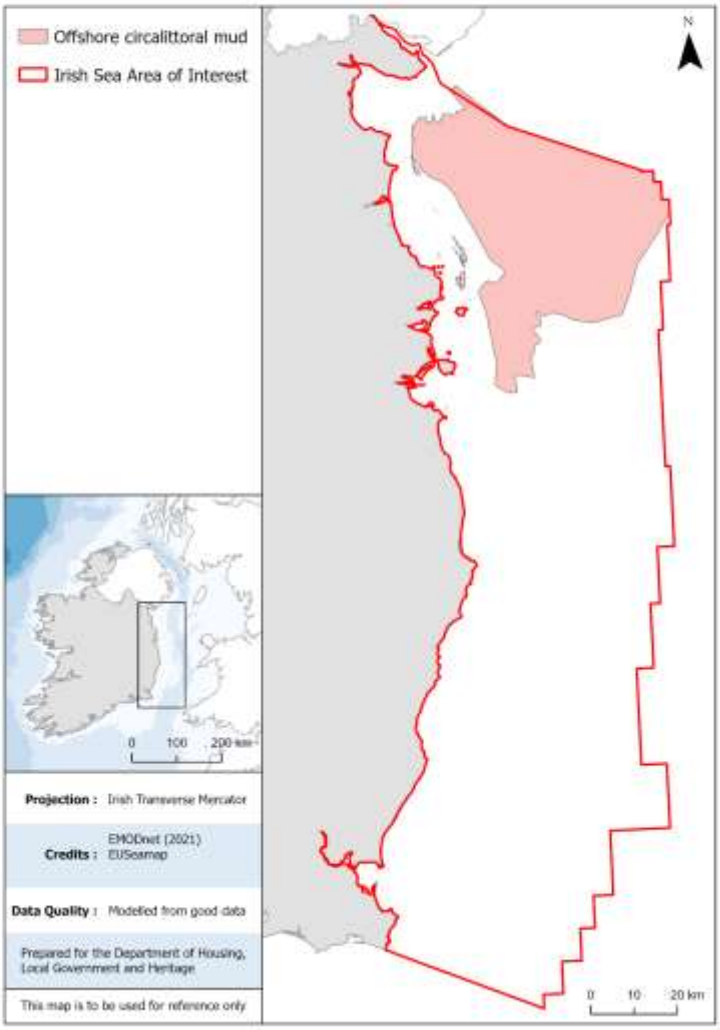

Figure 1. Data available for offshore circalittoral mud in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

36. Offshore Circalittoral Sand

Background

Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands occur between depths of 20m-200m. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms (JNCC, 2022).

Table 1. Offshore Circalittoral Sand characterising species defined by Tillin & Tyler-Walters (2013).

	Characterising species	MarLIN Links
Group 4	**Infaunal very small to medium sized suspensions and/or deposit feeding bivalves**	
	Nuculoma tenuis	
Group 5	**Small-medium suspension and/or deposit feefing polychaetes**	
	Chaetozone setosa	
	Levinsenia gracilis	
	Maldanidae (Maldane sarsi)	
	Owenia fusiformis	https://www.marlin.ac.uk/species/detail/1703
	Scoloplos armiger	
Group 7	**Very small-small, short lived (<2 years) free-living species**	
	Eudorellopsis deformis	
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**	
	Amphiura filiformis	https://www.marlin.ac.uk/species/detail/1400

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Offshore Circalittoral Sand habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. These broadscale habitats do not have existing protection or management but Ireland has a legal obligation under MSFD to protect them and they are amenable to spatial protection.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Offshore circalittoral sands are highly sensitive to pressures associated with the construction of offshore wind farms (high confidence). Loss of the physical habitat will result in a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). This biotope has a moderate sensitivity to the operation of ORE (medium confidence). Ecological groups 4, 5 and 8(c) are moderately sensitive to habitat structure change (low confidence). The process of extraction will remove all members of these ecological groups as they either live on the surface or are shallowly buried and resistance is assessed as **'none'**. Recovery for each of the groups is expected to occur within 2-10 years (resilience is '**medium**'), resulting in a medium sensitivity. Group 4 is also moderately sensitive to a change in suspended solids. This ecological group is not predicted to be sensitive to acute changes in turbidity. However at the pressure benchmark the change is chronic and sustained for a year. This is predicted to have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing and producing pseudofaeces for the filter feeders (Tillin & Tyler-Walters, 2014).

Offshore circalittoral sands are moderately sensitive to pressures associated with the fishing sector (medium confidence). Ecological groups 4 and 8(c) have a medium sensitivity to surface abrasion and penetration of the substratum (medium confidence). Species of group 4 are infauna found close to the sediment surface. This life habit provides some protection from abrasion at the surface only, however it was considered that surface abrasion may damage and kill a proportion of the population. Members of this ecological group will also be directly impacted by penetration and disturbance of the substratum below the surface. Abrasion at the surface of the sediment has the potential to directly impact ecological group 8(c). Many of the species represented by this group are epifaunal and would be directly exposed to any source of abrasion and subsurface penetration. *Amphiura* species are shallow burrowers but extend arms above the surface to feed, these would be directly exposed. In some structurally complex habitats, individuals beneath stones or in crevices may avoid this pressure (Tillin & Tyler-Walters, 2014).

Offshore circalittoral sands are moderately sensitive to pressures associated with the shipping sector (medium confidence). It must be stressed that this assessment is based on one characterising species only due to a lack of evidence on the remaining species. *Amphiura filiformis* has a medium sensitivity to hydrocarbon and PAH contamination (medium confidence) and a medium sensitivity to synthetic compound contamination (low confidence).

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, a number of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

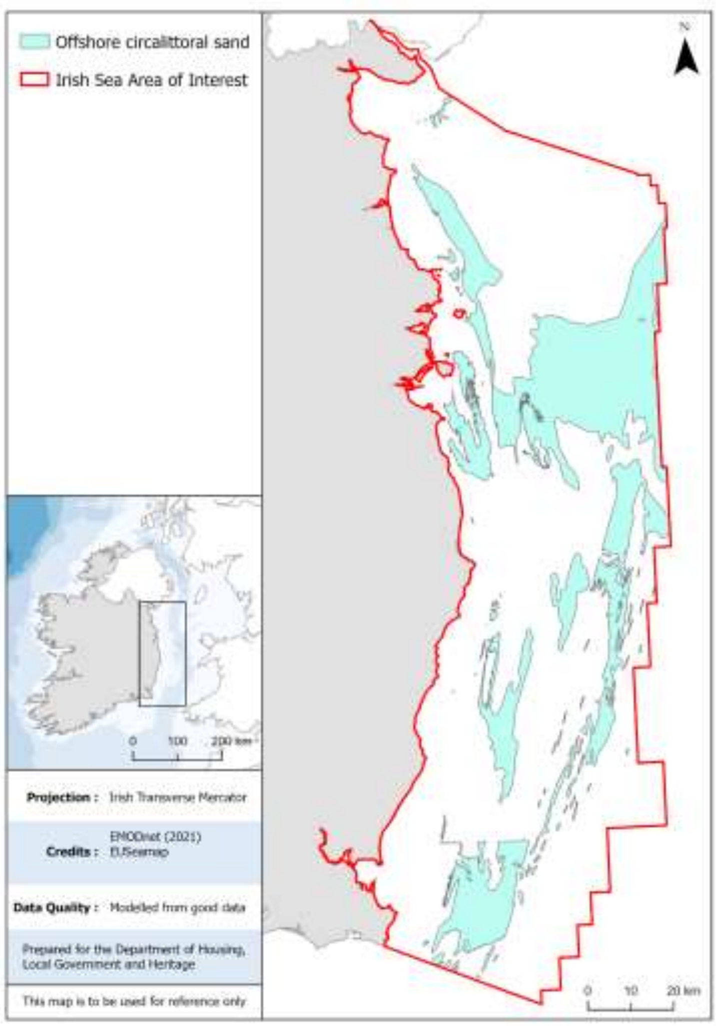

Figure 1. Data available for offshore circalittoral sand in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

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JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

37. Offshore Circalittoral Rock and Biogenic Reef

Background

Offshore circalittoral rock includes habitats of bedrock, boulders and cobbles which occur at depths between 30m to 200m. This habitat supports a wide range of species, and the community assemblages will vary depending on a number of physical factors such as wave action, tidal stream strength, salinity, turbidity, the degree of scouring and rock topography. The sensitivity analysis was based on the characterising species listed under circalittoral rock due to lack of information on characterising species in the offshore circalittoral rock habitat.

Table 1. **Offshore Circalittoral Rock characterising species**

	Characterising species	
Group 1(a)	**Erect, longer-lived epifaunal species with some flexibility**	
	Eunicella verrucosa	https://www.marlin.ac.uk/species/detail/1121
Group 1(b)	**Erect, shorter lived epifaunal species**	
	Tubularia indivisa	
	Sertularia argentea	
	Nemertesia antennina	
	Sertularella gayi	
	Nemertesia ramosa	https://www.marlin.ac.uk/species/detail/1318
	Abietinaria abietina	
	Flustra foliacea	https://www.marlin.ac.uk/species/detail/1609
Group 1(c)	**Soft-bodied epifaunal species**	
	Cylista elegans	
	Alcyonium digitatum	https://www.marlin.ac.uk/species/detail/1187
	Alcyonidium diaphanum	
	Amphilectus fucorum	
	Urticina felina	https://www.marlin.ac.uk/species/detail/1392
	Actinothoe sphyrodeta	
	Corynactis viridis	
	Halichondria panicea	
	Myxilla incrustans	
	Pachymatisma johnstonia	
	Metridium senile	
	Axinella infundibuliformis	

	Cliona celata	
	Dysidea fragilis	
	Haliclona viscosa	
	Polymastia boletiformis	
	Parasmittina trispinosa	
	Pentapora foliacea	https://www.marlin.ac.uk/species/detail/1389
	Stelligera montagui	
	Suberites carnosus	
	Alcyonium glomeratum	
	Hemimycale columella	
	Tethya aurantium	
	Stelligera stuposa	
	Porella compressa	
	Phakellia ventilabrum	
	Axinella dissimilis	https://www.marlin.ac.uk/species/detail/1380
Group 1(d)	**Small epifaunal species with hard or protected bodies**	
	Balanus crenatus	https://www.marlin.ac.uk/species/detail/1381
	Spirobranchus triqueter	https://www.marlin.ac.uk/species/detail/1794
	Calliostoma zizyphinum	
Group 3	**Mobile predators and scavengers**	
	Asterias rubens	https://www.marlin.ac.uk/species/detail/1194
	Cancer pagurus	https://www.marlin.ac.uk/species/detail/1179
	Henricia oculata	https://www.marlin.ac.uk/species/detail/1131
	Luidia ciliaris	
	Marthasterias glacialis	
	Stichastrella rosea	
Group 8(b)	**Surface dwelling Echinoids**	
	Echinus esculentus	https://www.marlin.ac.uk/species/detail/1311
Group 8(c)	**Free living interface suspension/deposit feeders: Ophiuroidea**	
	Ophiothrix fragilis	https://www.marlin.ac.uk/species/detail/1198

*Within each group species (shown in bold) with a good evidence base were selected for specific sensitivity assessment to ensure that the range of biological traits or habitat preferences expressed by species within that ecological group were represented.

Rationale for spatial protection in the Irish Sea

Offshore circalittoral rock and biogenic reef habitats were included in the features list as it is an MSFD priority habitat and is a broadly distributed feature of ecological importance within the Irish Sea. This habitat hosts a wide range of species, contributing to the biodiversity of Irish waters. In the current project, a decision was made to include this MSFD priority habitat given that there are no Natura designations for 'reef' in the offshore region of the western Irish Sea. This is not the case for biogenic reef, so in this project the sensitivity analysis focussed on the characterising species for offshore circalittoral rock.

Sensitivity Assessment

*Sensitivity scores and the ecological groups associated were similar among MSFD habitats.

Offshore circalittoral rock is highly sensitive to pressures associated with the construction and operation of offshore renewable infrastructure. Loss or change of the physical habitat could lead to a loss of biodiversity and lead to changes in the community structure associated with this biotope (high confidence). A change to sedimentary substrata would result in the loss of suitable substratum for *Eunicella verrucosa*. Based on the loss of suitable habitat for the species, resistance to this pressure is assessed as '**none**' and resilience is assessed as '**very low**' as the pressure benchmark refers to a permanent change. Sensitivity is, therefore, assessed as **'high'** (medium confidence)(Readman & Hiscock, 2017). In addition, the characterising species within group 1(a) has a high sensitivity to a change in habitat structure through extraction of the substratum (medium confidence). *Eunicella verrucosa* is epifaunal, occurs on rock, and would be sensitive to the removal of the habitat.

Offshore circalittoral rock is highly sensitive to pressures associated with the fishing sector. Ecological group 1(a) is highly sensitive to abrasion of the substratum (low confidence). *Eunicella verrucosa* is sessile epifauna and is likely to be severely damaged by heavy gears, such as scallop dredging (MacDonald *et al.*, 1996). This biotope is also moderately sensitive to a number of chemical pressures associated with the fishing sector.

Offshore circalittoral rock is moderately sensitive to pressures associated with the shipping sector. A number of characterising species were assigned a medium sensitivity to chemical pressures associated with the shipping sector (high confidence). Asterias rubens, *Ophiothrix fragilis and Echinus esculentus* have a medium sensitivity to hydrocarbon and PAH contamination while *Urticina felina, Cancer pagurus, Flustra foliacea, Echinus esculentus and Balanus crenatus* have a medium sensitivity to synthetic compound contamination. Lastly, *Echinus esculentus* has a medium sensitivity to transition elements and organo-metal contamination.

Further research needs

As with the other MSFD broadscale habitats, a better evidence base is needed as to the actual suite of species, particularly characterising species present in the habitats in the western Irish Sea. In addition, several of the pressures in the analyses for the broadscale habitats are scored based on the sensitivity of a small number of characterising species due to a lack of evidence for others. Further research is needed to assess the sensitivity of the full list of characterising species present to provide a more comprehensive analysis for each biotope.

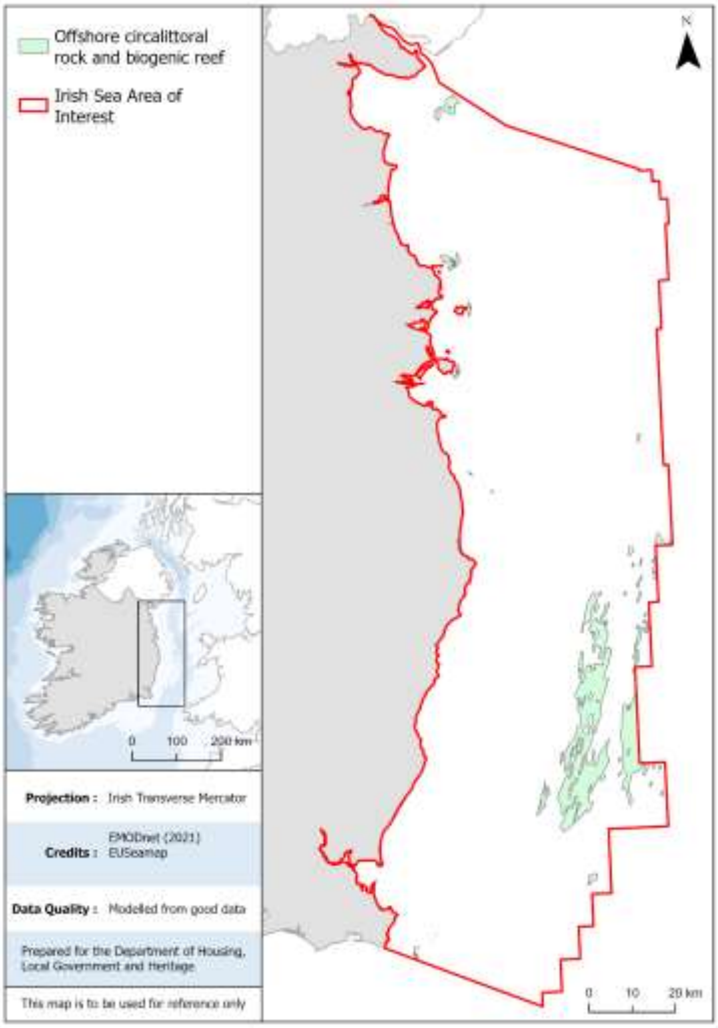

Figure 1. Data available for offshore circalittoral rock and biogenic reef in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
EUSeaMap EMODnet Benthic Broadscale Habitat Types	EMODnet	Modelled from good data	EUSeamap (2021)	

Information on the sensitivity assessment above has been sourced from:

Tillin, H.M. & Tyler-Walters, H. 2014. Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and

sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

References

JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. Available from: https://mhc.jncc.gov.uk/

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Readman, J.A.J. & Hiscock, K. (2017). *Eunicella verrucosa* Pink sea fan. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 04-05-2023]. Available from: https://www.marlin.ac.uk/species/detail/1121

Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A

Tillin, H.M. & Tyler-Walters, H. (2014). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities: Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes**.** JNCC Report 512B

38. Carbon Sequestration

The prevailing science suggests that areas of the seafloor that are dominated by mud-grade sediments can potentially store significant amounts of organic carbon, acting as a carbon sink and forming a key part of the carbon cycle (e.g., Atwood et al., 2020; Lee et al., 2019). This carbon stock can be disturbed by anthropogenic activity (e.g., ORE development, benthic trawling) potentially causing resuspension and remineralisation of carbon that can be released back to the atmosphere, through the water column (Avelar et al., 2017; Sala et al., 2021). Initially, quantifying carbon stock levels and qualifying carbon flow processes in marine sediments (in particular mud) is a first order need in terms of managing their disturbance (Luisetti et al., 2019; Smeaton et al., 2021).

There is a paucity of direct study of the impact of ORE development on carbon stock. However, work to date suggests that, whilst there is disturbance of the seafloor at different life stages of development (i.e., construction and decommissioning), offshore wind farms can trap more organic carbon than they release through sediment disturbance (Heinatz et al., 2023). Further work is required to study the effects in an Irish context. Seabed trawling is known to have a more sustained impact on seafloor sediments (e.g., Oberle et al., 2016), In the Western Irish Sea Mud Belt (Coughlan et al., 2015). There is no available information on the effect of benthic trawling on seabed carbon stocks in the Irish Sea, however it is suggested to represent a significant risk to seabed carbon stocks because of the impact it has on seabed sediments (Luisetti et al., 2019).

The effective management of seabed areas in relation to sedimentary carbon disturbance will ultimately depend on the environmental settings as well as the chemical characteristics of the carbon (e.g. reactivity) (Epstein and Roberts, 2022; Smeaton and Austin, 2022). The resuspended carbon in the sediment could possibly make its way into the atmosphere and a lack of direct evidence should not prevent us making recommendations to offset the risk.

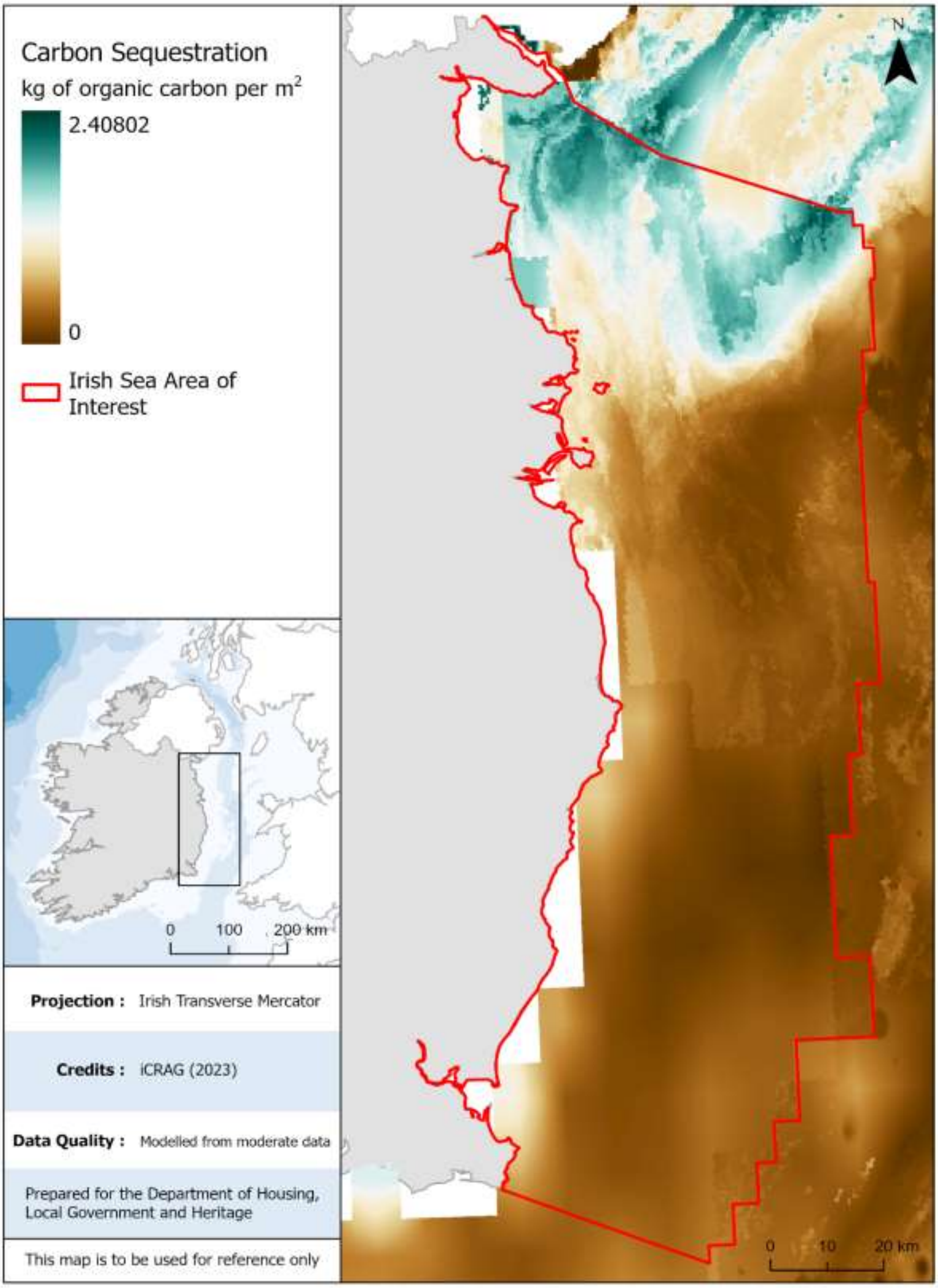

Figure 1. Modelled distribution of carbon content of sediments in the western Irish Sea.

Data sources and quality

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Diesing Carbon Sequestration	Diesing	Modelled from moderate data		
Smeaton Carbon Sequestration	Smeaton	Modelled from moderate data		
Wilson Carbon Sequestration	Wilson	Modelled from moderate data		

References

Atwood, T. B., Witt, A., Mayorga, J., Hammill, E., and Sala, E. (2020). Global patterns in marine sediment carbonstocks. *Frontiers in Marine Science*, *7*(March), 1–9. https://doi.org/10.3389/fmars.2020.00165

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39. Western Irish Sea Front

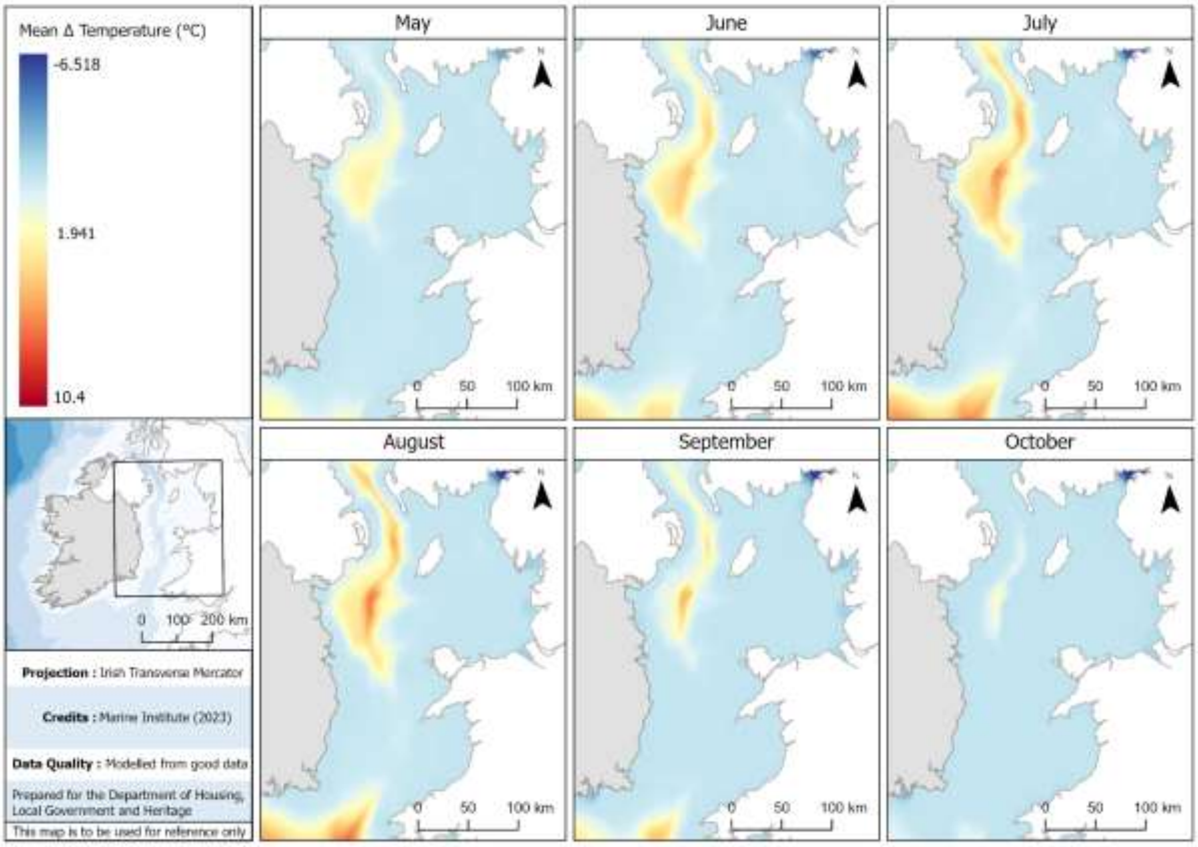

Figure 1: Satellite image of mean sea surface temperature (SST) change in the western Irish Sea, which shows the presence of the Western Irish Sea Front along the southern boundary of the warm stratified water © Marine Institute (2023).

Background

Physical characteristics

The Western Irish Sea Front marks a boundary between tidally mixed and stratified bodies of water in the Irish Sea during the spring and summer months (Hill et al., 1997; Simpson et al., 2009; Simpson and Hunter, 1974). The area between the Irish northeast coast and the Isle of Man is the deepest section of the Irish Sea and thus, where tidal energy becomes relatively weak. As a result, surface heating in the spring and summer leads to warming of the surface waters and a stabilization or stratification of the water column (Simpson and Hunter, 1974). Through May, June, and July the heating of the surface continues and the temperature difference between the stratified and mixed water can exceed 3° C (Simpson and Hunter, 1974). The horizontal temperature gradients extend downward to some extent and lead to the creation of the seasonal near surface gyre, which effectively becomes an isolated body of water with minimal exchange between adjacent mixed water (Hill et al., 1997; Simpson et al., 2009). As the thermal stratification intensifies at the surface, a residual cold dome of water is retained beneath which drives a lateral flow (baroclinic flow) across the front (Hill et al., 1997). The position of the front does not vary to any great degree from year to year and its presence is readily detectable due to pronounced changes in the colour of the sea, and aggregations of neuston due to convergent flows near the surface (Simpson and Hunter, 1974).

Ecological significance

The presence of the Western Irish Sea Front is ecologically significant, with important implication of organisms at all levels of the pelagic ecosystem. Frontal systems similar to the Western Irish Sea Front can form a distinct boundary between phytoplankton and zooplankton assemblages, enhance primary productivity, physically aggregate plankton, provide enhanced foraging for planktivorous fauna, which in turn provides enhanced foraging for large megafauna (seabirds, mammals, large fish, and sharks) (Acha et al., 2015; Cox et al., 2018; Davenport and Rees, 1993; Le Fevre, 1987; Scales et al., 2014).

Some studies in the past have indicated relatively high primary productivity at the Western Irish Sea Front (Richardson et al., 1985), however, more recent work suggests that anthropogenic nutrients are a controlling influence over primary productivity (Allen et al., 1998). These measurements were carried out repeatedly while stratification was present in a single season and indicate persistent higher values at the front (Richardson et al., 1985). Aggregations of neuston, including seaweed and associated larval fish species were found associated with fronts in the Irish Sea (Davenport and Rees, 1993). Larval fish in their first year, planktonic nephrops, and large zooplankton are found in high concentrations within the in the stratified water of the western Irish Sea (Dickey-Collas et al., 1996; Gowen et al., 1998; Hill et al., 1996), and the gyre provides a mechanism by which they are entrained and retained within the gyre (Dickey-Collas et al., 1996). These are all prey species for large fauna and the convergent flows at a front provide a mechanism which can aggregate and make these prey more available. Direct evidence of this is lacking, however, multiple seabirds forage along the western Irish Sea Front, periodically moving to maintain their position on the front (Dean et al., 2013; Durazo et al., 1998). The use of satellite tracking has demonstrated that Manx shearwaters (*Puffinus puffinus*) forge at the western Irish Sea Front and it has now been designated as an Special Protection Area (SPA) (JNCC, 2016). There is compelling and growing evidence that many frontal systems are important hot spots of pelagic biodiversity (Acha et al., 2015; Cox et al., 2018; Scales et al., 2014). Harbour porpoise use the Celtic Sea Front and respond to changes in the front position (Cox et al., 2018), indeed, the offshore migration of common dolphins is possibly linked to the seasonal breakdown of the Celtic Sea Front (Goold, 1998).

Rationale for spatial protection in the western Irish Sea

The Western Irish Sea Front is an area of ecological importance. Studies on seabirds have highlighted the importance of the area for forging and it likely that marine mammals, teleost fish and shark species also utilize the front (Cox et al., 2018; Scales et al., 2014).

The Western Irish Sea Front is not specifically protected by current legislation; however, protection of all pelagic habitats is laid down in the Marine Strategy Framework Directive (Directive 2008/56/EU). Several of the eleven qualitative descriptors in the MSFD relate to pelagic habitats and arguably support protection of frontal systems as a component of Good Environmental Status more generally in the Irish Sea.

Descriptor 1 - *Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.*

Descriptor 4 - *All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.*

Descriptor 7 – *Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.*

Descriptor 11 – *Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.*

The Western Irish Sea Front is amenable to spatial protection, which in turn also confers protection on a broad range of species which use the front. The Western Irish Sea Front is a predictable and seasonally persistent feature, which makes it amenable to spatial protection. There is also a precedent for protecting frontal systems; the Manx shearwaters SPA in the Irish Sea and the Pelagos Sanctuary in the Mediterranean Sea ("Pelagos Sanctuary official website," n.d.) explicitly target frontal systems and the species that use them. The Pelagos Sanctuary is also an example of transboundary management by three countries.

Sensitivity assessment

The western Irish Sea Front sensitivity assessment was based on the potential sensitivity of the front to the pressure 'changed water flow'. While other habitat assessments focused on characteristic species thought to be most sensitive, the range of species which use fronts is prohibitively large and varied and a species lead approach was therefore deemed unfeasible.

As such, this assessment was based on a literature review of all the relevant literature studying the impact of offshore wind turbines on local and regional hydrographic processes. There are two mechanisms relevant to wind farms that will create a wake. 1) Current flows flowing around infrastructure will create a wake effect, and 2) wind flow over and around an array of turbines and blades will create a wind shear that can generate vertical rotation in the water column, i.e., upwelling and downwelling (Ludewig, 2015). The individual wake created by each turbine may increase vertical mixing, scouring the seabed around structures, and resuspending sediments, i.e., increased turbidity (Carpenter et al., 2016; Lange et al., 2010; Ludewig, 2015). The turbulent wake is rapidly attenuated downstream of the turbine, becoming undetectable less than 1000 m downstream, although resuspended fine particulate matter may still be in suspension much further downstream. An assessment of a fixed bottom OWF off Germany, using hydrodynamic modelling, demonstrated no major impact of a monopile turbine on turbidity, nor was there a cumulative effect of multiple monopiles found (Lange et al., 2010).

Large turbine arrays will create wind shadows where the surface currents within and downstream of the array are reduced in speed, causing increases in surface temperatures, and thus intensifying stratification and altering thermocline depths (Christiansen et al., 2022). The changes in surface currents in turn changes the sea surface level, which creates large areas of upwelling and downwelling on the downstream side of the wind farm (Christiansen et al., 2022; Ludewig, 2015). While these changes are large in scale (>60 km), they are relatively small and within natural interannual variation (Christiansen et al., 2022), therefore, the potential sensitivity of the Western Irish Sea Front to these effects is assessed as low. However, this assessment should be kept under review as this area of research is relatively new and further research is needed.

Further research needs

While the sensitivity of frontal systems to wind farm created wakes is assessed as low, there is very little research on the potential impacts of increased sediment resuspension and turbidity due to ORE developments. Increased turbidity is recognised as a pressing ecological issue in recent years (Blain et al., 2021; Herbert-Read et al., 2022). Increasing wave energy, land use, and coastal eutrophication are causing increased turbidity in coastal regions globally and this has negative implications for fundamental ecological processes such as primary productivity and biogeochemical cycling. In the context of ORE developments, a large-scale reduction in bottom trawling will most likely reduce turbidity as trawling can re-suspend sediment and organic matter (Linders et al., 2018). Conversely, increased vertical mixing and upwelling because of multiple large wind farms may increase turbidity, however, this is purely speculative at this time. Research at existing wind farms can address some of these knowledge gaps with an increased focus on in situ sampling to inform better hydrodynamic modelling and prediction of environmental impacts. This means building collaborative research projects between Irish and European researchers to access these sites in other countries.

Data Sources

Dataset Name	Data Owning Organisation	Dataset Quality	Metadata URL	Comments
Marine Institute Oceanographic Models	Marine Institute	Modelled from good data		

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40. European Flat Oyster (*Ostrea edulis*)

Figure 1. European flat oyster, *Ostrea edulis* ©Dr Keith Hiscock (marlin.ac.uk)

Background

The native oyster *Ostrea edulis* has an oval or pear-shaped shell with a rough, scaly surface. The two halves (valves) of the shell are different shapes. The left valve is concave and fixed to the substratum, the right being flat and sitting inside the left. The shell is off-white, yellowish or cream in colour with light brown or bluish concentric bands on the right valve. The inner surfaces are pearly, white or bluish-grey, often with darker blue areas they grow up to 11 cm long, rarely larger. *Ostrea edulis* is associated with highly productive estuarine and shallow coastal water habitats on firm bottoms of mud, rocks, muddy sand, muddy gravel with shells and hard silt. In exploited areas, suitable habitat is/has been created in the form of 'cultch' - broken shells and other hard substrata. A lifespan of 5-10 years is probably typical as the majority of individuals in populations are 2-6 years old. The native oyster starts life as male, becoming mature at around 3 years of age. After spawning the oyster becomes a functional female. Gamete maturation begins in March or April and is in part temperature dependent. On the west coast of Ireland there is at least one spawning in each sexual phase during the summer. There may be some periodicity in spawning with peaks during full moon periods and fecundity may be as high as 2,000,000 in large individuals (Perry et al., 2017).

Rationale for spatial protection in the western Irish Sea

Ostrea edulis is listed by OSPAR with reference to its severe decline and sensitivity and was therefore nominated for inclusion on the feature list. This species is an ecosystem engineer providing habitat for biodiversity and is of historical significance. *Ostrea edulis* were once very common around the coast of Ireland but have now virtually disappeared due to overexploitation and habitat loss, however there is potential for restoration and reintroduction of the species to suitable areas.

Sensitivity assessment

***Ostrea edulis* are highly sensitive to pressure associated with construction and operation of ORE.** All marine habitats and benthic species are considered to have a resistance of 'None' to physical loss (to land or freshwater habitat) and to be unable to recover from a permanent loss of habitat (resilience is 'Very Low')(high confidence)(Tyler-Walters et al., 2018). *O. edulis* is highly sensitive to habitat structure change (medium confidence). The removal of the substratum would lead to the loss of the biogenic layer created by oysters and its biological community, the oyster cultch (which will remove an important chemical cue used by larvae when settling), and the substratum which provides a point of attachment for larvae. *O. edulis* is also highly sensitive to light and heavy smothering and siltation rate changes (medium sensitivity). As filter feeders that are permanently attached to the substratum, they would be unable to borrow up to the surface. In the low energy environments in which populations of this species develop, the deposited sediment is likely to remain for several tidal cycles, depending on local hydrography (Perry et al., 2017).

***Ostrea edulis* are highly sensitive to pressure associated with the fishing sector.** *Ostrea edulis* is somewhat resistant to some abrasion and is able to recover from some damage to shells. However, damage caused to oyster beds and their habitats by commercial fishing is considered to be of importance to levels of mortality and health of oyster beds and is therefore assessed as highly sensitive (medium confidence). Additionally, the effect of subsurface disturbance will be to displace, damage and remove individuals. Therefore, resistance is assessed as 'Low'. Resilience is assessed as 'Low' and sensitivity is, therefore, assessed as 'High' (medium confidence). *O. edulis* is also highly sensitive to a change in suspended solids (medium confidence). A short-term increase in sedimentation is likely to have an impact on *Ostrea edulis*. *Ostrea edulis* has a coping mechanism to remove increased levels of silt from within the mantle. This behaviour is energetically expensive, and may cause a decrease in growth rate of the organism, but is unlikely to cause mortality. However, at the level of the benchmark, there will be mortality as the level of sediment in the water column will exceed that of what the organism can survive (Perry et al., 2017).

***Ostrea edulis* are assessed as highly sensitive to the introduction or spread of invasive non-indigenous species (medium confidence), a pressure associated with the shipping sector.** Depending on which invasive species is introduced, *Ostrea edulis* may remain. Resistance is assessed as 'Low', a resilience of 'Very low' has been recorded since the successful removal of an invasive species is extremely rare which will mean that the habitat is likely to change. Therefore, sensitivity is assessed as 'High'. Due to the constant risk of new invasive species, the literature for this pressure should be revisited (Perry et al., 2017).

Further research needs

In order for restoration priority areas will need to be identified. In addition, a number of pressures were not assessed for *O. edulis* due to a lack of evidence. These include transition elements & organo-metal contamination, hydrocarbon & PAH contamination, synthetic compound contamination, introduction of other substances and electromagnetic energy.

Figure 2. Global distribution of *Ostrea edulis*, Source: https://mapper.obis.org/?taxonid=140658

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Appendix 11 Sensitivity analyses

1. American plaice or long rough dab (*Hippoglossoides platessoides)*

Sensitivity Assessment

Table 1. Sensitivity assessment for American plaice (*Hippoglossoides platessoides*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another seabed type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another sediment type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M
	Habitat structure change-removal of substratum (extraction)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Penetration or disturbance of	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

	substratum subsurface												

Table 1. cont. Sensitivity assessment for American plaice (*Hippoglossoides platessoides*).

Pressures		**Associated sector(s)**	**Resistance**				**Resilience**				**Sensitivity**			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
Physical	**Changes in suspended solids (water clarity)**	**O, F**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Smothering and siltation changes (light)	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Smothering and siltation changes (heavy)	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Underwater noise	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Barrier to species movement	**O, F**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrological	**Water flow changes**	**O**	H	L	L	L	H	L	L	L	NS	L	L	L
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

Table 1. cont. Sensitivity assessment for American plaice (*Hippoglossoides platessoides*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Deoxygenation	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Organic enrichment	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Removal of target species	F	L	H	H	H	M	M	M	M	M	M	M	M
	Removal of non-target species	F	M	M	M	M	M	M	M	M	M	M	M	M

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Literature search

Web of Science search terms

AB=(" American plaice" OR "long rough dab" OR "Hippoglossoides platessoides" OR "H. platessoides" OR “H. p. limandoides”)

AND AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR “ "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Database

ISI Web of Science

Search date
14th March 2023 - 214 results

Search output and screening process
Abstracts screened for relevance i.e., must describe witch flounder and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
Thirty abstracts passed initial screening. Of these, ten did not pass secondary screening (i.e., on further reading were determined as not relevant), two could not be accessed and therefore applicability could not be determined, and eighteen passed secondary screening and were accessible. Sensitivity assessments were therefore made based on evidence provided by the resultant eighteen papers supplemented with the latest IUCN Red List assessments.

2. Angel shark (*Squatina squatina)*

Sensitivity Assessment

Table 1. Sensitivity assessment for angel shark (*Squatina squatina*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	None	L	NR	NR	VL	L	NR	NR	H	L	NR	NR	
	Physical change (to another seabed type)	O, F	M	L	L	L	M	L	L	L	M	L	L	L	
	Physical change (to another sediment type)	O, F	M	L	L	L	M	L	L	L	M	L	L	L	
	Habitat structure change-removal of substratum (extraction)	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Penetration or disturbance of substratum subsurface	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-

Table 1. Sensitivity assessment for angel shark (*Squatina squatina*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	-
	Smothering and siltation changes (light)	O	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	-
	Smothering and siltation changes (heavy)	O	M	L	L	L	H	L	L	L	L	L	L	L	-
	Underwater noise	O, F, S	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	-
	Electromagnetic energy	O	M	L	L	L	H	L	L	L	L	L	L	L	-
	Barrier to species movement	O, F	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Death or injury by collision	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
Hydrological	Water flow changes	O	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR	-

Table 1. Sensitivity assessment for angel shark (*Squatina squatina*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR	-
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR	-
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Deoxygenation	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Organic enrichment	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Removal of target species	F	L	H	H	H	L	H	H	H	H	H	H	H	
	Removal of non-target species	F	L	H	H	H	L	H	H	H	H	H	H	H	

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Web of Science search terms
AB=("Angel shark" OR "Squatina spp." OR "Squatina squatina" OR "S. squatina") AND AB=("angl*" OR "beam" OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR "gear" OR "gillnet*" OR "hook*" OR "injury" OR "net*" OR "otter trawl*" OR "remov*" OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR "ship*" OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR "deoxy*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR "exposure" OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter*" OR "non-native*" OR "nitrate*" OR "nitrite*" OR "noise" OR "radionuclide" OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR "regime" OR "sedimentation" OR "silt*" OR "tributyltin" OR "turbid*")

Search date
8th March 2023 - 65 results

Search output and screening process
Abstracts screened for relevance i.e., must describe angel shark and mention one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
Of the 65 papers retrieved in the Web of Science search, 26 (40%) passed initial screening for relevance and 26 (40%) were accessible.

3. Basking shark (*Cetorhinus maximus)*

Sensitivity Assessment

Wilding, C.M., Wilson, C.M. & Tyler-Walters, H. 2020. *Cetorhinus maximus* Basking shark. In Tyler-Walters H. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 01-05-2023]. Available from: https://www.marlin.ac.uk/species/detail/1438

Table 1. Sensitivity assessment for basking shark (Cetorhinus maximus). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	H	L	NR	NR	H	L	H	H	Not sensitive	L	L	L	
	Physical change (to another seabed type)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Physical change (to another sediment type)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Habitat structure change-removal of substratum	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Abrasion/disturbance of substratum surface or seabed	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Penetration or disturbance of	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-

	substratum subsurface														

Table 1. Sensitivity assessment for basking shark (*Cetorhinus maximus*) cont.

Pressures		**Associated sector(s)**	**Resistance**				**Resilience**				**Sensitivity**				**References**
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Changes in suspended solids (water clarity)**	**O, F**	H	M	M	M	H	H	H	H	Not sensitive	M	M	M	-
	Smothering and siltation changes (light)	**O**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Smothering and siltation changes (heavy)	**O**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Underwater noise	**O, F, S**	H	L	NR	NR	H	H	H	H	Not sensitive	L	L	L	-
	Electromagnetic energy	**O**	H	L	NR	NR	H	H	H	H	Not sensitive	L	L	L	-
	Barrier to species movement	**O, F**	H	L	NR	NR	H	H	H	H	Not sensitive	L	L	L	-
	Death or injury by collision	**O, F, S**	M	L	NR	NR	M	L	NR	NR	M	L	L	L	-
Hydrological	**Water flow changes**	**O**	H	L	NR	NR	H	H	H	H	Not sensitive	L	L	L	

Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-

Table 1. Sensitivity assessment for basking shark (*Cetorhinus maximus*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Deoxygenation	O	H	L	NR	NR	H	H	H	H	Not Sensitive	L	L	L	-
	Organic enrichment	O	H	L	NR	NR	H	H	H	H	Not Sensitive	L	L	L	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Removal of target species	F	L	H	H	M	L	L	NR	NR	H	L	L	L	
	Removal of non-target species	F	M	M	M	M	M	L	NR	NR	M	L	L	L	

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4. Blonde ray (*Raja brachyura)*

Sensitivity Assessment

Table 1. Sensitivity assessment for blonde ray (*Raja brachyura*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	M	L	L	NR	M	L	L	NR	M	L	L	NR	-
	Physical change (to another seabed type)	O, F	M	L	L	NR	M	L	L	NR	M	L	L	NR	-
	Physical change (to another sediment type)	O, F	M	M	H	NR	H	M	H	NR	L	M	H	NR	6,8,10,15,16,18, 19
	Habitat structure change-removal of substratum (extraction)	O	M	M	H	NR	NEv	M	H	NR	L	M	H	NR	5,18
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Penetration or disturbance of substratum subsurface	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-

Table 1. Sensitivity assessment for blonde ray (*Raja brachyura*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Smothering and siltation changes (light)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NEv	NR	NR	-
	Smothering and siltation changes (heavy)	O	M	L	L	NR	M	L	L	NR	M	M	L	L	-
	Underwater noise	O, F, S	H	L	L	NR	H	L	L	NR	Not sensitive	H	L	L	-
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NEv	NR	NR	-
	Barrier to species movement	O, F	M	L	L	NR	H	L	L	NR	L	M	L	L	-
	Death or injury by collision	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NEv	NR	NR	-
Hydrological	Water flow changes	O	M	L	M	NR	H	L	M	NR	L	L	M	NR	6,7
Chemical	Transition elements & organo-metal contamination	O, F, S	NEv	L	M	NR	H	L	M	NR	Sensitive	NEv	L	M	-

Table 1. Sensitivity assessment for blonde ray (*Raja brachyura*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	L	M	NR	H	L	M	NR	Sensitive	L	M	NR	-
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Deoxygenation	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Organic enrichment	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Removal of target species	F	L	H	H	H	L	H	H	H	H	H	H	H	1,3,4,6,9, 14,15,17, 20
	Removal of non-target species	F	L	H	H	H	L	H	H	H	H	H	H	H	2,5,11,12 ,13,14,15 ,17,18

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Literature search

Web of Science search terms
AB=("blonde ray*" OR "blonde skate*" OR "Raja brachyura" OR "R. brachyura") AND AB=("angl*" OR "beam" OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR "gear" OR "gillnet*" OR "hook*" OR "injury" OR "net*" OR "otter trawl*" OR "remov*" OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR "ship*" OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR "deoxy*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR "exposure" OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter*" OR "non-native*" OR "nitrate*" OR "nitrite*" OR "noise" OR "radionuclide" OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR "regime" OR "sedimentation" OR "silt*" OR "tributyltin" OR "turbid*")

Search date
1st March - 28 results

https://www.webofscience.com/wos/woscc/summary/0b00f8f6-ddbe-4cb9-afad-dc14d8527a84-74aadd4e/relevance/1

Search output and screening process
Abstracts screened for relevance i.e. must describe porbeagle sharks and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
Of the 28 articles, 25 (89%) passed initial screening. Of these 25, 3 (12%) were excluded during secondary screening for relevance, and 1 (4%) text was available. In total, 20 papers were used to conduct the subsequent sensitivity assessment.

5. Bull huss (*Scyliorhinus stellaris)*

Sensitivity Assessment

Table 1. Sensitivity assessment for bull huss (*Scyliorhinus stellaris*). Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	M	L	L	NR	M	L	L	NR	M	L	L	NR	-
	Physical change (to another seabed type)	O, F	M	H	H	NR	M	L	L	NR	M	L	L	NR	-
	Physical change (to another sediment type)	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	4, 5
	Habitat structure change-removal of substratum (extraction)	O	H	M	L	NR	M	L	L	NR	L	L	L	NR	-
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Penetration or disturbance of substratum subsurface	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-

Table 1. cont. Sensitivity assessment for bull huss (*Scyliorhinus stellaris*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Smothering and siltation changes (light)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Smothering and siltation changes (heavy)	O	M	L	L	NR	M	L	L	NR	M	L	L	NR	-
	Underwater noise	O, F, S	H	L	L	NR	H	L	L	NR	Not sensitive	L	L	NR	-
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Barrier to species movement	O, F	M	L	L	NR	H	L	L	L	L	L	L	L	-
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Hydrological	Water flow changes	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
Chemical	Transition elements & organo-metal contamination	O, F, S	NEv	M	H	NR	H	H	H	NR	Sensitive	M	H	NR	6

Table 1. cont. Sensitivity assessment for bull huss (*Scyliorhinus stellaris*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	M	H	NR	H	H	H	NR	Sensitive	M	H	NR	-
	Synthetic compound contamination	O, F, S	NEv	L	NR	NR	H	L	NR	NR	Sensitive	L	NR	NR	-
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Deoxygenation	O	NR	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Organic enrichment	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Removal of target species	F	L	NR	NR	NR	L	NR	NR	NR	H	NR	NR	NR	1, 2, 3, 5, 6
	Removal of non-target species	F	L	H	H	H	M	H	H	H	M	H	H	H	1, 2, 3, 5, 6

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Literature search

Web of Science search terms
AB=("Bull huss" OR "Nursehound" OR "large-spotted dogfish" OR "greater spotted dogfish" OR "Scyliorhinus stellaris" OR "S. stellaris") AND AB=("angl*" OR "beam" OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR "gear" OR "gillnet*" OR "hook*" OR "injury" OR "net*" OR "otter trawl*" OR "remov*" OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR "ship*" OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR "deoxy*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR "exposure" OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter*" OR "non-native*" OR "nitrate*" OR "nitrite*" OR "noise" OR "radionuclide" OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR "regime" OR "sedimentation" OR "silt*" OR "tributyltin" OR "turbid*")

Search date
3rd February 2023- 25 results

Search output and screening process

Abstracts screened for relevance i.e. must describe bull huss and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening

Of the 25 papers retrieved in the Web of Science search, 7 (28%) passed initial screening for relevance and 4 (58%) were accessible. The most recent ICES advice (2021) was subsequently added to the list of available literature. One related publication using productivity susceptibility analyses added as a result of broader reading (McCully Phillips, 2015). In total this report was generated based on 6 available sources and expert judgement.

6. Cuckoo ray (*Leucoraja naevus)*

Sensitivity Assessment

Table 1. Sensitivity assessment for cuckoo ray (Leucoraja naevus). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	None	L	NR	NR	VL	L	NR	NR	H	L	NR	NR	
	Physical change (to another seabed type)	O, F	H	L	L	L	M	L	L	L	L	L	L	L	
	Physical change (to another sediment type)	O, F	H	L	L	L	M	L	L	L	L	L	L	L	
	Habitat structure change-removal of substratum (extraction)	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Abrasion/disturbance of substratum surface or seabed	O, F	M	L	L	L	M	L	L	L	M	L	L	L	-
	Penetration or disturbance of substratum subsurface	O, F	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-

Table 1. Sensitivity assessment for cuckoo ray (*Leucoraja naevus*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	-
	Smothering and siltation changes (light)	O	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	-
	Smothering and siltation changes (heavy)	O	L	L	L	L	M	L	L	L	M	L	L	L	-
	Underwater noise	O, F, S	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	-
	Electromagnetic energy	O	M	L	L	L	H	L	L	L	L	L	L	L	-
	Barrier to species movement	O, F	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	-
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NEv	NR	NR	-
Hydrological	Water flow changes	O	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR	-

Table 1. Sensitivity assessment for cuckoo ray (*Leucoraja naevus*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR	-
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR	-
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Deoxygenation	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Organic enrichment	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Removal of target species	F	L	M	M	M	M	M	M	M	M	M	M	M	
	Removal of non-target species	F	L	M	M	M	M	M	M	M	M	M	M	M	

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Web of Science search terms

AB=("cuckoo ray" OR "Leucoraja naevus" OR "L. naevus" OR "Leucoraja spp." OR "Leucoraja species") AND AB=("angl*" OR "beam" OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR "gear" OR "gillnet*" OR "hook*" OR "injury" OR "net*" OR "otter trawl*" OR "remov*" OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR "ship*" OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR "deoxy*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR "exposure" OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter*" OR "non-native*" OR "nitrate*" OR "nitrite*" OR "noise" OR "radionuclide" OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR "regime" OR "sedimentation" OR "silt*" OR "tributyltin" OR "turbid*")

Search date

20th March 2023 - 21 results using the search terms.

Search output and screening process

Abstracts screened for relevance i.e., must describe Spurdog and mention one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening

Of the 21 papers retrieved in the Web of Science search, 10 (48%) passed initial screening for relevance and 9 (43%) were accessible.

Note that no sensitivity analysis was completed for Dog Whelk.

8. Edible Sea Urchin (*Echinus esculentus)*

Sensitivity Assessment

Table 1. Sensitivity assessment for Edible Sea Urchin (*Echinus esculentus*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	-
	Physical change (to another seabed type)	O, F	N	L	NR	NR	VL	L	NR	NR	H	L	NR	NR	-
	Physical change (to another sediment type)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Habitat structure change-removal of substratum (extraction)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Abrasion/disturbance of substratum surface or seabed	O, F	M	H	M	M	H	M	M	M	L	M	M	M	2, 7, 12
	Penetration or disturbance of substratum subsurface	O, F	M	H	M	M	H	M	M	M	L	M	M	M	2, 7, 12

Table 1. cont. Sensitivity assessment for Edible Sea Urchin (*Echinus esculentus*). Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Refs
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Changes in suspended solids (water clarity)**	**O, F**	H	L	L	NR	H	M	M	M	NS	M	L	L	3, 11, 13
	Smothering and siltation changes (light)	**O**	H	L	L	NR	H	L	L	L	NS	L	L	M	3, 13
	Smothering and siltation changes (heavy)	**O**	M	L	L	NR	H	M	M	M	L	L	L	L	3
	Underwater noise	**O, F, S**	NEv	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Hydrological	**Water flow changes**	**O**	H	L	L	NR	H	L	L	NR	NS	L	L	NR	
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	L	L	L	L	H	L	L	L	L	L	L	L	4, 5, 10

Table 1. cont. Sensitivity assessment for Edible Sea Urchin (*Echinus esculentus*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	L	M	M	M	H	M	M	M	L	M	M	M	4, 5, 15
	Synthetic compound contamination	O, F, S	L	M	M	M	H	M	M	M	L	M	M	M	5, 15
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	-
	Deoxygenation	O	L	L	L	L	H	L	L	L	L	L	L	L	6
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Removal of target species	F	M	L	L	NR	H	M	M	M	L	M	M	M	-
	Removal of non-target species	F	M	M	M	M	H	M	M	M	L	M	M	M	2, 7, 9

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Literature search

Web of Science search terms
(“edible sea urchin” OR “*echinus esculentus” OR “e. esculentus”*) AND ("angl*" OR “beam” OR "bottom trawl*" "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*”) OR ("aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming") OR ("collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*") OR ("anoxia" OR "copper" OR "current*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter" OR "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR “oil” OR "PAH*" OR "pathogen*" OR "PCB*" OR "plastic*" OR “regime” OR “salinity” OR "sedimentation" OR "silt*" OR “temperatur*” OR “translocation” OR "tributyltin" OR “turbid*” OR “visual” OR "warm*")

Database
ISI Web of Science

Search date
1st March 2023 - 98 results

Search output and screening process
Abstracts screened for relevance i.e. must describe edible sea urchins and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
Of the 98 papers retrieved by the Web of Science search, 36 (35%) abstracts passed initial screening.

9. European Eel *(Anguilla anguilla)*

Sensitivity Assessment

No MarESA or FeAST sensitivity assessments for European eel were available. However, there was an OSPAR status assessment in 2022 that covered the majority of the identified pressures. To address the remaining pressures and to identify key considerations in the western Irish Sea, an external expert in the subject area was consulted. The following sensitivity assessment is therefore based on the OSPAR assessment supplemented with key literature (as such no individual resistance or resilience scores are available).

Table 1. Sensitivity assessment for European Eel (Anguilla anguilla) NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O									H	M	M	M
	Physical change (to another seabed type)	O, F									NEv	NR	NR	NR
	Physical change (to another sediment type)	O, F									NEv	NR	NR	NR
	Habitat structure change-removal of substratum (extraction)	O									NEv	NR	NR	NR

Table 1. cont. Sensitivity assessment for European Eel (*Anguilla anguilla*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Abrasion/disturbance of substratum surface or seabed	O, F									NEv	NR	NR	NR
	Penetration or disturbance of substratum subsurface	O, F									NEv	NR	NR	NR
	Changes in suspended solids (water clarity)	O, F									NEv	NR	NR	NR
	Smothering and siltation changes (light)	O									NEv	NR	NR	NR
	Smothering and siltation changes (heavy)	O									NEv	NR	NR	NR
	Underwater noise	O, F, S									L	L	M	L
	Electromagnetic energy	O									M	H	H	M
	Barrier to species movement	O, F									H	H	H	H
	Death or injury by collision	O, F, S									NEv	NR	NR	NR
Hydrological	Water flow changes	O									NEv	NR	NR	NR

Table 1. cont. Sensitivity assessment for European Eel (*Anguilla anguilla*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Transition elements & organo-metal contamination	O, F, S									Sensitive	L	M	M
	Hydrocarbon & PAH contamination	O, F, S									Sensitive	L	M	M
	Synthetic compound contamination	O, F, S									NEv	NR	NR	NR
	Introduction of other substances	O, F, S									NEv	NR	NR	NR
	Deoxygenation	O									NEv	NR	NR	NR
	Organic enrichment	O									NR	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S									Sensitive	NR	NR	NR
	Removal of target species	F									H	H	M	H
	Removal of non-target species	F									H	H	M	H

Key references for sensitivity assessment

ICES 2022. European eel (*Anguilla anguilla*) throughout its natural range. In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, ele.2737.nea, https://doi.org/10.17895/ices.advice.19772374

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Westerberg, H. and Lagenfelt, I. (2008), Sub-sea power cables and the migration behaviour of the European eel. Fisheries Management and Ecology, 15: 369-375. https://doi.org/10.1111/j.1365-2400.2008.00630.x

10. Icelandic cyprine (Ocean quahog) (*Arctica islandica)*

Sensitivity Assessment

Assessed by MaRLIN see Tyler-Walters, H. & Sabatini, M. 2017. *Arctica islandica* Icelandic cyprine. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1519

Table 1. Sensitivity assessment for icelandic cyprine (Ocean quahog) *Arctica islandica*. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another seabed type)	O, F	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another sediment type)	O, F	L	L	NR	NR	VL	H	H	H	H	L	L	L	See full reference list below
	Habitat structure change-removal of substratum	O	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Abrasion/disturbance of substratum surface or seabed	O, F	L	H	H	M	VL	H	M	M	H	H	M	M	See full reference list below
	Penetration or disturbance of subsurface	O, F	L	H	H	M	VL	H	M	M	H	H	M	M	See full reference list below

Table 1. cont. **Sensitivity assessment for icelandic cyprine (Ocean quahog)** ***Arctica islandica*****.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Changes in suspended solids (water clarity)**	**O, F**	H	L	NR	NR	H	H	H	H	NS	L	L	L	See full reference list below
	Smothering and siltation changes (light)	**O**	H	H	H	M	H	H	H	H	NS	H	H	M	See full reference list below
	Smothering and siltation changes (heavy)	**O**	H	H	H	M	H	H	H	H	NS	H	H	M	See full reference list below
	Underwater noise	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See full reference list below
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See full reference list below
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See full reference list below
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See full reference list below
Hydrological	**Water flow changes**	**O**	H	L	NR	NR	H	H	H	H	NS	L	L	L	See full reference list below
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	See full reference list below

Table 1. cont. Sensitivity assessment for icelandic cyprine (Ocean quahog) *Arctica islandica.*

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	See full reference list below
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	See full reference list below
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	See full reference list below
	Deoxygenation	O	H	H	H	H	H	H	H	H	NS	H	H	H	See full reference list below
	Organic enrichment	O	H	M	L	M	H	H	H	H	NS	M	L	M	See full reference list below
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NR	NR	NR	NR	NEV	NR	NR	NR	See full reference list below
	Removal of target species	F	L	H	H	L	VL	H	M	M	H	H	M	L	See full reference list below
	Removal of non-target species	F	L	H	M	M	VL	H	M	M	H	H	M	M	See full reference list below

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11. Pink sea fan (*Eunicella verrucosa)*

Sensitivity Assessment

Assessed by MaRLIN see Readman, J.A.J. & Hiscock, K. 2017. *Eunicella verrucosa* Pink sea fan. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 27-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1121

Table 1. Sensitivity assessment for Pink sea fan *Eunicella verrucosa*. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another seabed type)	O, F	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another sediment type)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Habitat structure change-removal of substratum	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Abrasion/ disturbance of substratum surface	O, F	L	M	M	L	M	M	M	M	M	M	M	L	See full reference list below
	Penetration or disturbance of substratum subsurface	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

Table 1. cont. Sensitivity assessment for Pink sea fan *Eunicella verrucosa*. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Refs
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	H	M	M	M	H	H	H	H	NS	M	M	M	See full reference list below
	Smothering and siltation changes (light)	O	H	M	M	M	H	H	H	H	NS	M	M	M	See full reference list below
	Smothering and siltation changes (heavy)	O	L	L	NR	NR	M	M	M	M	M	L	L	L	See full reference list below
	Underwater noise	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Electromagnetic energy	O	NEv	NR	NR	NR	NR	NR	NR	NR	NEv	NR	NR	NR	
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Hydrological	Water flow changes	O	H	M	L	M	H	H	H	H	NS	M	L	M	See full reference list below
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	

Table 1. cont. Sensitivity assessment for Pink sea fan *Eunicella verrucosa*.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Deoxygenation	O	L	L	NR	NR	M	M	M	M	M	L	L	L	See full reference list below
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	M	M	L	M	M	M	M	M	M	M	L	M	See full reference list below
	Removal of target species	F	N	L	NR	NR	L	M	M	M	H	L	L	L	See full reference list below
	Removal of non-target species	F	L	L	NR	NR	M	M	M	M	M	L	L	L	See full reference list below

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12. Short snouted seahorse (*Hippocampus hippocampus*)

Sensitivity Assessment

Assessed by MaRLIN see Sabatini, M., Nash, R.A. & Ballerstedt, S. (2021) *Hippocampus hippocampus* Short snouted seahorse. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 24-02-2023]. Available from: https://www.marlin.ac.uk/species/detail/1788 (Accessed 24th February 2023).

Table 1. Sensitivity assessment for short snouted seahorse (*Hippocampus hippocampus*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	NR	NR	NR
	Physical change (to another seabed type)	O, F	H	M	M	M	H	H	H	H	NS	L	L	L
	Physical change (to another sediment type)	O, F	H	L	NR	NR	H	H	H	H	NS	L	L	L
	Habitat structure change-removal of substratum	O	H	L	NR	NR	H	H	H	H	NS	L	L	L
	Abrasion/ disturbance of substratum surface	O, F	L	H	M	M	M	M	M	M	M	M	M	M
	Penetration or disturbance of substratum subsurface	O, F	L	L	NR	NR	M	M	M	M	M	L	L	L

Table 1. cont. Sensitivity assessment for short snouted seahorse (H*ippocampus hippocampus*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Changes in suspended solids (water clarity)	O, F	M	L	NR	NR	H	M	M	M	L	L	L	L
	Smothering and siltation changes (light)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Smothering and siltation changes (heavy)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Underwater noise	O, F, S	M	M	M	M	L	M	M	M	L	M	M	M
	Electromagnetic energy	O	NEv	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Barrier to species movement	O, F	NEv	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrological	Water flow changes	O	M	L	NR	NR	H	M	M	M	L	L	L	L
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR

Table 1. cont. Sensitivity assessment for short snouted seahorse (H*ippocampus hippocampus*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Deoxygenation	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Organic enrichment	O	L	L	NR	NR	M	M	M	M	M	L	L	L
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	N	L	NR	NR	M	M	M	M	M	L	L	L
	Removal of target species	F	L	H	H	H	M	M	M	M	M	M	M	M
	Removal of non-target species	F	L	H	M	M	M	M	M	M	M	M	M	M

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13. Spotted ray (*Raja montagui)*

Sensitivity Assessment

Table 1. Sensitivity assessment for spotted ray (Raja montagui). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O	None	L	NR	NR	VL	L	NR	NR	H	L	NR	NR
	Physical change (to another seabed type)	O, F	H	L	L	L	M	L	L	L	L	L	L	L
	Physical change (to another sediment type)	O, F	H	L	L	L	M	L	L	L	L	L	L	L
	Habitat structure change-removal of substratum (extraction)	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Abrasion/disturbance of substratum surface or seabed	O, F	M	L	H	L	M	L	L	L	M	L	L	L
	Penetration or disturbance of substratum subsurface	O, F	NA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 1. Sensitivity assessment for spotted ray (Raja montagui) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Changes in suspended solids (water clarity)	O, F	H	NR	NR	NR	H	NR	NR	NR	Not sensitive	NR	NR	NR
	Smothering and siltation changes (light)	O	H	NR	NR	NR	H	NR	NR	NR	Not sensitive	NR	NR	NR
	Smothering and siltation changes (heavy)	O	L	L	L	L	L	L	L	L	M	L	L	L
	Underwater noise	O, F, S	H	L	L	L	H	L	L	L	Not sensitive	NR	NR	NR
	Electromagnetic energy	O	M	L	L	L	H	L	L	L	L	L	L	L
	Barrier to species movement	O, F	H	L	L	L	H	L	L	NR	Not sensitive	L	L	L
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NEv	NR	NR
Hydrological	Water flow changes	O	H	L	M	L	H	L	M	L	Not sensitive	L	L	L
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR

Table 1. Sensitivity assessment for spotted ray (Raja montagui) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	Sensitive	NR	NR	NR
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Deoxygenation	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Organic enrichment	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Removal of target species	F	L	M	M	M	M	M	M	M	M	M	M	M
	Removal of non-target species	F	L	M	M	M	M	M	M	M	M	M	M	M

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Literature search

Web of Science search terms

AB=(“spotted ray” OR “Raja montagui” OR “R. montagui” OR "Raja spp." OR "Raja species") AND AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Search date

20th March 2023 - 41 results

Search output and screening process

Abstracts screened for relevance i.e., must describe spotted ray and mention one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening

Of the 41 papers retrieved in the Web of Science search, 19 (46%) passed initial screening for relevance and 18 (44%) were accessible.

14. Starry smooth-hound *(Mustelus asteriasi)*

Sensitivity Assessment

Table 1. Sensitivity assessment for starry smooth-hound (Mustelus asteriasi). Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive, S = sensitive

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	M	L	L	NR	M	L	L	NR	M	L	L	NR	-
	Physical change (to another seabed type)	O, F	M	M	H	NR	M	M	H	NR	M	M	H	NR	2
	Physical change (to another sediment type)	O, F	M	M	H	NR	M	M	H	NR	M	M	H	NR	11
	Habitat structure change-removal of substratum (extraction)	O	M	M	H	H	M	M	H	H	M	M	H	H	2, 3, 11
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Penetration or disturbance of substratum subsurface	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-

Table 1. cont. Sensitivity assessment for for starry smooth-hound (Mustelus asteriasi).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Refs
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Smothering and siltation changes (light)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Smothering and siltation changes (heavy)	O	M	L	L	NR	M	L	L	NR	NEv	L	L	NR	-
	Underwater noise	O, F, S	H	L	L	NR	H	L	L	NR	NS	L	L	NR	-
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Barrier to species movement	O, F	M	L	L	NR	H	L	L	NR	L	L	L	NR	-
	Death or injury by collision	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
Hydrological	Water flow changes	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
Chemical	Transition elements & organo-metal contamination	O, F, S	NEv	M	L	NR	H	M	L	NR	S	NEv	M	L	-

Table 1. cont. Sensitivity assessment for for starry smooth-hound (Mustelus asteriasi).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	M	M	NR	H	M	M	NR	S	M	M	NR	9
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Deoxygenation	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Organic enrichment	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	H	H	M	NR	H	H	H	NR	NS	H	M	NR	6
	Removal of target species	F	L	H	H	H	L	H	H	H	H	H	H	H	2,3,4,5,10,12
	Removal of non-target species	F	L	H	H	H	M	H	H	H	M	H	H	H	1,2,7,8,10,13

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Literature search

Web of Science search terms

AB=("Mustelus asterias" OR "M. asterias" OR "starry smoothhound*" OR "starry smooth-hound*") AND AB=("angl*" OR "beam" OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR "gear" OR "gillnet*" OR "hook*" OR "injury" OR "net*" OR "otter trawl*" OR "remov*" **OR** "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR "ship*" OR "steaming" **OR** "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" **OR** "anoxia" OR "copper" OR "current*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR "exposure" OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter" OR "nitrate*" OR "nitrite*" OR "noise" OR "radionuclide" OR "nutrient*" OR "oil" OR "oil" OR "PAH*" OR "pathogen*" OR "PCB*" OR "plastic*" OR "regime" OR "salinity" OR "sedimentation" OR "silt*" OR "temperatur*" OR "translocation" OR "tributyltin" OR "turbid*" OR "visual" OR "warm*")

Database

ISI Web of Science

Search date

1st March 2023 - 24 results

Search output and screening process

Abstracts screened for relevance i.e. must describe starry smooth-hound sharks and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening

Of the 24 papers retrieved by the Web of Science search, 14 (58%) abstracts passed initial screening. Of these 14, 2 (14%) could not be accessed and therefore applicability could not be determined. Sensitivity assessments were therefore made based on evidence provided by the resultant 12 papers.

15. Thornback Ray (*Raja clavata)*

Sensitivity Assessment

Table 1. Sensitivity assessment for Thornback Ray (*Raja clavata*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Physical change (to another seabed type)	O, F	H	M	L	L	M	L	L	L	L	L	L	L
	Physical change (to another sediment type)	O, F	H	M	M	H	H	L	L	L	NS	L	L	L
	Habitat structure change-removal of substratum (extraction)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Abrasion/disturbance of substratum surface or seabed	O, F	M	L	L	L	M	L	L	L	M	L	L	L
	Penetration or disturbance of substratum subsurface	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

Table 1. cont. Sensitivity assessment for Thornback Ray (*Raja clavata*). Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
Physical	**Changes in suspended solids (water clarity)**	**O, F**	H	L	L	L	H	L	L	L	NS	L	L	L
	Smothering and siltation changes (light)	**O**	H	L	L	L	H	L	L	L	NS	L	L	L
	Smothering and siltation changes (heavy)	**O**	H	L	L	L	M	L	L	L	L	L	L	L
	Underwater noise	**O, F, S**	H	L	L	L	H	L	L	L	NS	L	L	L
	Electromagnetic energy	**O**	H	M	M	L	M	L	L	L	L	L	L	L
	Barrier to species movement	**O, F**	H	L	L	L	H	L	L	L	NS	L	L	L
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrological	**Water flow changes**	**O**	H	L	L	L	H	L	L	L	NS	L	L	L
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	H	L	L	L	NEv	NR	NR	NR	L	NR	NR	NR

Table 1. cont. Sensitivity assessment for Thornback Ray (*Raja clavata*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Deoxygenation	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Organic enrichment	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Removal of target species	F	M	H	M	H	H	H	M	M	L	H	M	M
	Removal of non-target species	F	H	H	M	H	H	M	M	M	NS	M	M	M

Literature search

Web of Science search terms

AB=("thornback ray" OR "Raja clavata" OR "R.clavata" OR "Raie bouclee" OR "Raya de clavos") AND AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter" OR "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR “oil” OR "PAH*" OR "pathogen*" OR "PCB*" OR "plastic*" OR “regime” OR “salinity” OR "sedimentation" OR "silt*" OR “temperatur*” OR “translocation” OR "tributyltin" OR “turbid*” OR “visual” OR "warm*")

Database

ISI Web of Science

Search date

21st February 2023 - 184 results

https://www-webofscience-com.ucc.idm.oclc.org/wos/woscc/summary/b1a8c599-e5bd-45d5-85ae-f3a614bda8d9-724275cf/relevance/1

Search output and screening process

Abstracts screened for relevance i.e. must describe thornback rays and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening

88 (48%) abstracts passed initial screening. Of these, 88, 22 (25%) did not pass secondary screening (determined not relevant upon further reading), 65 (75%) passed secondary screening and were accessible. Sensitivity assessments was based on the evidence provided by 65 publications.

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16. Tope (*Galeorhinus galeus*)

Sensitivity Assessment

Table 1. Sensitivity assessment for tope (*Galeorhinus galeus*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	H	L	L	NR	H	L	L	NR	NS	L	L	NR	-
	Physical change (to another seabed type)	O, F	H	H	L	L	L	L	L	L	L	L	L	L	3, 11, 23
	Physical change (to another sediment type)	O, F	H	H	L	L	L	L	L	L	L	L	L	L	3, 11, 23
	Habitat structure change-removal of substratum (extraction)	O	H	H	L	L	L	L	L	L	L	L	L	L	3, 11, 23
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Penetration or disturbance of substratum subsurface	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-

Table 1. cont. Sensitivity assessment for tope (*Galeorhinus galeus*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Smothering and siltation changes (light)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Smothering and siltation changes (heavy)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Underwater noise	O, F, S	H	L	M	NR	H	L	M	NR	NS	L	M	NR	28
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Barrier to species movement	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Hydrological	Water flow changes	O	H	M	M	H	H	M	M	H	NS	M	M	H	2, 5, 20
Chemical	Transition elements & organo-metal contamination	O, F, S	NEv	M	M	H	H	L	M	H	Sensitive	L	M	H	9, 16, 21

Table 1. cont. Sensitivity assessment for tope (*Galeorhinus galeus*) cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	L	M	H	H	L	M	H	Sensitive	L	M	H	-
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Deoxygenation	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	-
	Organic enrichment	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Removal of target species	F	L	H	M	H	L	H	M	H	H	H	M	H	3,4, 6, 8, 10, 12, 17, 22, 24, 25, 27, 29, 30, 32, 33, 34, 35, 36, 37, 38, 39, 40
	Removal of non-target species	F	L	H	M	H	L	H	M	H	H	H	M	H	1, 3, 7, 10, 12, 13, 14, 15, 18, 19, 22, 26, 30, 37

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Literature search

Web of Science search terms

AB=("tope" OR "Galeorhinus galeus" OR "G. galeus" OR "school shark*" OR "snapper shark*" OR "soupfin shark*" OR "sharpie shark*" OR "vitamin shark*" OR "Requin-hâ" OR "Cazón" OR "Galeorhinus vitaminicus" OR "tiburón aceitoso" AND "angl*" OR "beam" OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR "gear" OR "gillnet*" OR "hook*" OR "injury" OR "net*" OR "otter trawl*" OR "remov*" **OR** "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR "ship*" OR "steaming" **OR** "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" **OR** "anoxia" OR "copper" OR "current*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR "exposure" OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter" OR "nitrate*" OR "nitrite*" OR "noise" OR "radionuclide" OR "nutrient*" OR "oil" OR “oil” OR "PAH*" OR "pathogen*" OR "PCB*" OR "plastic*" OR “regime” OR “salinity” OR "sedimentation" OR "silt*" OR “temperatur*” OR “translocation” OR "tributyltin" OR “turbid*” OR “visual” OR "warm*")

Database
ISI Web of Science

Search date
30th January 2023 - 177 results

Search output and screening process
Abstracts screened for relevance i.e. must describe tope sharks and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
71 (40%) abstracts passed initial screening. Of these 71, 19 (27%) did not pass secondary screening (i.e., on further reading were determined as not relevant), 12 (17%) could not be accessed and therefore applicability could not be determined, and 40 (56%) passed secondary screening and were accessible, Sensitivity assessments were therefore made based on evidence provided by the resultant 40 papers.

17. Turbot (*Scophthalmus maximus*)

Sensitivity Assessment

Table 1. Sensitivity assessment for Turbot (*Scophthalmus maximus*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another seabed type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another sediment type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M
	Habitat structure change-removal of substratum (extraction)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Penetration or disturbance of	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

	substratum subsurface													

Table 1. cont. **Sensitivity assessment for Turbot (*Scophthalmus maximus*).**

Pressures		**Associated sector(s)**	**Resistance**				**Resilience**				**Sensitivity**			
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**
Physical	**Changes in suspended solids (water clarity)**	**O, F**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Smothering and siltation changes (light)	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Smothering and siltation changes (heavy)	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Underwater noise	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Barrier to species movement	**O, F**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrological	**Water flow changes**	**O**	H	L	L	L	H	L	L	L	NS	L	L	L
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

Table 1. cont. Sensitivity assessment for Turbot (*Scophthalmus maximus*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Deoxygenation	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Organic enrichment	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Removal of target species	F	L	H	H	H	M	H	H	H	M	H	H	H
	Removal of non-target species	F	M	H	H	H	M	H	H	H	M	H	H	H

References for sensitivity assessment

Cardinale, M., Chanet, B., Martínez Portela, P., Munroe, T.A., Nimmegeers, S., Shlyakhov, V., Turan, C. & Vansteenbrugge, L. (2021) *Scophthalmus maximus*. *The IUCN Red List of Threatened Species* 2021: e.T198731A144939322. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T198731A144939322.en. (and references therein).

Literature search

Web of Science search terms

AB=("turbot*" OR "Scophthalmus maximus" OR "S. maximus")

AND AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR “ "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Database
ISI Web of Science

Search date
13th March 2023 - >3000 results

Search output and screening process
Abstracts screened for relevance i.e. must describe witch flounder and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
It was not possible to screen and review the greater than 3000 papers in the time available. The sensitivity assessment was therefore made based on evidence provided by certain key papers supplemented with the latest IUCN Red List assessment (2021) and knowledge gained from the assessments of similar flatfish such as witch and American plaice.

18. Witch Flounder (*Glyptocephalus cynoglossus)*

Sensitivity Assessment

Table 1. Sensitivity assessment for Witch Flounder (*Glyptocephalus cynoglossus*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another seabed type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M
	Physical change (to another sediment type)	O, F	L	H	H	H	M	M	M	M	M	M	M	M
	Habitat structure change-removal of substratum (extraction)	O	L	H	H	H	M	M	M	M	M	M	M	M
	Abrasion/disturbance of substratum surface or seabed	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Penetration or disturbance of	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

	substratum subsurface													

Table 1. cont. Sensitivity assessment for Witch Flounder (*Glyptocephalus cynoglossus*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Changes in suspended solids (water clarity)	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Smothering and siltation changes (light)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Smothering and siltation changes (heavy)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Barrier to species movement	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrological	Water flow changes	O	H	L	L	L	H	L	L	L	NS	L	L	L
Chemical	Transition elements & organo-metal contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR

Table 1. cont. Sensitivity assessment for Witch Flounder (*Glyptocephalus cynoglossus*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Deoxygenation	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Organic enrichment	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Removal of target species	F	L	H	H	H	M	M	M	M	M	M	M	M
	Removal of non-target species	F	M	M	M	M	M	M	M	M	M	M	M	M

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Literature search

Web of Science search terms

AB=("witch flounder*" OR "Glyptocephalus cynoglossus" OR "G. cynoglossus" OR "pole flounder*" OR "craig fluke" OR "Torbay sole*" OR "grey sole*")

AND AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR “ "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Database
ISI Web of Science
Search date
10th March 2023 - 44 results

Search output and screening process
Abstracts screened for relevance i.e. must describe witch flounder and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
Eight abstracts passed initial screening. Of these one did not pass secondary screening (i.e., on further reading were determined as not relevant), one could not be accessed and therefore applicability could not be determined, and six passed secondary screening and were accessible, Sensitivity assessments were therefore made based on evidence provided by the resultant six papers supplemented with the latest IUCN Red List assessment (2021).

19. Ross Worm Reefs *Sabellaria spinulosa*

Sensitivity Assessment

Assessed by MaRLIN see Tillin, H.M., Marshall, C., Gibb, N. & Garrard, S. L. 2022. *Sabellaria spinulosa* on stable circalittoral mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 26-04-2023]. Available from: https://www.marlin.ac.uk/habitat/detail/377

Table 1. Sensitivity assessment for Ross Worm Reefs *Sabellaria spinulosa*. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another seabed type)	O, F	N	M	L	NR	VL	H	H	H	H	M	L	L	See full reference list below
	Physical change (to another sediment type)	O, F	N	M	L	NR	VL	H	H	H	H	M	L	L	See full reference list below
	Habitat structure change-removal of substratum	O	N	H	H	H	M	M	H	M	M	H	H	H	See full reference list below
	Abrasion/disturbance of substratum surface	O, F	L	L	NR	NR	M	M	H	M	M	L	L	L	See full reference list below
	Penetration or disturbance of substratum subsurface	O, F	N	M	H	H	M	M	H	M	M	M	H	M	See full reference list below

Table 1. cont. Sensitivity assessment for Ross Worm Reefs *Sabellaria spinulosa*. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Refs
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Changes in suspended solids (water clarity)**	**O, F**	H	H	L	H	H	H	H	H	NS	H	L	H	See full reference list below
	Smothering and siltation changes (light)	**O**	H	H	M	NR	H	H	H	H	NS	H	M	L	See full reference list below
	Smothering and siltation changes (heavy)	**O**	N	L	NR	NR	M	H	L	H	M	L	L	L	See full reference list below
	Underwater noise	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Barrier to species movement	**O, F**	M	L	NR	NR	H	M	L	M	L	L	L	L	See full reference list below
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Hydrological	**Water flow changes**	**O**	H	H	L	H	H	H	H	H	NS	H	L	H	See full reference list below
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	

Table 1. cont. Sensitivity assessment for Ross Worm Reefs *Sabellaria spinulosa*

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Deoxygenation	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	H	L	NR	NR	H	H	H	H	NS	L	L	L	See full reference list below
	Removal of target species	F	H	L	NR	NR	H	H	H	H	NS	L	NR	NR	See full reference list below
	Removal of non-target species	F	N	L	NR	NR	M	H	M	H	M	L	L	L	See full reference list below

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20. Sea-pen and burrowing megafauna

Sensitivity Assessment

Assessed by MaRLIN see Hill, J.M., Tyler-Walters, H. & Garrard, S. L. 2022. Seapens and burrowing megafauna in circalittoral fine mud. In Tyler-Walters H. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 26-04-2023]. Available from: https://www.marlin.ac.uk/habitat/detail/131

Table 1. Sensitivity assessment for Sea-pen and burrowing megafauna. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another seabed type)	O, F	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another sediment type)	O, F	N	H	M	M	VL	H	H	H	H	M	L	M	See full reference list below
	Habitat structure change-removal of substratum (extraction)	O	N	M	L	M	L	M	M	M	H	M	L	M	See full reference list below
	Abrasion/disturbance of substratum surface or seabed	O, F	M	H	H	L	L	M	M	M	M	M	L	L	See full reference list below
	Penetration or disturbance of	O, F	L	H	M	L	L	M	M	M	H	M	L	L	See full reference

	substratum subsurface													list below

Table 1. cont. Sensitivity assessment for Sea-pen and burrowing megafauna. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		**Associated sector(s)**	**Resistance**				**Resilience**				**Sensitivity**				**References**
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Changes in suspended solids (water clarity)**	**O, F**	H	M	L	M	H	H	H	H	NS	M	L	M	See full ref list below
	Smothering and siltation changes (light)	**O**	H	L	NR	NR	H	H	H	H	NS	L	L	L	See full ref list below
	Smothering and siltation changes (heavy)	**O**	H	L	NR	NR	H	H	H	H	NS	L	L	L	See full ref list below
	Underwater noise	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Electromagnetic energy	**O**	NR	NR	NR	NR	NR	NR	NR	NR	NEV	NR	NR	NR	
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Hydrological	**Water flow changes**	**O**	L	H	H	M	L	M	M	M	H	M	L	M	See full ref list below
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	

Table 1. cont. Sensitivity assessment for Sea-pen and burrowing megafauna.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Deoxygenation	O	M	L	NR	NR	L	M	M	M	M	L	L	L	See full reference list below
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NR	NR	NR	NR	NEv	NR	NR	NR	
	Removal of target species	F	H	L	NR	NR	H	H	H	H	NS	L	L	L	See full reference list below
	Removal of non-target species	F	M	H	H	L	L	M	M	M	M	M	L	L	See full reference list below

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21. Barrel Jellyfish *(Rhizostoma octopus)*

Table 1. Sensitivity assessment for Barrel jellyfish (*Rhizostoma octopus*). NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Physical change (to another seabed type)	O, F	H	L	L	NR	H	L	L	NR	Not sensitive	L	L	NR	6, 36
	Physical change (to another sediment type)	O, F	H	L	L	NR	H	L	L	NR	Not sensitive	L	L	NR	
	Habitat structure change-removal of substratum (extraction)	O	H	L	L	NR	M	L	L	NR	L	L	L	L	
	Abrasion/disturbance of substratum surface or seabed	O, F	H	L	L	NR	H	L	L	NR	Not sensitive	L	L	NR	
	Penetration or disturbance of substratum subsurface	O, F	H	L	L	NR	H	L	L	NR	Not sensitive	L	L	NR	

Table 1. cont. Sensitivity assessment for Barrel jellyfish *(Rhizostoma octopus*). Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Smothering and siltation changes (light)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Smothering and siltation changes (heavy)	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Underwater noise	O, F, S	M	L	L	L	H	M	H	H	L	L	M	M	11
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Barrier to species movement	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Death or injury by collision	O, F, S	M	L	L	L	H	M	H	L	L	L	H	L	
Hydrological	Water flow changes	O	L	L	L	M	H	L	L	M	L	L	L	M	10
Chemical	Transition elements & organo-metal contamination	O, F, S	H	L	L	M	H	L	L	M	Not sensitive				14, 16

Table 1. cont. Sensitivity assessment for Barrel jellyfish (*Rhizostoma octopus*).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	
	Deoxygenation	O	H	H	L	M	H	L	L	L	Not sensitive	L	L	L	13, 19, 30, 34
	Organic enrichment	O	H	H	L	L	H	L	L	L	Not sensitive	L	L	L	20
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Removal of target species	F	M	M	M	M	H	M	M	M	L	M	M	M	1, 2
	Removal of non-target species	F	M	M	M	M	H	M	M	M	L	M	M	M	1, 2

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Literature search

Web of Science search terms

Web of Science search terms

AB=("barrel jelly*" OR “Rhizostoma pulmo” OR “R. pulmo” OR “dustbin-lid jelly*” OR “frilly-mouthed jellyfish”) OR AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR “aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR "litter" OR "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR “oil” OR "PAH*" OR "pathogen*" OR "PCB*" OR "plastic*" OR “regime” OR “salinity” OR "sedimentation" OR "silt*" OR “temperatur*” OR “translocation” OR "tributyltin" OR “turbid*” OR “visual” OR "warm*")

Database

ISI Web of Science

Search date

1st March 2023 - 154 results

https://www.webofscience.com/wos/woscc/summary/8eb2e18b-1207-459f-84d6-7ed94ed095cc-74ab3dc2/relevance/1

Database

ISI Web of Science

Search date

30th January 2023 - 177 results

Search output and screening process

Abstracts screened for relevance i.e. must describe jellyfish sharks and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening

Sensitivity assessments were made based on evidence provided by 36 papers (20%) that were deemed relevant out of the initial 177.

22. Herring Spawning Areas/Grounds/Beds

Sensitivity Assessment

Table 1. Sensitivity assessment for Herring Spawning Areas/Grounds/Beds. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	M	M	H	H	M	H	H
	Physical change (to another seabed type)	O, F	L	H	H	H	VL	M	M	H	H	M	H	H
	Physical change (to another sediment type)	O, F	L	H	H	H	VL	M	M	H	H	M	H	H
	Habitat structure change-removal of substratum (extraction)	O	L	H	H	H	VL	M	M	H	H	M	H	H
	Abrasion/disturbance of substratum surface or seabed	O, F	M	H	H	H	M	M	M	H	M	M	H	H
	Penetration or disturbance of	O, F	M	H	H	H	M	M	M	H	M	M	H	H

	substratum subsurface													

Table 1. cont. Sensitivity assessment for Herring Spawning Areas/Grounds/Beds.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Changes in suspended solids (water clarity)	O, F	H	H	H	H	H	M	M	H	L	M	M	H
	Smothering and siltation changes (light)	O	L	H	H	H	L	M	M	H	H	M	M	H
	Smothering and siltation changes (heavy)	O	L	H	H	H	L	M	M	H	H	M	M	H
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Barrier to species movement	O, F	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hydrological	Water flow changes	O	M	L	M	L	M	L	L	L	M	L	L	L
Chemical	Transition elements & organo-metal contamination	O, F, S	M	M	M	H	M	L	L	L	M	L	L	M

Table 1. cont. Sensitivity assessment for Herring Spawning Areas/Grounds/Beds.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S	M	M	M	H	M	M	M	M	M	M	M	M
	Synthetic compound contamination	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Deoxygenation	O	M	M	M	M	H	M	M	M	L	M	M	M
	Organic enrichment	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR
	Removal of target species	F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Removal of non-target species	F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

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Expectations for a new millennium. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks.

Literature search

Web of Science search terms

AB=("herring" OR "Clupea harengus" OR "C. harengus")

AND AB = (“spawning bed” OR “spawning area” OR “spawning ground” OR “coarse sediment”)

AND AB=("angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR “ "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Database
ISI Web of Science

Search date
07th March 2023 - 74 results

Search output and screening process
Abstracts screened for relevance i.e. must describe herring spawning and mention of one of the listed sectors and/or pressures from MARESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. In Excel, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
7 abstracts passed initial screening. Of these 7, 1 did not pass secondary screening (i.e., on further reading were determined as not relevant), 1 could not be accessed and therefore applicability could not be determined, and 5 passed secondary screening and were accessible.

One of these was a recent literature review of the subject that had screened over 700 relevant papers. Three additional papers were added to the analysis based on the reviewers knowledge: two additional grey literature sources and one additional peer-review paper. Sensitivity assessments were therefore made based on evidence provided by the resultant 8 papers.

23. Forage and Juvenile Fish

Sensitivity Assessment

No MarESA sensitivity assessment was available for forage fish. A FeAST assessment was available for sandeel, which was used as the basis of the current sensitivity assessment. As such no individual resistance or resilience scores are available. The assessment was supplemented with key literature resulting from the search documented below. As this assessment relates to a species assemblage the sensitivity score for the most sensitive species was used in each pressure.

Table 1. Sensitivity assessment for Forage and Juvenile Fish. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Physical loss (to land or freshwater habitat)	O									M			
	Physical change (to another seabed type)	O, F									H			
	Physical change (to another sediment type)	O, F									NA			
	Habitat structure change-removal of substratum (extraction)	O									M			
	Abrasion/ disturbance of substratum surface or seabed	O, F									M			

Table 1. cont. Sensitivity assessment for Forage and Juvenile Fish.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Physical	Penetration or disturbance of substratum subsurface	O, F									M			
	Changes in suspended solids (water clarity)	O, F									NA			
	Smothering and siltation changes (light)	O									M			
	Smothering and siltation changes (heavy)	O									M			
	Underwater noise	O, F, S									NA			
	Electromagnetic energy	O									NA			
	Barrier to species movement	O, F									NA			
	Death or injury by collision	O, F, S									NA			
Hydrological	Water flow changes	O									NA			
Chemical	Transition elements & organo-metal contamination	O, F, S									NEv			

Table 1. cont. Sensitivity assessment for Forage and Juvenile Fish.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity			
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC
Chemical	Hydrocarbon & PAH contamination	O, F, S									Sensitive	M	M	L
	Synthetic compound contamination	O, F, S									Sensitive	M	M	L
	Introduction of other substances	O, F, S									NEv			
	Deoxygenation	O									NA			
	Organic enrichment	O									NA			
Biological	Introduction or spread of invasive non-indigenous species	O, F, S									NA			
	Removal of target species	F									H			
	Removal of non-target species	F									M			

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Literature search

Important note: including the full list of forage and juvenile fish species in the WoS search resulted in over 28,000 records. Reducing the search to “forage fish” and “juvenile fish” resulted in over 4,000 records. See below for how the screening was handled.

Web of Science search terms FULL SEARCH

AB=("sprat" OR " Sprattus sprattus" OR "S. sprattus" OR "sandeel*" OR " Ammodytes" OR " Ammodytes tobianus" OR "A. tobianus" OR "sand eel*" OR " Hyperoplus lanceolatus" OR "H. lanceolatus" OR “forage fish” OR “whiting” OR ”Merlangius merlangus” OR “M. merlangus” OR “nursery” OR “juvenile fish” OR "herring" OR "Clupea harengus" OR "C. harengus" OR "norway pout" OR "Trisopterus esmarkii" OR "T. esmarkii ") AND AB=(“trawl” OR "angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR “ "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Web of Science search terms REDUCED SEARCH

AB = (“forage fish” OR “juvenile fish”) AND AB=(“trawl” OR "angl*" OR “beam” OR "bottom trawl*" OR "by-catch" OR "dredge*" OR "fish*" OR “gear” OR "gillnet*" OR "hook*" OR “injury” OR "net*" OR "otter trawl*" OR “remov*” OR "aggregate*" OR "anchor*" OR "ballast" OR "barrier*"OR "beach*" OR "launch*" OR "moor*" OR "noise" OR “ship*” OR "steaming" OR "collision*" OR "construction" OR "electro*" OR "turbine*"OR "renewable*" OR "wave" OR "wind" OR "wind farm*" OR "anoxia" OR "copper" OR "current*" OR “deoxy*” OR "disease*" OR "disturbance" OR "endocrine disru*" OR "eutrophication" OR “exposure” OR "heavy metals" OR "hydrocarbon" OR "hypoxia" OR “litter*” OR “non-native*” OR “ "nitrate*" OR "nitrite*" OR "noise" OR “radionuclide” OR "nutrient*" OR "oil" OR "PAH*" OR "PCB*" OR “regime” OR "sedimentation" OR "silt*" OR "tributyltin" OR “turbid*”)

Database
ISI Web of Science

Search date
7th March 2023

Search output and screening process
WoS can only output the first 1000 results. Therefore the first 1000 titles for both the FULL and REDUCED search results were screened for relevance i.e. must describe forage or juvenile fish and mention one of the listed sectors and/or pressures from MarESA. Workflow follows the Rapid Evidence Assessment approach. The title and all auxiliary information (including abstract) were downloaded from ISI Web of Science in a .ris and excel format. The results of both the FULL and REDUCED title screening were joined, abstracts were read and listed to either pass or fail the initial screening process with a reason provided.

Outcome from screening
51 abstracts passed initial screening. Of these, 24 did not pass secondary screening (i.e., on further reading were determined as not relevant).

24. Sub-tidal Mussel Beds *(Mytilus edulis)*

Sensitivity Assessment

Assessed by MaRLIN see Tyler-Walters, H., Tillin, H.M., Mainwaring, K., & Williams, E. 2022. *Mytilus edulis* beds on sublittoral sediment. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 26-04-2023]. Available from: https://www.marlin.ac.uk/habitat/detail/36

Table 1. Sensitivity assessment for Sub-tidal Mussel Beds *(Mytilus edulis)*. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Physical loss (to land or freshwater)**	**O**	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another seabed type)	**O, F**	N	L	NR	NR	VL	H	M	M	H	L	L	L	See full reference list below
	Physical change (to another sediment type)	**O, F**	H	L	NR	NR	H	H	H	H	NS	L	L	L	
	Habitat structure change-removal of substratum	**O**	N	H	H	H	L	H	M	M	H	H	M	M	See full reference list below
	Abrasion/disturbance of substratum surface	**O, F**	L	H	M	M	M	H	M	M	M	H	M	M	See full reference list below
	Penetration or disturbance of substratum	**O, F**	L	H	H	M	M	H	M	M	M	H	M	M	See full reference list below

Table 1. cont. Sensitivity assessment for Sub-tidal Mussel Beds *(Mytilus edulis)*. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Refs
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Changes in suspended solids (water clarity)**	**O, F**	H	H	H	M	H	H	H	H	NS	H	H	M	See full ref list below
	Smothering and siltation changes (light)	**O**	M	H	H	M	M	H	M	M	M	H	M	M	See full ref list below
	Smothering and siltation changes (heavy)	**O**	M	H	H	M	M	H	M	M	M	H	M	M	See full ref list below
	Underwater noise	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Electromagnetic energy	**O**	NEv	NR	NR	NR	Nev	NR	NR	NR	NEv	NR	NR	NR	
	Barrier to species movement	**O, F**	M	L	NR	NR	H	H	H	H	Low	L	L	L	See full ref list below
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Hydrological	**Water flow changes**	**O**	M	H	H	M	M	H	M	M	M	H	M	M	See full ref list below
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	None	H	M	M	L	H	M	M	H	H	M	M	See full ref list below

Table 1. cont. Sensitivity assessment for Sub-tidal Mussel Beds *(Mytilus edulis)*.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	N	H	M	M	L	H	M	M	H	H	M	M	See full reference list below
	Synthetic compound contamination	O, F, S	N	H	M	M	L	H	M	M	H	H	M	M	See full reference list below
	Introduction of other substances	O, F, S	NEv	NR	NR	NR	NR	NR	NR	NR	NEv	NR	NR	NR	
	Deoxygenation	O	H	H	H	H	H	H	H	H	NS	H	H	H	See full reference list below
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	L	M	M	M	VL	H	M	M	H	M	M	M	See full reference list below
	Removal of target species	F	L	H	H	H	M	H	M	M	M	H	M	M	See full reference list below
	Removal of non-target species	F	L	H	H	H	M	H	M	M	M	H	M	M	See full reference list below

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25. Circalittoral Coarse Sediments

Sensitivity Assessment

Table 1. Sensitivity assessment for Circalittoral Coarse Sediments. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**		
Physical	**Physical loss (to land or freshwater)**	**O**	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(b),1(d),2,3,5,6,7,8(a),8(b),8(c),8(d),10	4
	Physical change (to another seabed type)	**O, F**	L	L	NR	NR	M	L	L	NR	H	L	L	NR	Group 8(d)	4
	Physical change (to another sediment type)	**O, F**	L	L	NR	NR	M	L	L	NR	H	L	L	NR	Group 8(d)	4
	Habitat structure change-removal of substratum	**O**	N	M	L	NR	L	L	NR	NR	H	L	L	NR	Group 5, 8(d)	4
	Abrasion/disturbance of substratum surface	**O, F**	M	H	H	H	M	M	M	M	M	M	M	M	Group 2,5,8c,10	4
	Penetration or disturbance of substratum	**O, F**	M	H	H	H	M	M	M	M	M	M	M	M	Group 2,5,8a, 8c, 8d,10	4

Table 1. cont. Sensitivity assessment for Circalittoral Coarse Sediments. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associatedwith sensitivity score	Refs
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	**Changes in suspended solids (water clarity)**	**O, F**	M	H	M	M	M	M	M	M	M	M	M	M	Group 2,8d	4
	Smothering and siltation changes (light)	**O**	N				H				M	*L			*Balanus crenatus*	6
	Smothering and siltation changes (heavy)	**O**	N	H	H	H	L	L	NR	NR	H	L	L	L	Group 5	4
	Underwater noise	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	**Water flow changes**	**O**	N	H	H	H	M	L	L	NR	M	L	L	L	Group8(d)	4
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	M				M				M	*L			*Echinus esculentus*	5

Table 1. cont. Sensitivity assessment for Circalittoral Coarse Sediments

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Asterias rubens, Echinus esculentus*	2, 5
	Synthetic compound contamination	O, F, S	N				H				M	*M			*Lanice conchilega, Echinus esculentus, Balanus crenatus*	1, 5, 6
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	N				H				M	*H			*Asterias rubens, Balanus crenatus*	2, 6
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	N	H	H	H	VL	M	M	L	H	M	M	L	Group 8(d)	4
	Removal of target species	F	N	H	H	H	VL	L	NR	NR	H	L	L	L	Group 8(d)	4
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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26. Circalittoral Mixed Sediments

Sensitivity Assessment

Table 1. Sensitivity assessment for Circalittoral Mixed Sediments. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(b), 1(c),1,(d), 2, 3, 4, 5, 6, 8(c), 10	7
	Physical change (to another seabed type)	O, F	L	M	L	NR	M	M	L	H	M	M	L	L	Group 10	7
	Physical change (to another sediment type)	O, F	L	M	L	NR	M	M	L	H	M	M	L	L	Group 10	7
	Habitat structure change-removal of substratum	O	N	M	L	M	L	M	L	M	H	M	L	M	Group 2	7
	Abrasion/disturbance of substratum surface	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 2	7
	Penetration of substratum	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 2	7

Table 1. cont. **Sensitivity assessment for Circalittoral Mixed Sediments.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	Refs
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	H	M	M	M	M	M	M	M	M	M	M	Group 2, 4	7
	Smothering and siltation changes (light)	O	N				H				M	*L			*Ophiothrix fragilis*	5
	Smothering and siltation changes (heavy)	O	N	L	L	NR	L	M	M	M	H	L	L	L	Group 2,	7
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	H	H	L	H	H	H	H	H	NS	H	L	H		
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		

Table 1. cont. Sensitivity assessment for Circalittoral Mixed Sediments

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Asterias rubens, Nephtys hombergii, Ophiothrix fragilis*	3, 4, 5
	Synthetic compound contamination	O, F, S	L				M				M	*L			*Spiophanes bombyx*	1
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	N				H				M	*H			*Alcyonium digitatum, Asterias rubens, Ophiothrix fragilis*	2, 3, 5L
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2	7
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

References for sensitivity assessment

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27. Circalittoral Mud

Sensitivity Assessment

Table 1. Sensitivity assessment for Circalittoral Mud. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(a), 3, 5, 6, 8(a), 8(c), 9, 10	9
	Physical change (to another seabed type)	O, F	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	9
	Physical change (to another sediment type)	O, F	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	9
	Habitat structure change- removal of substratum	O	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	9
	Abrasion/disturbance of substratum surface	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 1(a)	9
	Penetration or disturbance of substratum	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 1(a)	9

Table 1. cont. **Sensitivity assessment for Circalittoral Mud.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids	O, F	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Smothering and siltation changes (light)	O	M				H				L	*H			*Asterias rubens, Amphiura filiformis*	4, 6
	Smothering and siltation changes (heavy)	O	N	L	L	NR	M	M	M	M	M	L	L	L	Group 2, 5, 8(a), 8(c), 10	9
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	
Chemical	Transition elements & organo-metal contamination	O, F, S	L				H				L	*H			*Asterias rubens, Amphiura filiformis, Nephrops norvegicus*	4, 6, 7

Table 1. cont. Sensitivity assessment for Circalittoral Mud

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Amphiura chiajei, Asterias rubens, Amphiura filiformis*	3, 4, 6
	Synthetic compound contamination	O, F, S	N				H				M	*L			*Brissopsis lyrifera, Amphiura filiformis*	2, 6
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	L				M				M	*H			*Funiculina quadrangularis, Brissopsis lyrifera, Asterias rubens, Virgularia mirabilis, Nephrops norvegicus*	1, 2, 4, 5, 7
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	M	H	H	H	M	M	M	M	M	M	M	M	Group 9	9
	Removal of non-target species	F	H	L	NR	NR	H	H	H	H	NS	L	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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28. Circalittoral Sand

Sensitivity Assessment

Table 1. Sensitivity assessment for Circalittoral Sand. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 4, 5, 6, 7, 8(a)	4
	Physical change (to another seabed type)	O, F	L	M	L	NR	M	M	L	H	M	M	L	L	Group 8(a)	4
	Physical change (to another sediment type)	O, F	L	M	L	NR	M	M	L	H	M	M	L	L	Group 8(a)	4
	Habitat structure change - removal of substratum	O	N	L	NR	NR	H	L	NR	NR	M	L	NR	NR	Group 4, 5, 6, 8(a)	4
	Abrasion/disturbance of substratum surface	O, F	M	L	NR	NR	M	L	NR	NR	M	L	NR	NR	Group 4	4
	Penetration or disturbance of substratum	O, F	L	H	H	M	M	L	NR	NR	M	L	L	L	Group 4, 8(a)	4

Table 1. cont. Sensitivity assessment for Circalittoral Sand. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	Refs
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	L	NR	NR	M	L	NR	NR	M	L	NR	NR	Group 4	4
	Smothering and siltation changes (light)	O	L				H				L	*M			*Spiophanes bombyx, Owenia fusiformis*	1, 2
	Smothering and siltation changes (heavy)	O	L	L	NR	NR	M	L	NR	NR	M	L	NR	NR	Group 4, 5, 8(a)	4
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	H	M	L	NR	H	H	H	H	NS	M	L	L		
Chemical	Transition elements & organo-metal contamination	O, F, S	L				H				L	*L			*Spiophanes bombyx*	1

Table 1. cont. Sensitivity assessment for Circalittoral Sand

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	L				H				L	*M			*Spiophanes bombyx*	1
	Synthetic compound contamination	O, F, S	N				H				M	*L			*Spiophanes bombyx*	1
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	L				H				L	*M			*Spiophanes bombyx*	1
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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29. Infralittoral Coarse Sediments

Sensitivity Assessment

Table 1. Sensitivity assessment for Infralittoral Coarse Sediment. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 2,3,4,5,6,7,8(a)	11
	Physical change (to another seabed type)	O, F	L	M	L	NR	M	M	L	H	M	M	L	L	Group 8(a)	11
	Physical change (to another sediment type)	O, F	L	M	L	NR	M	M	L	H	M	M	M	L	Group 8(a)	11
	Habitat structure change-removal of substratum	O	N	M	L	NR	M	M	L	NR	M	M	L	NR	Group 2,3,4,5,6,8(a)	11
	Abrasion/disturbance of substratum surface	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2,4	11
	Penetration or disturbance of substratum	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2,4,8(a)	11

Table 1. cont. **Sensitivity assessment for Infralittoral Coarse Sediment.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	Refs
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	H	M	M	M	M	M	M	M	M	M	M	Group 2,4	11
	Smothering and siltation changes (light)	O	M				H				L	*L			*Spiophanes bombyx, Lanice conchilega, Asterias rubens*	1, 2, 4
	Smothering and siltation changes (heavy)	O	N	H	H	H	M	L	NR	NR	M	L	L	L	Group 2,4,5,8(a)	11
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEV	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	H	M	L	NR	H	H	H	H	NS	M	L	L		
Chemical	Transition elements & organo-metal contamination	O, F, S	L				H				L	*H			*Spiophanes bombyx, Lanice conchilega, Abra alba, Nephtys hombergii, Ensis ensis, Echinocardium cordatum, Liocarcinus depurator, Carcinus maenas*	1, 2, 3, 5, 6, 7, 8, 9

Table 1. cont. Sensitivity assessment for Infralittoral Coarse Sediment

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/ characterising species associated with sensitivity score	Refs
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Nephtys hombergii, Ensis ensis, Echinocardium cordatum, Carcinus maenas*	5, 6, 7, 9
	Synthetic compound contamination	O, F, S	N				H				M	*M			*Spiophanes bombyx, Lanice conchilega, Abra alba, Ensis ensis, Echinocardium cordatum*	1, 2, 3, 6, 7
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	N				H				M	*H			*Asterias rubens, Echinocardium cordatum, Liocarcinus depurator*	4, 7, 8
Biological	Introduction or spread of invasive species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv					
	Removal of target species	F	M	H	H	H	M	M	M	M	M				Group 2	11
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS					

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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30. Infralittoral Mixed Sediments

Sensitivity Assessment

Table 1. Sensitivity assessment for Infralittoral Mixed Sediment. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(b), 1(c), 1(d), 2, 3, 4, 5, 6, 7, 8(c), 10	12
	Physical change (to another seabed type)	O, F	L	M	L	NR	M	L	L	NR	M	L	L	NR	Group 10	12
	Physical change (to another sediment type)	O, F	L	M	L	NR	M	L	L	NR	M	L	L	NR	Group 10	12
	Habitat structure change- removal of substratum	O	N	M	L	NR	M	M	M	L	M	M	L	L	Group 1(b), 1(c), 1(d), 2, 3, 4, 5, 6, 8(c), 10	12
	Abrasion/disturbance of substratum surface	O, F	M	M	H	M	M	M	L	M	M	M	L	M	Group 1(c), 2, 4, 8(c), 10	12
	Penetration or disturbance of substratum subsurface	O, F	L	M	H	M	M	M	L	M	M	M	L	M	Group 2, 4, 8(c), 10	12

Table 1. cont. Sensitivity assessment for Infralittoral Mixed Sediment. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	Refs
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**		
Physical	**Changes in suspended solids (water clarity)**	**O, F**	M	H	M	M	M	M	M	M	M	M	M	M	Group 2, 4	12
	Smothering and siltation changes (light)	**O**	L	H	M	M	VL	H	M	M	H	H	M	M	*Ostrea edulis*	8
	Smothering and siltation changes (heavy)	**O**	N	H	H	H	M	L	NR	NR	M	L	L	L	Group 1(c), 1(d), 2, 4, 5, 8(c), 10	12
	Underwater noise	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	**Water flow changes**	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	N				H				M	*H			*Venerupis corrugata*	10

Table 1. cont. Sensitivity assessment for Infralittoral Mixed Sediment.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Asterias rubens, Ophiothrix fragilis, Carcinus maenas*	3, 4, 6
	Synthetic compound contamination	O, F, S	L				M				M	*H			*Lanice conchilega, Urticina felina, Cancer pagurus, Aphelochaeta marioni, Venerupis corrugata*	1, 5, 7, 9, 10
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	N				H				M	*H			*Alcyonium digitatum, Asterias rubens, Ophiothrix fragilis*	2, 3, 4
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2	12
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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31. Infralittoral Mud

Table 1. Sensitivity assessment for Infralittoral Mud. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sectors	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(b), 2, 3, 4, 5, 6, 7, 10	7
	Physical change (to another seabed type)	O, F	L	M	L	NR	M	L	L	NR	M	L	L	NR	Group 10	7
	Physical change (to another sediment type)	O, F	L	M	L	NR	M	L	L	NR	M	L	L	NR	Group 10	7
	Habitat structure change-removal of substratum	O	N	M	L	NR	H	H	H	H	M	M	L	L	Group 1(b), 1(c), 1(d), 2, 3, 4, 5, 6, 8(a), 8(b), 8(c), 10	7
	Abrasion/ disturbance of substratum surface	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2, 4, 10	7
	Penetration or disturbance of substratum subsurface	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2, 4, 5, 8(a), 10	7

Table 1. cont. **Sensitivity assessment for Infralittoral Mud.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	H	M	M	M	M	M	M	M	M	M	M	Group 2, 4	7
	Smothering and siltation changes (light)	O	L				H				L	*M			*Cerastoderma edule*	8
	Smothering and siltation changes (heavy)	O	N	M	L	NR	H	H	H	H	M				Group 2, 4, 5, 10	7
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR	Group 10	7
Chemical	Transition elements & organo-metal contamination	O, F, S	L				M				M	*H			*Hediste diversicolor*	2

Table 1. cont. Sensitivity assessment for Infralittoral Mud.

Pressures		Associated sectors	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Asterias rubens, Carcinus maenas*	1, 4
	Synthetic compound contamination	O, F, S	N				H				M	*H			*Hediste diversicolor, Aphelochaeta marioni, Arenicola marina*	2, 5, 9
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	N				H				M	*H			*Asterias rubens, Liocarcinus depurator, Cerastoderma edule*	1, 3, 8
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2	7
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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32. Infralittoral Sand

Sensitivity Assessment

Table 1. Sensitivity assessment for Infralittoral Sand. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(b), 1(c), 1(d), 3, 5, 6, 7	10
	Physical change (to another seabed type)	O, F	L	M	L	NR	H	M	L	NR	L	M	L	NR	Group 7	10
	Physical change (to another sediment type)	O, F	L	M	L	NR	H	M	L	NR	L	M	L	NR	Group 7	10
	Habitat structure change-removal of substratum (extraction)	O	N	H	M	L	H	H	H	H	M	H	M	L	Group 1(b), 1(c), 1(d), 3, 5, 6	10
	Abrasion/disturbance of substratum surface or seabed	O, F	M	L	NR	NR	M	L	NR	NR	M	L	NR	NR	Group 1(c), 4	10
	Penetration or disturbance of substratum subsurface	O, F	L	L	NR	NR	M	L	NR	NR	M	L	NR	NR	Group 1(c), 4	10

Table 1. cont. **Sensitivity assessment for Infralittoral Sand.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**		
Physical	**Changes in suspended solids (water clarity)**	**O, F**	M	L	NR	NR	M	L	NR	NR	M	L	NR	NR	Group 4	10
	Smothering and siltation changes (light)	**O**	N				H				M	*L			*Balanus crenatus*	11
	Smothering and siltation changes (heavy)	**O**	N	H	H	H	M	L	NR	NR	M	L	L	L	Group 1(c), 1(d), 4, 5	10
	Underwater noise	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	**Water flow changes**	**O**	H	M	L	NR	H	H	H	H	NS	M	L	L		
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	L				H				L	*H			*Spiophanes bombyx, Lanice conchilega, Asterias rubens, Cancer pagurus, Balanus crenatus*	1, 3, 4, 8, 11

Table 1. cont. Sensitivity assessment for Infralittoral Sand.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Asterias rubens, Carcinus maenas*	4, 7
	Synthetic compound contamination	O, F, S	N				H				M	*H			*Spiophanes bombyx, Spio filicornis, Lanice conchilega, Urticina felina, Cancer pagurus, Balanus crenatus*	1, 2, 3, 6, 8, 11
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	N				H				M	*H			*Asterias rubens, Liocarcinus depurator, Balanus crenatus*	4, 5, 11
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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33. Offshore Circalittoral Coarse Sediments

Sensitivity Assessment

Table 1. Sensitivity assessment for Offshore Circalittoral Coarse Sediments. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = Very Low, NS = not sensitive.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 2, 4, 5, 6	2
	Physical change (to another seabed type)	O, F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Physical change (to another sediment type)	O, F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Habitat structure change-removal of substratum (extraction)	O	N	M	L	NR	M	L	NR	NR	M	L	L	NR	Group 2, 4, 5, 6	2
	Abrasion/disturbance of substratum surface or seabed	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2, 4, 5	2
	Penetration or disturbance of substratum subsurface	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2, 4, 5	2

Table 1. cont. **Sensitivity assessment for Offshore Circalittoral Coarse Sediments.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	H	M	M	M	M	M	M	M	M	M	M	Group 2, 4	2
	Smothering and siltation changes (light)	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Smothering and siltation changes (heavy)	O	N	H	H	H	M	L	NR	NR	M	L	L	L	Group 2, 4, 5	2
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	H	M	L	NR	H	H	H	H	NS	M	L	L		
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Coarse Sediments.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2	2
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

References for sensitivity assessment

1. Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A
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34. Offshore Circalittoral Mixed Sediments

Sensitivity Assessment

Table 1. Sensitivity assessment for Offshore Circalittoral Mixed Sediments. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 4, 5, 6, 8(c)	2
	Physical change (to another seabed type)	O, F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Physical change (to another sediment type)	O, F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Habitat structure change-removal of substratum (extraction)	O	N	M	L	NR	L	L	NR	NR	H	L	L	NR	Group 5	2
	Abrasion/disturbance of substratum surface	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 4, 5, 8(c)	2
	Penetration or disturbance of subsurface	O, F	M	H	H	H	M	M	M	M	M	M	M	M	Group 4, 5, 8(c)	2

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Mixed Sediments. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	H	M	M	M	M	M	M	M	M	M	M	Group 4	2
	Smothering and siltation changes (light)	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Smothering and siltation changes (heavy)	O	N	H	H	H	L	L	NR	NR	H	L	L	L	Group 5	2
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	H	M	L	NR	H	H	H	H	NS	M	L	L		
Chemical	Transition elements & organo-metal contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Mixed Sediments.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

References for sensitivity assessment

1. Tillin, H, Tyler-Walters, H. (2013). Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 1 Report: Rationale and proposed ecological groupings for Level 5 biotopes against which sensitivity assessments would be best undertaken JNCC Report No. 512A
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35. Offshore Circalittoral Mud

Sensitivity Assessment

Table 1. Sensitivity assessment for Offshore Circalittoral Mud. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sectors	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(a), 1(c), 2, 3, 4, 5, 6, 8(c)	5
	Physical change (to another seabed type)	O, F	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	5
	Physical change (to another sediment type)	O, F	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	5
	Habitat structure change-removal of substratum (extraction)	O	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	5
	Abrasion/disturbance of substratum surface or seabed	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 1(a)	5
	Penetration or disturbance of substratum subsurface	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 1(a)	5

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Mud. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	H	M	M	M	M	M	M	M	M	M	M	Group 2, 4	5
	Smothering and siltation changes (light)	O	M				H				L	*H			*Asterias rubens, Amphiura filiformis*	2, 3
	Smothering and siltation changes (heavy)	O	N	H	H	H	M	L	NR	NR	M	L	L	L	Group 1(c), 2, 4, 5, 8(c)	5
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	5
Chemical	Transition elements & organo-metal contamination	O, F, S	L				H				L	*H			*Abra alba, Asterias rubens*	1, 2

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Mud.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Asterias rubens, Amphiura filiformis*	2, 3
	Synthetic compound contamination	O, F, S	L				H				M	*M			*Abra alba, Amphiura filiformis*	1, 3
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	N				H				M	*H			*Asterias rubens*	2
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	M	H	H	H	M	M	M	M	M	M	M	M	Group 2	5
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

References for sensitivity assessment

1. Budd, G.C. 2007. *Abra alba* White furrow shell. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 24-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1722
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36. Offshore Circalittoral Sand

Sensitivity Assessment

Table 1. Sensitivity assessment for Offshore Circalittoral Sand. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 4, 5, 7, 8(c)	4
	Physical change (to another seabed type)	O, F	L	M	L	NR	H	M	L	NR	L	M	L	NR	Group 7	4
	Physical change (to another sediment type)	O, F	L	M	L	NR	H	M	L	NR	L	M	L	NR	Group 7	4
	Habitat structure change-removal of substratum	O	N	M	L	NR	M	M	L	M	M	M	L	L	Group 4, 5 8(c)	4
	Abrasion/disturbance of substratum surface or seabed	O, F	M	L	NR	NR	M	L	NR	NR	M	M	L	M	Group 4, 8(c)	4
	Penetration or disturbance of substratum subsurface	O, F	L	H	H	M	M	L	NR	NR	M	M	L	M	Group 4, 8(c)	4

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Sand. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**		
Physical	**Changes in suspended solids (water clarity)**	**O, F**	M	L	NR	NR	M	L	NR	NR	M	L	NR	NR	Group 4	4
	Smothering and siltation changes (light)	**O**	L				H				L	*H			*Amphiura filiformis, Owenia fusiformis*	1, 2
	Smothering and siltation changes (heavy)	**O**	N	M	L	L	M	M	L	M	M	M	L	L	Group 4, 5, 8(c)	4
	Underwater noise	**O, F, S**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	**Water flow changes**	**O**	H	M	L	NR	H	H	H	H	NS	M	L	L		
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	L				H				L	*L			*Amphiura filiformis*	

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Sand.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				M				M	*M			*Amphiura filiformis*	1
	Synthetic compound contamination	O, F, S	N				M				M	*L			*Amphiura filiformis*	1
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	M				H				L	*H			*Amphiura filiformis*	1
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

References for sensitivity assessment

1. Hill, J.M. & Wilson, E. 2008. *Amphiura filiformis* A brittlestar. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 24-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1400
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37. Offshore Circalittoral Rock and Biogenic Reef

Sensitivity Assessment

Table 1. Sensitivity assessment for Offshore Circalittoral Rock and Biogenic Reef. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	Group 1(a), 1(b), 1(c), 1(d), 3, 8(b), 8(c)	10
	Physical change (to another seabed type)	O, F	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	10
	Physical change (to another sediment type)	O, F	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	10
	Habitat structure change-removal of substratum	O	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	10
	Abrasion/disturbance of substratum surface or seabed	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 1(a)	10
	Penetration or disturbance of subsurface	O, F	L	H	H	L	L	M	L	M	H	M	L	L	Group 1(a)	10

Table 1. cont. **Sensitivity assessment for Offshore Circalittoral Rock and Biogenic Reef.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Physical	Changes in suspended solids (water clarity)	O, F	M	L	L	NR	H	H	H	H	L	L	L	L	Group 1(d)	10
	Smothering and siltation changes (light)	O	L				No Info				H	*L			*Axinella dissimilis*	3
	Smothering and siltation changes (heavy)	O	L	L	NR	NR	M	M	L	M	M	L	L	L	Group 1(c), 8(c)	10
	Underwater noise	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Electromagnetic energy	O	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		
Hydrological	Water flow changes	O	N	M	L	M	L	M	L	M	H	M	L	M	Group 1(a)	10
Chemical	Transition elements & organo-metal contamination	O, F, S	N				H				M	*L			*Echinus esculentus*	12

Table 1. cont. Sensitivity assessment for Offshore Circalittoral Rock and Biogenic Reef.

Pressures		Associated sectors	Resistance				Resilience				Sensitivity				Group/characterising species associated with sensitivity score	References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC		
Chemical	Hydrocarbon & PAH contamination	O, F, S	N				H				M	*H			*Asterias rubens, Ophiothrix fragilis, Echinus esculentus*	2, 5, 12
	Synthetic compound contamination	O, F, S	N				H				M	*H			*Urticina felina, Cancer pagurus, Flustra foliacea, Echinus esculentus, Balanus crenatus*	6, 7, 11, 12, 13
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR		
	Deoxygenation	O	L				M				M	*H			*Alcyonium digitatum, Asterias rubens, Henricia oculata, Ophiothrix fragilis, Eunicella verrucosa, Balanus crenatus*	1, 2, 4, 5, 8, 13
	Organic enrichment	O														
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NEv	NR	NR	NR	NEv	NR	NR	NR	NEv	NR	NR	NR		
	Removal of target species	F	L	H	H	M	H	H	H	M	L	H	H	M	Group (b)	10
	Removal of non-target species	F	H	M	L	NR	H	H	H	H	NS	M	L	L		

*Overall confidence scores taken from MarLIN sensitivity analyses for characterising species.

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38. Carbon sequestration

Sensitivity Assessment

Table 1. Sensitivity assessment for carbon sequestration. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Physical loss (to land or freshwater habitat)**	**O**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Physical change (to another seabed type)	**O, F**	None	L	L	NR	NEv	L	L	NR	NEv	L	L	NR	
	Physical change (to another sediment type)	**O, F**	None	L	L	NR	NEv	L	L	NR	NEv	L	L	NR	
	Habitat structure change-removal of substratum (extraction)	**O**	None	L	L	NR	NEv	L	L	NR	NEv	L	L	NR	
	Abrasion/disturbance of substratum surface or seabed	**O, F**	None	L	L	NR	NEv	L	L	NR	NEv	L	L	NR	
	Penetration or disturbance of substratum subsurface	**O, F**	None	L	L	NR	NEv	L	L	NR	NEv	L	L	NR	

Table 1. cont. **Sensitivity assessment for carbon sequestration.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Smothering and siltation changes (light)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Smothering and siltation changes (heavy)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Underwater noise	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Electromagnetic energy	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Hydrological	Water flow changes	O	None	L	L	NR	High	L	L	NR	Medium	L	L	NR	
Chemical	Transition elements & organo-metal contamination	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

Table 1. cont. Sensitivity assessment for carbon sequestration.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Synthetic compound contamination	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Introduction of other substances	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Deoxygenation	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Removal of target species	F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Removal of non-target species	F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

Evidence on the sensitivity of carbon sequestration to these pressures was limited and the team did not have the expertise to interpret it. We approached Mark Coughlan, an expert in the field for a synthesis of the current knowledge which can be found in appendix 10 (case report 30).

39. Western Irish Sea Front

Sensitivity Assessment

Table 1. Sensitivity assessment for Western Irish Sea Front. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sectors	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Physical change (to another seabed type)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Physical change (to another sediment type)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Habitat structure change-removal of substratum (extraction)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Abrasion/disturbance of substratum surface or seabed	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Penetration or disturbance of substratum subsurface	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-

Table 1. Sensitivity assessment for Western Irish Sea Front cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Changes in suspended solids (water clarity)	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Smothering and siltation changes (light)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Smothering and siltation changes (heavy)	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Underwater noise	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Electromagnetic energy	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Barrier to species movement	O, F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Death or injury by collision	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Hydrological	Water flow changes	O	H	L	L	L	H	L	L	L	Not sensitive	L	L	L	
Chemical	Transition elements & organo-metal contamination	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-

Table 1. Sensitivity assessment for Western Irish Sea Front cont.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Synthetic compound contamination	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Introduction of other substances	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Deoxygenation	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Organic enrichment	O	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-
	Removal of target species	F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Removal of non-target species	F	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

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40. European Flat Oyster (*Ostrea edulis)*

Sensitivity Assessment

Assessed by MaRLIN see Perry, F., Jackson, A. & Garrard, S. L. 2017. *Ostrea edulis* Native oyster. In Tyler-Walters H. and Hiscock K. *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 28-04-2023]. Available from: https://www.marlin.ac.uk/species/detail/1146

Table 1. Sensitivity assessment for European Flat Oyster, *Ostrea edulis*. NR = not relevant, NA = not assessed, NEv = no evidence, H = high, M = medium, L = low, VL = very low, N = none, NS = not sensitive. Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Physical	Physical loss (to land or freshwater habitat)	O	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another seabed type)	O, F	N	H	H	H	VL	H	H	H	H	H	H	H	See full reference list below
	Physical change (to another sediment type)	O, F	H	L	NR	NR	H	H	H	H	NS	L	L	L	See full reference list below
	Habitat structure change-removal of substratum (extraction)	O	N	H	H	H	VL	H	H	M	H	H	M	M	See full reference list below
	Abrasion/disturbance of substratum surface or seabed	O, F	L	H	M	M	L	H	H	M	H	H	M	M	See full reference list below
	Penetration or disturbance of substratum subsurface	O, F	L	H	M	M	L	H	H	M	H	H	M	M	See full reference list below

Table 1. cont. **Sensitivity assessment for European Flat Oyster, *Ostrea edulis*.** Associated sectors include activities related to offshore renewable energy (O), Fishing (F), or shipping (S).

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	**Pressure type**		**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	**Score**	**QoE**	**AoE**	**DoC**	
Physical	**Changes in suspended solids (water clarity)**	**O, F**	L	H	M	M	L	H	H	M	H	H	M	M	See full reference list below
	Smothering and siltation changes (light)	**O**	L	H	H	M	VL	H	H	M	H	H	M	M	See full reference list below
	Smothering and siltation changes (heavy)	**O**	N	H	H	M	VL	H	H	M	H	H	M	M	See full reference list below
	Underwater noise	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Electromagnetic energy	**O**	NEv	NR	NR	NR	NR	NR	NR	NR	NEv	NR	NR	NR	
	Barrier to species movement	**O, F**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
	Death or injury by collision	**O, F, S**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Hydrological	**Water flow changes**	**O**	H	M	M	M	H	H	H	H	NS	M	M	M	See full reference list below
Chemical	**Transition elements & organo-metal contamination**	**O, F, S**	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	

Table 1. cont. Sensitivity assessment for European Flat Oyster, *Ostrea edulis*.

Pressures		Associated sector(s)	Resistance				Resilience				Sensitivity				References
Classification	Pressure type		Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	Score	QoE	AoE	DoC	
Chemical	Hydrocarbon & PAH contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Synthetic compound contamination	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Introduction of other substances	O, F, S	NA	NR	NR	NR	NA	NR	NR	NR	NA	NR	NR	NR	
	Deoxygenation	O	H	M	M	M	H	H	H	H	NS	M	M	M	See full reference list below
Biological	Introduction or spread of invasive non-indigenous species	O, F, S	L	M	M	M	VL	H	H	M	H	M	M	M	See full reference list below
	Removal of target species	F	N	H	M	M	VL	H	H	M	H	H	M	M	See full reference list below
	Removal of non-target species	F	N	M	M	M	VL	H	H	M	H	M	M	M	See full reference list below

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