Principles Report

Marine Protected Sites Screening Tool

The Crown Estate

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Contents

Acronyms

Abbreviation	Definition
BDMPS	Biologically Defined Minimum Population Size
cSAC	Candidate Special Areas of Conservation
EEZ	Exclusive Economic Zone
HPMA	Highly Protected Marine Areas
HRA	Habitats Regulations Assessment
LSE	Likely Significant Effects
MCZ	Marine Conservation Zones
MHWS	Mean high water spring
PIZ	Primary Impact Zone
RIAA	Report to Inform Appropriate Assessment
SAC	Special Areas of Conservation
SCIs	Sites of Community Importance
SIZ	Secondary Impact Zone
SNCBs	Statutory Nature Conservation Bodies
SPA	Special Protection Areas
TCE	The Crown Estate
WTG	Wind turbine generator

Glossary

Term	Description
Appropriate Assessment (AA)	Stage 2 of the Habitats Regulations Assessment process, required where likely significant effects (LSE) cannot be ruled out at the screening stage.
Array	The area of an offshore wind development containing turbines and associated infrastructure.
Aggregates Extraction	The commercial removal of sand, gravel, and crushed rock from the seabed for use in construction, coastal defence, and land reclamation.
BDMPS	Biologically Defined Minimum Population Scales; codes used in bird assessments relating to population connectivity.
Co-located Hydrogen (Co Located H2)	Hydrogen production, storage, or associated infrastructure that is developed alongside offshore wind farms within the same array area. This typically involves using electricity generated by offshore wind turbines to produce hydrogen via electrolysis, enabling integrated offshore energy solutions.
Conservation Objectives	The goals set for a protected site, usually to maintain or restore habitats and species for which the site is designated.
Connectivity Screening	The process of checking whether a spatial overlap or impact pathway exists between a proposed activity and a protected site.
De minimis	A legal term meaning too small to be meaningful or taken into consideration; immaterial.
Designated Site Type	The legal category of a protected site used in screening (e.g., SAC, SPA, MCZ).
Electromagnetic Fields (EMF)	Electric and magnetic disturbances produced by subsea cables or equipment.
European Sites	Collective term for SACs, cSACs, SPAs, proposed SACs, potential SPAs, Sites of Community Importance (SCI) and Ramsar sites.

Term	Description
Export Cable	Subsea cables used to transmit electricity from offshore wind arrays to shore.
Feature Group	Categories of protected features such as Birds, Fish, Habitats, or Mammals.
Fixed Offshore Wind Farm	Offshore wind farms where turbines are installed on fixed foundations (such as monopiles, jackets, or gravity bases) that are secured directly to the seabed.
Floating Offshore Wind Farm (FLOW)	Offshore wind farms where turbines are mounted on floating platforms that are anchored to the seabed using mooring lines or chains.
Habitats Regulations	The Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017.
Habitats Regulations Assessment (HRA)	A legally required process to determine whether a plan/project will affect European sites.
Migratory Waterbirds	Birds that migrate seasonally between breeding and wintering grounds, often across international boundaries.
Protected Site	Collective term for European sites, HPMAs, and MCZs.
Ramsar Site	A wetland site of international importance designated under the Ramsar Convention.

1. Introduction

1.1. Background and purpose of the report

1.1.1 A marine Screening Tool was developed by NIRAS on behalf of The Crown Estate (TCE) to support the process of identifying whether certain marine development activities are likely to have a significant effect on any European offshore marine site or European site (Special Areas of Conservation (SAC), candidate SACs (cSAC), Special Protection Areas (SPA), proposed SACs, potential SPA (pSPA), Sites of Community importance (SCI), or Ramsar site).

1.1.2 The tool was originally built for the Offshore Wind Round 4 Plan HRA (fixed bottom wind), developed further for the Round 5 (Celtic Sea Floating Offshore Wind) Plan HRA (floating wind and co-located hydrogen), and has since evolved to support screening in relation to marine aggregates extraction. The tool has also been extended to include screening for more categories of protected sites and now includes Marine Conservation Zones (MCZ) alongside HRA screening. The tool does not currently support screening with respect to areas identified or required to compensate for damage to a European site, and although HRA screening is provided for the whole of the UK and for transboundary sites, the tool does not currently support screening for Nature Conservation Marine Protected Area (NCMPA) sites in Scotland.

1.1.3 Currently, the tool supports HRA and MCZ screening for fixed offshore wind, floating offshore wind (and co-located hydrogen) and marine aggregate extraction.

1.1.4 The screening method used by the tool is based on a set of assumptions which look for pressure-effect (impact) pathways between activities associated with a plan or project (i.e. marine development) and receptors (protected site features). In essence, the tool looks for connectivity between developments area(s), protected sites and their designated features.

1.1.5 The purpose of this report is to set out the default principles underpinning the tool, particularly the assumptions relating to development activities which may result in pressures acting on receptors, and the assumptions which define whether connectivity may exist (screened in) or not (screened out).

1.1.6 The screening principles (buffer distances) used by the tool can be amended manually. This can be done by using the 'Test new parameters' feature of the tool. Every screening distance used by the tool for each feature and pressure can be adjusted.

1.1.7 It is assumed that this report will be used by individuals familiar with the screening process and HRA/protected site assessments; therefore, no information is provided on the legislative context for screening or the wider assessment processes such as preparation of a Report to Inform Appropriate Assessment or MCZ assessment. Further, while providing a way to undertake screening rapidly and in a consistent, repeatable manner, the tool does not negate the need to engage in robust consultation with Statutory Nature Conservation Bodies (SNCBs) in relation to screening.

1.1.8 The tool does not automate all aspects of screening. Detail of the additional steps required to complete screening for breeding seabirds in the non-breeding season, migratory waterbirds, and migratory seabirds, are provided in Appendix B. Further information is also available in the worked example provided for the Round 4 plan-level HRA, provided as Appendix B.

1.1.9 Practical instructions and examples of how to use the tool can be found in the 'User Guide' NIRAS, (2025a).

1.2. Evidence Base

1.2.1 The methods employed by the screening tool have been developed from an evidence base comprised of a number of previous offshore wind development rounds managed by The Crown Estate:

- 2017 Project Extensions HRA (NIRAS, 2019)
- Round 4 HRA (NIRAS 2021a)
- Round 4 MCZ Assessment (NIRAS 2021b)
- Round 5 Plan-level HRA (NIRAS, 2024)
- Capacity Increase Plan-level HRA and MCZ Assessment (NIRAS, 2025b)

1.2.2 Evidence is also drawn from methods used in relation to screening for plan-level HRAs and strategic assessments undertaken on behalf of other competent authorities, including the sectoral plan for offshore wind in Scotland (ABPmer, 2019) and the draft UK Offshore Energy Strategic Environmental Assessment 4 (BEIS, 2022). Plan-level screening undertaken for marine aggregates (ABPmer, 2022; NIRAS, 2016) was referred to when the tool was modified to include this sector.

1.2.3 Co-located hydrogen production was included in the HRA and MCZ Screening Tool development as it was considered as part of the assessment for the Round 5 - Celtic Sea Floating Offshore Wind Plan (NIRAS, 2022).

1.2.4 In contrast to offshore wind and aggregates extraction, the production of hydrogen using marine renewable power is at an early stage of development and had not been included in any previous national or strategic Plan when considered as part of the Round 5 Plan. The approach taken in relation to screening was to identify the likely infrastructure requirements for co-located hydrogen production, storage and distribution and to consider how these would affect the environmental impact of any associated floating wind development.

1.3. Consideration of Guidance

Screening methods have been developed with reference to key guidance documents. These primarily relate to HRA; however, the screening tool applies equivalent principles to MCZ screening. The relevant documents are:

- Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (European Commission, 2002);
- Communication from the Commission on the precautionary principle (European Commission, 2000);
- EU Guidance on wind energy development in accordance with the EU nature legislation (European Commission, 2011);
- When new marine Natura 2000 sites should be taken into account in offshore renewable energy consents and licences (DECC, 2016);

- National Assembly for Wales Research Briefing. The Planning Series: 16 – Habitats Regulations Assessment (Davies & Dodds, 2017);
- Managing Natura 2000 sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (European Commission, 2018);
- Guidance on the use of Habitats Regulations Assessment (Ministry of Housing, Communities and Local Government, 2019);
- The Planning Inspectorate (2016) guidance, although developed for project consenting, provides useful information on the HRA process;
- Habitats regulations assessments: protecting a European site (DEFRA, 2021)
- Marine conservation zones and marine licensing (Marine Management Organisation, 2013a).

1.3.1 The principles outlined here are also applicable to MCZs.

1.4. Precautionary Principle

1.4.1 The screening tool adopts a precautionary approach to ensure that no relevant protected sites, features or pressures are excluded, basing screening on establishing connectivity. The implication of this approach is that protected sites and features are screened in unless a clear conclusion of no likely significant effect can be made because of an absence of connectivity. In plan-level HRAs, the approach taken has been to carry all sites, features and pressures screened in by the tool through to Stage 2 (assessment), then undertake an 'initial assessment' in which the long-list is reduced to a shorter list requiring more detailed assessment. In many project level HRAs it is customary to minimise the number of sites-features-pressures in Stage 2 by undertaking such 'filtering' as part of the screening process.

1.5. Engagement and Consultation

1.5.1 The opinions of relevant SNCBs were sought in relation to screening and RIAA outcomes for previous plan-level HRAs (NIRAS, 2020; NIRAS, 2022). This is not stated to imply specific endorsement of the tool by SNCBs, but as evidence that its use for HRA and MCZ screening has been accepted. In such previous uses SNCBs have at times provided advice which resulted in adjustments to screening outcomes; this is an important part of the overall screening process.

2. Screening Methods

2.1. Scope

2.1.1 As The Crown Estate manages the seabed below mean high water spring (MHWS) only, the scope of screening is limited to infrastructure and activities in the marine environment below MHWS. As such, onshore infrastructure such as transmission assets are excluded.

2.1.2 Protected sites and features included in screening are all those for which impact pathways may exist with marine development. For example, sand dune and some saltmarsh habitats are present above mean high water but are included in the tool because of the potential for remote or indirect effects, such as via altered sediment transport processes due to the presence of fixed structures in the marine environment.

2.1.3 No protected sites are considered in relation to bats because the species for which sites are designated in the UK are considered to be sedentary. Migration of bats from protected sites in EU Member States is understood to be diffuse across a broad front with individuals dispersing widely across the UK (Hooker *et al.,* 2025).

2.1.4 Receptors are combined into logical groups so that screening methods (parameters) can be defined efficiently, irrespective of the category of protected site, with adjustments to reflect species-specific considerations where necessary. On this basis, the following receptor groups are considered by the screening tool:

- Habitats – Annex I features of SACs, MCZ habitat and geomorphological/geological features, and 'sessile species' which are features of MCZs (such as pink sea fan or taxa with limited mobility, such as squat lobster)
- Marine mammals (including otters) which are Annex II features of protected sites:
    - Grey and harbour seal,
    - Harbour porpoise and bottlenose dolphin,
    - Otter.
- Migratory fish (and freshwater pearl mussel) which are Annex II features of protected sites:
    - Atlantic salmon (and freshwater pearl mussel, which it is assumed should be screened in whenever LSE for Atlantic salmon cannot be excluded)
    - River lamprey,
    - Sea lamprey,
    - Allis shad,
    - Twaite shad.
- Seabirds and migratory birds which are features of SPAs, Ramsar sites or MCZs.

2.1.5 HRA and MCZ screening is undertaken in the same way by the tool. Details are provided in the sections below.

2.1.6 For Ramsar sites, the tool is currently limited to ornithological features of sites in the UK, not including Crown dependencies (e.g. Channel Islands). If screening for other features of Ramsar sites and/or non-UK Ramsar sites is required, this currently needs to be undertaken separately.

2.2. Identification of Pressures

2.2.1 The screening tool relies on generalised assumptions about the pressures associated with the various development activities, for all phases from construction through to decommissioning, based on established approaches to plan-level screening, as summarised in Section 1.2. More detailed information such as design envelope parameters required for a RIAA or MCZ/HPMA assessment (areas of impact, turbine capacity etc.) are not utilised by the screening tool.

2.2.2 Pressures relate to impact pathways, which are based on the following broad groupings described for Natura 2000 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC Project, 2001):

a) Physical Loss/Gain of habitats from removal or smothering;

b) Physical Damage of habitats and species from siltation, erosion or physical injury/death;

c) Non-Physical (Indirect) Disturbance from noise, barrier effects or visual presence and reduced availability or exclusion/displacement of species, including prey;

d) Toxic Contamination from the introduction of synthetic compounds and introduction of non-synthetic contaminants;

e) Non-Toxic Contamination from nutrient enrichment, organic enrichment, changes in suspended sediment and turbidity, changes in salinity or changes to the thermal regime; and

f) Biological Disturbance from introduction of microbial pathogens, the introduction of invasive non-native species and translocation, or from selective extraction of selected species.

2.2.3 These impact pathways can lead to pressures, which help underpin management advice for European sites in Natural England's conservation advice packages for Marine Protected Areas (Natural England, 2020), and JNCC's pressure-activities database (Robson et al., 2018). They can also be related to NRW's Regulation 37 advice packages, and DAERAs Guidance for Marine Protected Area Assessments in the NI inshore (DAERA, 2022).

2.2.4 The pressures referred to by the screening tool, for all activities, are set out in Table 2.1. For the purposes of the tool, pressures from SNCB management advice are not utilised directly; rather, a minimum number of pressure categories have been identified in order to comprehensively describe the range of pressures relevant to each activity type. For example, P3 (indirect physical damage) encompasses all effects relating to hydrodynamic changes due to the presence of infrastructure, such as scour formation, wave climate changes, and the deposition of suspended sediments.P16 (entanglement) covers entanglement risk with, for example, mooring lines and was expanded to include entrainment in water intakes for the purpose of screening for co-located hydrogen production. Natural England (2020) pressure codes are related to the impact pathways referred to in Appendix 1. This analysis is for fixed offshore wind, and is not currently available for aggregates extraction, floating wind or co-located hydrogen.

2.2.5 Certain pressures, such as P1 habitat loss/gain and P2 direct physical damage, are universal to all activities supported by the tool. Others such as P17 salinity are only relevant to a single activity type (co-located hydrogen production in this example).

Table 2.1 Pressures caused by impact pathways considered by the screening tool.

Pathway	Code	Name	Description
I. Physical Loss/Gain of habitats from removal or smothering	P1	Habitat Loss/Gain	Permanent or temporary change to habitat availability or quality.
II. Physical Damage of habitats and species from siltation, abrasion, erosion, coastal process effects or physical injury/death	P2	Direct Physical Damage	Immediate damage to habitats or species caused by activities or equipment.
	P3	Indirect Physical Damage	Secondary effects such as sediment changes or erosion.
	P4–P6	Collision	Risk of animals colliding with infrastructure (e.g., turbines, vessels).
	P16*	Entanglement	Risk of animals becoming caught in ropes, nets, or debris. Also used to describe entrainment into equipment
III. Non-Physical (Indirect) Disturbance from noise or visual presence and reduced availability or exclusion/displacement of species, including prey, and direct impacts of noise	P7	Physical Presence	Disturbance caused by human presence or structures.
	P8	Underwater Noise	Sound pressure or particle displacement related impacts.
	P9	Above Water Noise	Airborne noise affecting wildlife above the water's surface.

Pathway	Code	Name	Description
IV. Toxic Contamination from the introduction of synthetic compounds or non-synthetic contaminants	P10	Toxic Contaminants	Introduction of harmful substances into the environment.
V. Non-Toxic Contamination from changes in suspended sediment and turbidity, light and EMF emissions or changes to the thermal regime. (No pathway identified for nutrient enrichment or organic enrichment.)	P11	Electromagnetic Fields (EMF)	Electrical or magnetic disturbances from cables and equipment.
	P12	Light	Artificial lighting effects on wildlife behaviour and habitats.
	P13	Temperature	Alteration of water or air temperature in the environment.
	P14	Suspended Sediments	Particles stirred into the water column affecting visibility and habitat quality.
	P17*	Salinity	Changes in the salt concentration of water.
VI. Biological Disturbance from introduction of microbial pathogens, the introduction of invasive non-native species and translocation, or from selective extraction of selected species	P15	Invasive Species	Introduction or spread of invasive non-native species.

* numbering is non-sequential because entanglement and salinity were added as pressures for floating wind and co-located hydrogen production.

2.3. Feature specific Screening Criteria

2.3.1 As noted in Section 1.4, for the purposes of screening, the tool assumes that connectivity alone is sufficient to screen in. For most receptors, connectivity is evaluated using feature-specific spatial criteria which relate to the potential range (distance) of impacts associated with pressures and/or the ranging behaviour of mobile species. There is an exception for certain bird features, for which additional analysis (not provided by the screening tool) is required (see paragraph 1.1.7).

2.3.2 For screening by the tool, connection between features of protected sites and activities is determined by spatial parameters. The spatial parameters (distances) are specific to each pressure where they describe the potential range of influence of activities, and reflect typical maximum ranging behaviour from protected sites for features.

2.3.3 The following sections set out the screening criteria for the different activity types, having first set out assumptions for the pressures associated with each (i.e. which of the long-list of pressures from Table 2.1 should be applied for screening).

2.3.4 Different criteria has been applied to marine aggregates extraction compared to screening for offshore wind. Ranging behaviour is prioritised over pressure effect distance in most cases (other than for birds), reflecting the relatively conservative distances assumed for such behaviour. Refer to section 5 for further details.

3. Screening Criteria for Fixed Offshore Wind

3.1. Habitats

3.1.1 Habitat features occur only within protected sites. The range of influence of each pressure is relevant to screening (Table 3.1).

3.1.2 Pressures excluded from screening for fixed offshore wind in relation to habitats are:

- P4/5 Collision (marine mammals and fish/birds) - pressure not relevant to habitats.
- P7 Physical presence - pressure only relevant for mobile species.
- P8/9 Underwater/above water noise - particle displacement through noise will physically interact with subtidal and intertidal habitats. Relevant species, such as biogenic reef forming species might be sensitive. However, there is no evidence that habitats or relevant species will be affected.
- P11 Electromagnetic Fields (EMF) - believed not to be important for features or associated species and communities.
- P12 Light - believed not to be important for features or associated species and communities.
- P16 Entanglement – only relevant for certain features in relation to floating wind or co-located hydrogen production.
- P17 Salinity – only relevant in relation to co-located hydrogen production.

Table 3.1 Pressures used for screening in relation to fixed offshore wind for habitats and associated spatial criteria.

Pressure	Spatial extent	Rationale
Fixed Offshore wind		
P1 Habitat loss/gain This relates to the loss of coastal/offshore seabed habitats due to installation of structures including WTG device foundations and cable protection, and where relevant the associated introduction of new habitat. This is a permanent impact which occurs during the construction phase.	0 km	Impact is restricted to the footprint of physical structures, i.e. direct overlap.
P2 Direct physical damage This relates to the physical damage caused by, for example, pre-sweeping, cable burial, survey equipment deployment (e.g. cores, trawls), or anchors. This is relevant to the construction, operation and decommissioning phases.	0 km	Impact is restricted to the footprint of physical structures, i.e. direct overlap.
P3 Indirect physical damage This relates to changes in hydrological energy flows resulting in scour, changes to wave	15 km	Environmental change induced through altered coastal processes is assumed to occur up to a typical

Pressure	Spatial extent	Rationale
exposure arising from the physical presence of structures in the marine environment or temporary seabed preparation works. Impacts could include: changes to wave characteristics such as wave height, period and direction, changes to tidal currents (speed and direction), changes to tidal and current wave interactions, changes to the magnitude and direction of sediment transport processes, erosion (scour) and deposition impacts. Damage/disturbance due to smothering by dredge disposal is also included. This is relevant to the construction, operation and decommissioning phases.		maximum tidal excursion distance of 15 km (ABPmer, 2018).
P10 Toxic contamination This relates to reduced water quality from, for example, spillages or mobilisation of contaminated sediments resulting in toxic effects. This is relevant to the construction, operation and decommissioning phases.	15 km	Coastal and marine habitats are considered potentially sensitive to effects from contamination where they may be present below high water. Screening will be based on a typical maximum tidal excursion, in line with the approach adopted for P3. This is not applicable to habitats above mean high water. The assessment will not cover accidental releases such as oil spills resulting from vessel collisions which could disperse over wider areas but are not planned.
P13 Temperature Operating submarine power cables generates heat which can result in temperature changes to adjacent sediments where the cable is buried. The high heat capacity of water means that temperature changes experienced by fauna, other than those present as infauna, will be negligible and this pressure therefore relates only to subtidal habitats. This is relevant to the operational phase only.	0.01 km	Effect ranges are expected to be limited to the immediate vicinity of cables (OSPAR, 2009) and a buffer of 10 m (0.01 km) will be applied.
P14 Suspended sediments This relates to increased turbidity arising from disturbance of seabed sediments with potential associated impacts such as reduction in dissolved oxygen levels, reduced light penetration and altered suspended sediment supply. Mudflats	15 km	Subtidal habitats (other than estuaries and mudflats) are assumed to be potentially sensitive and a 15 km (tidal excursion, as for P3) buffer will be used for screening.

Pressure	Spatial extent	Rationale
which are associated with naturally high levels of suspended sediments, and habitats above high water, are not considered to be sensitive to suspended sediments. This is relevant to the construction, operation and decommissioning phases.		
P15 Invasive non-native species (INNS) INNS can smother or replace existing habitats. This is relevant to the construction, operation and decommissioning phases.	15 km	It is assumed that subtidal and other habitats below high water could be sensitive to effects arising from the presence of non-native species and a 15 km (tidal excursion) parameter will be used for screening.

3.2. Marine mammals (including otters)

3.2.1 Pressures excluded from screening in relation to fixed offshore wind for cetaceans and pinnipeds are:

- P5 Collision (birds) - not relevant for marine mammals.
- P13 Temperature - not included because the magnitude of any increase in water temperature in areas over operational submarine power cabling will be negligible and not expected even to be detectable by highly mobile species such as marine mammals or the prey which they are dependent upon.
- P15 Invasive non-native species - believed not to represent risk of significant impact for marine mammals or prey they depend upon.
- P17 (Entanglement) & P18 (Salinity) – not relevant to fixed wind.

3.2.2 Pressures excluded from screening for otter are:

- P5 Collision (birds)- not relevant for otters.
- P11 Electromagnetic Fields (EMF) – there is no evidence that otters are sensitive to EMF.
- P13 Temperature - any increase in water temperature over operational submarine power cabling will be negligible and not expected to be detectable by highly mobile species such as otter.
- P14 Suspended sediments – it is not anticipated that otters are sensitive to suspended sediment to the extent they may become elevated by activities associated with offshore wind.
- P15 Invasive non-native species - not believed to represent risk of any significant impact for otters.
- P17 (Entanglement) & P18 (Salinity) – not relevant to fixed wind.

3.2.3 Ranging behaviour is key for marine mammal screening. Assumptions are set out below and summarised in Table 3.2.

3.2.4 Grey seal may travel considerable distances from their breeding and haul out sites to forage and previous plan-level HRAs have commonly adopted a 100 km buffer for this species (e.g. NIRAS, 2019, ABPmer, 2017; MMO, 2013b; 2015). This approach is based on evidence that most foraging occurs within this range (Jones et al., 2015; SCOS, 2016). A 100 km buffer is therefore applied in relation to grey seal.

3.2.5 Harbour seal generally range less than grey seal and normally feed within 40-50 km of their haul out sites (Thompson, 1993; SCOS, 2017). A 50 km buffer is therefore applied for harbour seal.

3.2.6 Bottlenose dolphin and harbour porpoise may range over relatively large distances (e.g. ABPmer, 2014). Previous Plan-level HRAs (e.g. Wood Environmental, 2019), including the 2017 Project Extensions Plan-Level HRA (NIRAS, 2019) have adopted the approach of screening in all sites within the Marine Mammal Management Units (MMMUs) defined by the UK Inter-Agency Marine Mammal Working Group (IAMMWG, 2015). These include UK sites and any sites outside UK waters with interest features in the same MMMU as the plan area.

3.2.7 An alternative approach for these features has been to use a conservative distance-based criterion and to screen in all sites within this range. A common distance for marine mammals has been 100 km, although sometimes sites beyond this distance have subsequently been screened in where foraging is considered to occur at greater range or potential development sites are within a relevant management unit (e.g. ABPmer, 2019). This was the distance used for the R4 and R5 Plan-level HRAs (NIRAS, 2021a) (NIRAS, 2022). Other HRAs have sought to consider whether animals make significant use of habitats outside European marine sites within their screening approaches; for example, BEIS (2019) screened in marine mammals from all UK SACs.

3.2.8 Otters are mobile and so are expected to occur both within and outside European sites. Therefore, both the potential range of each pressure and the animals' ranging behaviour are relevant to screening for impacts. An allowance of 10 km has been made for ranging behaviour, which is based on the 2017 Project Extensions HRA (NIRAS, 2019). Otters are territorial and guidance for surveys to assess impacts suggests distances of up to 200 m are appropriate (SNH, 2020). Standing advice in England notes that male otters may range up to 35 km (Natural England, 2018). Other plan-level HRAs, including in Scotland where otter tend to be more abundant, have noted that otters may utilise coastal waters, out to approximately 10 m water depth (ABPmer, 2018) and have assumed a conservative buffer of 10 km (e.g. ABPmer, 2017). Although it is noted that individuals may on occasions dive deeper (e.g. Kruuk, (1995) reported that otters had been observed diving to 14 m depth), or range more widely, the 10 km screening distance is adopted by the tool.

Table 3.2 Pressures used for screening in relation to marine mammals (seals, cetaceans and otter) and associated spatial criteria for fixed offshore wind.

Pressure	Group	Spatial extent	Rationale
Fixed offshore wind			
P1 Habitat loss/gain This relates to the loss of coastal/offshore seabed habitats due to installation of structures including WTG device foundations and cable protection, and where relevant the associated introduction of new habitat. This is a permanent impact which occurs during the construction phase. Impact as per Annex I habitats but to habitats designated for marine mammals.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal.	Ranging behaviour used to consider potential impacts to prey species.
Impact as per Annex I habitats but to habitats designated for otters outside relevant European sites.	Otter	0 km	Loss of habitat outside the designated site is expected to be of negligible consequence for otter, therefore only direct overlap will be assessed.
P2 Direct physical damage This relates to the physical damage caused by, for example, pre-sweeping, cable burial, survey equipment deployment (e.g. cores, trawls), or anchors. This is relevant to the construction, operation and decommissioning phases. Impact as per Annex I habitats but to habitats designated for marine mammals	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Ranging behaviour will be used to consider potential impacts to prey species.
Impact as per Annex I habitats but to habitats designated for otters outside relevant European sites.	Otter	0 km	Direct damage to habitat outside the designated site is expected to be of negligible consequence for otter, therefore only direct overlap will be used.

Pressure	Group	Spatial extent	Rationale
P3 Indirect physical damage This relates to changes in hydrological energy flows resulting in scour, changes to wave exposure etc. arising from the physical presence of structures in the marine environment or temporary seabed preparation works. Impacts could include: changes to wave characteristics such as wave height, period and direction, changes to tidal currents (speed and direction), changes to tidal and current wave interactions, changes to the magnitude and direction of sediment transport processes, erosion (scour) and deposition impacts. Damage/disturbance due to smothering by dredge disposal is also included. This is relevant to the construction, operation and decommissioning phases Impact as per Annex I habitats but to habitats designated for marine mammals.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Ranging behaviour will be used to consider potential impacts to prey species. These markedly exceed the assumed range of impact (15 km, as per Annex I habitats).
Impact as per Annex I habitats but to habitats designated for otters outside relevant European sites.	Otter	0 km	Indirect damage to habitat outside the designated site is expected to be of negligible consequence for otter, therefore only direct overlap will be used.
P4 Collision This relates to collisions between vessels and marine mammals/otters. This is relevant to the construction, operation and decommissioning phases.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Collisions could occur within offshore wind farm areas, or along vessel transit routes. Vessel transit routes are unknown and the Plan area cannot therefore be buffered to encompass them; however, since marine mammals are wide-ranging the incorporation of this behaviour into the screening process is

Pressure	Group	Spatial extent	Rationale
			considered a reasonable approach.
	Otter	10 km	Collisions could occur along vessel transit routes. Vessel transit routes are unknown; however, since otters are wide-ranging the incorporation of this behaviour into the screening process is considered a reasonable approach.
P7 Physical Presence This relates to the potential for the physical presence of offshore wind farm structures such as turbines and foundations to cause disturbance to individuals or a barrier to the movement of mobile species. It is recognised that some structures will be present during construction but for purposes of screening this is relevant to the operational phase only.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	The pressure would be expected to apply wholly within the Plan area (i.e. at or very close to the location of individual projects). Ranging behaviour used.
	Otter	10 km	The potential range of any impact, if occurring, is uncertain but considered likely to be limited to no more than a few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range, therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P8 Underwater Noise Underwater noise may lead to death, injury or disturbance and direct or	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and	Underwater noise could impact upon sensitive receptors such as marine mammals over considerable distances.

Pressure	Group	Spatial extent	Rationale
indirect (e.g. through impacts upon prey) impacts to marine mammals/fish. The pressure is considered in relation to all phases of development, although it is probable that the highest emissions of underwater noise in terms of the range of effect will occur during construction which could include foundation piling and/or UXO detonations.		grey seal; 50 km harbour seal	Screening will therefore account for the ranging behaviour of marine mammals.
Otter could potentially be disturbed in the coastal environment by noise from export cable installation works. This pressure could therefore be relevant during construction.	Otter	10 km	The potential range of any impact, if occurring, is uncertain but considered likely to be limited to no more than a few kilometres. Whilst the impact range is relatively small, it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P9 Above Water Noise Seals (whilst hauled out) could be subject to disturbance from airborne noise produced by activities such as construction vessels/plant, aircraft etc. This pressure is relevant during construction, operation or decommissioning. This is not considered to be a relevant pressure for cetaceans and so applies only to pinnipeds.	Seals	100 km grey seal; 50 km harbour seal	Above water noise is considered potentially disturbing for some few kilometres. Ranging behaviour is therefore considered to be appropriate for screening purposes.
Otters could be subject to disturbance from airborne noise produced by activities such as construction vessels/plant, aircraft etc. This pressure could be relevant during construction, operation or decommissioning.	Otter	10 km	Above water noise is considered potentially disturbing for some few kilometres. Whilst the impact range is relatively small, it can affect animals whilst they range. Therefore, the ranging behaviour of marine

Pressure	Group	Spatial extent	Rationale
			mammals is considered to be appropriate for screening purposes.
P10 Toxic contamination This relates to reduced water quality from, for example, mobilisation of contaminated sediments resulting in toxic effects. This is relevant to the construction, operation and decommissioning phases.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Toxic contamination is considered potentially relevant for some few kilometres (15 km as per Annex I habitats). Whilst the impact range is relatively small, it can affect animals whilst they range. Therefore, ranging behaviour is considered to be appropriate for screening purposes.
	Otter	10 km	Toxic contamination is considered potentially disturbing for some few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes. The assessment will not cover accidental releases such as oil spills resulting from vessel collisions which could disperse over wider areas but are not planned.
P11 Electromagnetic Field (EMF) There is evidence that cetaceans are sensitive to magnetic fields (Gill et al., 2005) and although there is considerable uncertainty about the importance of this sensitivity in the context of EMF associated with submarine power cabling this potential impact will be considered.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise	Submarine power cabling used by offshore wind farms typically results in elevations above the background level of the earth's geomagnetic field for distances of up to some tens of metres (Normandeau et al., 2011); a very conservative potential impact range is

Pressure	Group	Spatial extent	Rationale
NB. this pressure does not apply to pinnipeds for which there is no evidence of magnetic sensitivity. This is relevant to the operational phase only.			100 m (0.1 km). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, ranging behaviour is appropriate for screening
P12 Light Seals, primarily when hauled out, could be subject to light pollution. This is not considered to be a relevant pressure for cetaceans and so applies only to pinnipeds.	Seals	100 km grey seal; 50 km harbour seal	The potential range of disturbance is uncertain but assumed unlikely to be more than a few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, ranging behaviour is appropriate for screening
Otters could potentially be disturbed by light pollution.	Otter	10 km	The potential range of disturbance is uncertain but assumed unlikely to be more than a few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P14 Suspended sediments This relates to increased turbidity arising from disturbance of seabed sediments with potential associated impacts such as reduction in dissolved oxygen levels, reduced light penetration and altered suspended sediment supply. Whilst suspended sediment changes are not considered to have any potential to result in a direct impact to marine mammals, there is a potential for this	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	For suspended sediments effects a 15 km (tidal excursion) buffer has previously been adopted (e.g. for habitats). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be

Pressure	Group	Spatial extent	Rationale
pressure to affect their prey species. Therefore, it is included in the screening assessment This is relevant to the construction, operation and decommissioning phases.			appropriate for screening purposes.

3.3. Migratory fish (including freshwater pearl mussels)

3.3.1 Spatial criteria for migratory fish species have been determined based on their ranging behaviours (Table 3.3).

3.3.2 Pressures excluded from screening for fish in relation to fixed offshore wind are:

- P4 Collision (marine mammals) - only relevant to marine mammals.
- P5 Collision (birds) - only relevant to birds.
- P13 Temperature - not included because the magnitude of any increase in water temperature in areas over operational submarine power cabling will be negligible and not expected even to be detectable by highly mobile species such as migratory fish, or the prey which they are dependent upon.
- P15 Invasive non-native species - believed not to represent risk of significant impact for migratory fish, or the prey they depend upon.

3.3.3 Previous plan-level HRAs have generally screened anadromous fish using broad scale approaches, e.g. screening in all sites within 100 km (NIRAS, 2019, ABPmer, 2011) or within large regions. This reflects that some species, notably Atlantic salmon, make long migrations and may potentially encounter offshore wind farm development activities well away from the relevant site during marine migrations. Such an approach may be over-precautionary for certain species such as river lamprey whose distributions are likely to be restricted to coastal areas; however, information on the marine distribution of these and other species is generally limited and therefore approaches adopted in previous plan-level HRAs have been adopted here as follows:

- Atlantic salmon (and freshwater pearl mussel), regional areas (Figure 3.1)
- River lamprey and sea lamprey, 100 km.

3.3.4 Evidence is available to suggest that shad species can move very substantial distances through the marine environment. Nachón *et al.,* (2020) reported that both allis and twaite shad migrated up to 600 km from their natal rivers around the Bay of Biscay. Davies et al., (2020) tagged fish from the River Severn and subsequently recorded individuals in rivers in southwest England and southeast Ireland, implying movements through the Celtic Sea.

3.3.5 A regional approach to screening would be optimal but there is insufficient evidence to define these regions, and so a ranging behaviour value of 600 km has been assumed for both shad species.

3.3.6 For Atlantic salmon, the screening tool uses polygons created based on the areas outlined in Figure 3.1. UK sites with Atlantic salmon or freshwater pearl mussel as interest features are screened in by the tool if fish may pass through the relevant region during migration. Screening rules are defined in Table 3.3.

Table 3.3 Regional screening rules for Atlantic salmon (and freshwater pearl mussel).

Plan/Project in (Region)	Sites in these regions to be screened in						
	Shetland	**North**	**NW**	**W**	**S**	**E**	**NE**
Shetland	Y	Y	Y	Y	N	N	Y
North	N	Y	Y	Y	N	N	Y
North West (NW)	N	N	Y	Y	N	N	N
West (W)	N	N	N	Y	N	N	N
South (S)	N	N	N	N	Y	Y	Y
East (E)	N	N	N	N	N	Y	Y
North East (NE)	N	N	N	N	N	N	Y

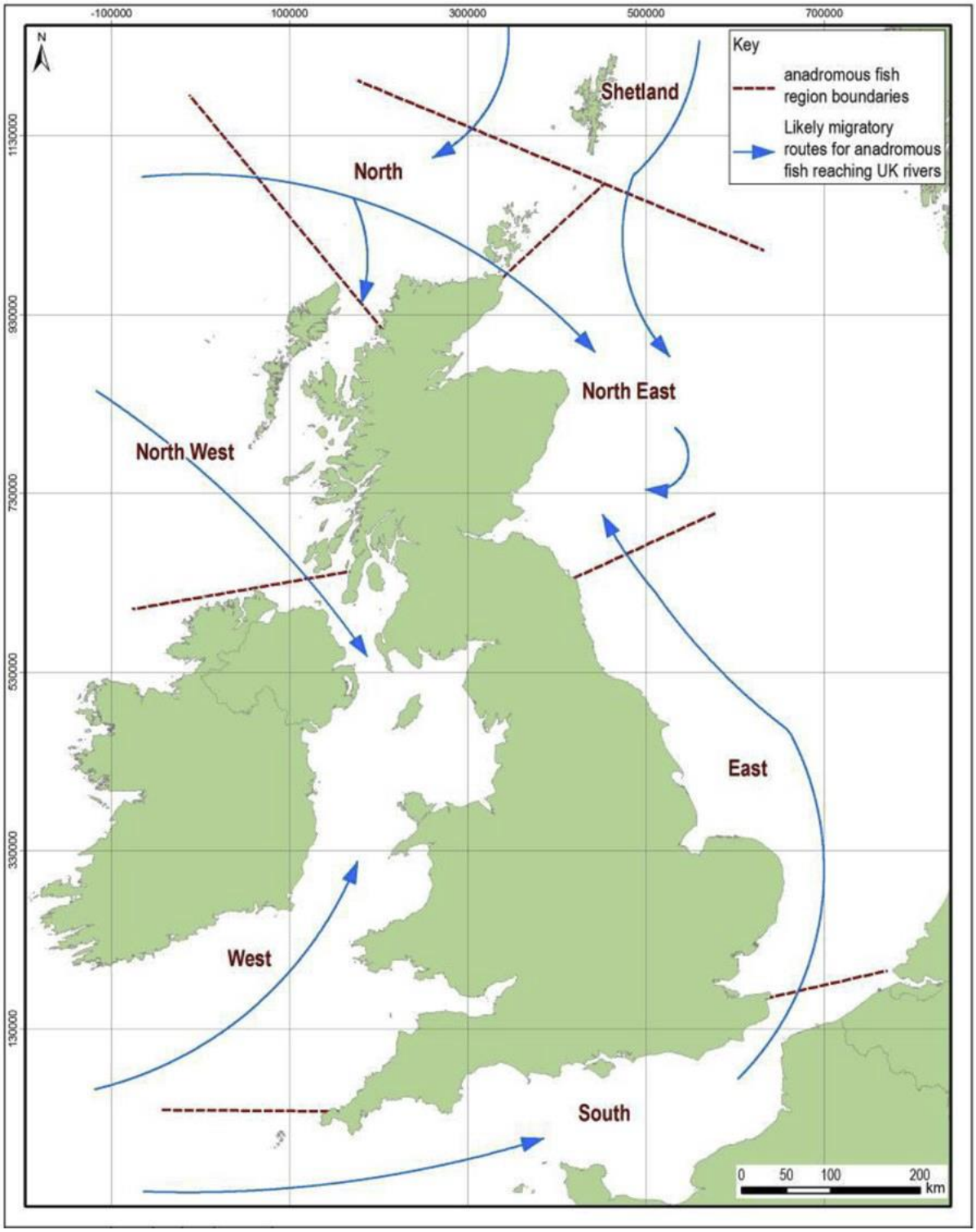

Figure 3.1 Proposed regional boundaries for Atlantic salmon (from ABPmer (2014), cited in ABPmer (2018)).

Table 3.4 Pressures used for screening in relation to migratory fish (including freshwater pearl mussel) and associated spatial criteria for fixed offshore wind.

Pressure	Group	Spatial extent	Rationale
Fixed offshore wind			
P1 Habitat loss/gain (Impact as per Annex I habitats but to habitats designated for fish)	Migratory Fish and Freshwater Pearl Mussel	0 km	Loss of habitat outside the designated site is expected to be of negligible consequence for fish, therefore screening is based on direct overlap.
P2 Direct physical damage (Impact as per Annex I habitats but to habitats designated for fish).	Migratory Fish and Freshwater Pearl Mussel	0 km	Direct damage to habitat outside the designated site is expected to be of negligible consequence for fish, therefore screening is based on direct overlap.
P3 Indirect physical damage (Impact as per Annex I habitats but to habitats designated for fish).	Migratory Fish and Freshwater Pearl Mussel	15 km	Environmental change induced through altered coastal processes is potentially assumed to occur up to a typical maximum tidal excursion distance of 15 km.
P7 Physical Presence This relates to the potential for the physical presence of offshore wind farm structures such as turbines and foundations to cause disturbance to individuals or a barrier to the movement of mobile species. This is relevant to the operational phase only.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	The pressure would be expected to apply wholly within the Plan area (i.e. at or very close to the location of individual projects). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of fish is considered to be appropriate for screening purposes.
P8 Underwater Noise Underwater noise may lead to death, injury or disturbance and direct or indirect (e.g. through impacts upon prey) impacts to marine mammals/fish. The pressure is considered in relation to all phases of development, although it is probable that the highest emissions of underwater noise in	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Based on Popper et al. (2014) Atlantic salmon and lamprey are not hearing specialists and have low to intermediate sensitivity to underwater noise with low risk of behavioural effects in the far-field (beyond some hundreds of metres). The shad species are related to herring which are known to be hearing specialists and, potentially therefore, more sensitive to far

Pressure	Group	Spatial extent	Rationale
terms of the range of effect will occur during construction which could include foundation piling and/or UXO detonations.			field impacts. Whilst the impact range is relatively small it can affect animals whilst they range, therefore ranging behaviour is considered to be appropriate for screening purposes.
P10 Toxic contamination This relates to reduced water quality from, for example, mobilisation of contaminated sediments resulting in toxic effects. This is relevant to the construction, operation and decommissioning phases.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Toxic contamination will have an effect at a relatively short range (15 km as per Annex I habitats). Ranging behaviour is therefore considered to be appropriate for screening purposes. The assessment will not cover accidental releases such as oil spills resulting from vessel collisions which could disperse over wider areas but are not planned.
P11 Electromagnetic Field (EMF) There is evidence that lamprey are sensitive to electrical fields which may be induced by EMF and that Atlantic salmon are sensitive to magnetic fields (Gill *et al.,* 2005) and although there is considerable uncertainty about the importance of this sensitivity in the context of EMF associated with submarine power cabling this potential impact will be considered. NB. this pressure does not apply to shad for which there is no evidence of magnetic sensitivity. This is relevant to the operational phase only.	Migratory Fish and Freshwater Pearl Mussel	100 km lamprey and region for salmon and freshwater pearl mussel	Submarine power cabling used by offshore wind farms typically results in elevations above the background level of the earth's geomagnetic field for distances of up to some tens of metres (Normandeau *et al.,* 2011); a very conservative potential impact range is 100 m (0.1 km). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, ranging behaviour is appropriate for screening.
P14 Suspended sediments Increased turbidity arising from disturbance of seabed sediments with potentially associated reduction in dissolved oxygen levels and risk of clogging gills etc. This pressure is relevant to the construction, operation and decommissioning phases.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of fish is considered to be appropriate for screening purposes.

3.4. Birds

3.4.1 Birds are highly mobile and can travel some distance from their breeding sites to forage or migrate to and from their non-breeding areas. There is, therefore, the potential for an impact to occur to bird features well beyond the protected site boundary. Furthermore, the extent and nature of their interaction with offshore wind farms can vary throughout their lifecycle. For the purposes of screening, bird features are grouped into four categories, reflecting these different potential interactions, each of which requires a different approach to screening:

- Breeding seabirds in the breeding season,
- Breeding seabirds in the non-breeding season,
- Non-breeding seabirds and waterbirds in the non-breeding season (includes Irish Sea Front SPA[1]),
- Migratory seabirds, migratory waterbirds and landbirds.

3.4.2 The pressures relevant to birds in each of these categories are summarised in Table 3.5, along with the spatial screening criteria applied by the tool. Wade *et al.,* (2016) is referenced to determine the sensitivity of each species to these pathways, where necessary. It is considered that there is no potential for an LSE to arise for pressures not included in Table 3.5.

3.4.3 Reflecting the mobile nature of birds, each screening criterion is applied to the SPA boundary and the area within which birds are assumed to be potentially present beyond that boundary. In the case of breeding birds, for example, this is taken to be the area of sea within foraging range of the protected site (as defined by foraging range studies and summarised, in this case, by Woodward *et al.,* 2019). Other approaches are required for birds during the non-breeding season and during migration where the presence of birds is not linked to foraging range and these are described further below.

3.4.4 In some cases establishing connectivity is considered sufficient to conclude LSE, on a precautionary basis (i.e. screen in). However, due to the considerable distances over which many birds range, this approach can lead to the screening in of a very large number of protected sites, even though the risk of LSE for a large number of these will, in reality, be very low. This is particularly the case when considering breeding birds in the non-breeding season (where birds may be dispersed over very large areas) and migratory birds. For these categories additional steps are required to complete screening after initial use of the tool (see Appendix B).

[1] The Irish Sea Front SPA was classified on the basis of its foraging habitat for Manx shearwater. For screening purposes it is treated in the same way as SPAs such as the Outer Thames Estuary and Liverpool Bay that are designated for non-breeding features.

Table 3.5 Pressures used for screening in relation to birds and associated spatial criteria.

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding seabirds and waterbirds in the non-breeding season	Migratory seabirds, waterbirds and landbirds
Fixed offshore wind (array and export cables/pipelines)				
P1 Habitat loss/gain Development within the SPA boundary could result in the loss of those habitats that directly support the features of that site. This is relevant to the operational phase only.	Foraging range of each species	Included if feature screened in for P5/7/8	0 km	N/A
P2 Direct physical damage This relates to the physical damage caused by, for example, cable burial, survey equipment deployment (e.g. cores, trawls), or anchors. This is relevant to the construction, operation and decommissioning phases.	Foraging range of each species	Included if feature screened in for P5/7/8	0 km	N/A
P3 Indirect physical damage This relates to changes in hydrological energy flows resulting in scour, changes to wave exposure etc. arising from the physical presence of structures in the marine environment. Impacts could include: changes to wave characteristics such as wave height, period and direction, changes to tidal currents (speed and direction), changes to tidal and current wave interactions, changes to the magnitude and direction of sediment transport processes, erosion (scour), reduced availability of prey	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding seabirds and waterbirds in the non-breeding season	Migratory seabirds, waterbirds and landbirds
and deposition impacts. Damage/disturbance due to the smothering by suspended sediment deposition or dredge disposal are also included. This is relevant to the operational phase only.				
P5 Collision (birds) This pressure relates to the mortality arising from birds colliding with turbine structures. This only occurs within the wind farm area once operational.	Foraging range of each species	BDMPS+ Collision risk modelling	0 km	0 km from defined migration corridor + collision risk modelling
P7 Physical Presence (visual disturbance and barrier effects) This pressure relates to the displacement and barrier effect that could occur if birds avoid the area occupied by the wind farm during operation and/or the vessels and activities involved during construction/operation/decommissioning.	15 km + foraging range of each species	BDMPS+ Displacement analysis	15 km	N/A
P8 Underwater Noise Underwater noise may lead to disturbance and direct or indirect (e.g. through impacts upon prey) impacts to bird features. The pressure is considered in relation to all phases of development, although it is probable that the highest emissions of	15 km + foraging range of each species	BDMPS+ Displacement analysis	15 km	N/A

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding seabirds and waterbirds in the non-breeding season	Migratory seabirds, waterbirds and landbirds
underwater noise in terms of the range of effect will occur during construction which could include foundation piling and/or UXO detonations.				
P9 Above water noise This pressure relates to the disturbance that could arise from the noise generated by construction and decommissioning activities or the movement of vessels during construction/operation/decommissioning.	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A
P10 Toxic contamination This relates to reduced water quality from, for example, spillages or mobilisation of contaminated sediments resulting in toxic effects. This is relevant to the construction, operation and decommissioning phases.	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A
P12 Light The behaviour of birds could be affected by light pollution.	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A
P14 Suspended sediments This relates to increased turbidity arising from disturbance of seabed sediments with potential associated impacts such as reduction in dissolved oxygen levels, reduced light penetration and altered suspended sediment supply. Whilst suspended	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding seabirds and waterbirds in the non-breeding season	Migratory seabirds, waterbirds and landbirds
sediment changes are not considered to have any potential to result in a direct impact to bird features, there is a potential for this pressure to affect their prey species. Therefore it is included in the screening assessment. This is relevant to the construction, operation and decommissioning phases.				

Breeding seabirds in the breeding season

3.4.5 Breeding seabirds in the breeding season are screened in by the tool using the criteria detailed in Table 3.6 for foraging range, in addition to the pressure effect ranges explained in Table 3.5.

3.4.6 Using the absolute maximum foraging distance recorded for any species is considered to be over-precautionary as many species can exhibit extreme behaviours, particularly if individuals are unconstrained by provisioning for young. Conversely, using a simple mean or median foraging distance may underestimate foraging ranges and exclude important connectivity between a colony and foraging areas upon which that colony relies.

3.4.7 For the purposes of the screening tool, where possible, the mean-maximum foraging range plus an additional 1 standard deviation is used. This is considered precautionary whilst still excluding atypical extremes of foraging behaviour. Where this measure cannot be obtained from Woodward *et al.*, (2019), the maximum value is used instead, except for Leach's petrel and Arctic skua where only a mean foraging range is the best available evidence. The use of the values in Table 3.6 has been checked against the detailed site-specific data reported in Woodward *et al.,* (2019) to ensure that these ranges are suitably precautionary and do not result in the use of screening criteria that will discount LSE prematurely.

3.4.8 Separate rules are applied by the tool for certain categories of protected site:

- Sites designated to protect the sea areas used by features for foraging or other purposes (e.g. Northumberland Marine SPA). These sites are distinguished in the screening tool and screening is based on direct overlap between activity area (plus pressure buffer) and the protected site.
- Sites designated for breeding colonies and foraging areas (e.g. Skomer, Skokholm and Seas off Pembrokeshire SPA). The foraging ranges from Woodward *et al.*, (2019) are

applied from the site boundary. Since foraging ranges are already included in SPA boundary calculations this could potentially incorporate sea areas outside of the foraging range of certain features and, if relevant, this should be considered in subsequent assessments.

Table 3.6 Species-specific foraging ranges for breeding seabirds in the breeding season derived from Woodward et al., (2019)

Species	Foraging range (km)	Rationale
Common eider (*Somateria mollissima*)	21.5	Mean-maximum (standard deviation not available)
Red-throated diver (*Gavia stellata*)	9	Maximum (standard deviation not available)
European storm petrel (*Hydrobates pelagicus*)	336	Maximum (standard deviation not available)
Leach's petrel (*Oceanodroma leucorhoa*)	657	Mean (mean-maximum not available)
Northern fulmar (*Fulmarus glacialis*)	542.3 + 657.9	Mean-maximum plus one standard deviation
Manx shearwater (*Puffinus puffinus*)	1,346.8 + 1,018.7	Mean-maximum plus one standard deviation
Northern gannet (*Morus bassanus*)	315.2 + 194.2	Mean-maximum plus one standard deviation
European shag (*Phalacrocorax aristotelis*)	13.2 + 10.5	Mean-maximum plus one standard deviation
Cormorant (*Phalacrocorax carbo*)	25.6 + 8.3	Mean-maximum plus one standard deviation
Black-legged kittiwake (*Rissa tridactyla*)	156.1 + 144.5	Mean-maximum plus one standard deviation
Black-headed gull (*Chroicocephalus ridibundus*)	19	Maximum (standard deviation not available)
Mediterranean gull (*Ichthyaetus melanocephalus*)	20	Maximum (standard deviation not available)
Common gull (*Larus canus*)	50	Maximum (standard deviation not available)

Great black-backed gull (*Larus marinus*)	73	Maximum (standard deviation not available)
Herring gull (*Larus argentatus*)	58.8 + 26.8	Mean-maximum plus one standard deviation
Lesser black-backed gull (*Larus fuscus*)	127 + 109	Mean-maximum plus one standard deviation
Sandwich tern (*Thalasseus sandvicensis*)	34.3 + 23.2	Mean-maximum plus one standard deviation
Little tern (*Sternula albifrons*)	5	Maximum (standard deviation not available)
Roseate tern (*Sterna dougallii*)	12.6 + 10.6	Mean-maximum plus one standard deviation
Common tern (*Sterna hirundo*)	18.0 + 8.9	Mean-maximum plus one standard deviation
Arctic tern (*Sterna paradisaea*)	25.7 + 14.8	Mean-maximum plus one standard deviation
Great skua (*Stercorarius skua*)	443.3 + 487.9	Mean-maximum plus one standard deviation
Arctic skua (*Stercorarius parasiticus*)	63.3	Mean-maximum (from Woodward *et al.* 2019 database)
Common guillemot (*Uria aalge*)	73.2 + 80.5	Mean-maximum plus one standard deviation
Razorbill (*Alca torda*)	88.7 + 75.9	Mean-maximum plus one standard deviation
Black guillemot (*Cepphus grylle*)	4.8 + 4.3	Mean-maximum plus one standard deviation
Atlantic puffin (*Fratercula arctica*)	137.10 + 128.3	Mean-maximum plus one standard deviation

Breeding seabirds in the non-breeding season

3.4.9 For this group, initial screening by the tool is followed by further analysis. Information on each step is provided below(see also Appendix B for a worked example of the additional analysis).

3.4.10 Breeding birds from SPAs and Ramsar sites in the non-breeding season are not constrained to specific areas by the necessity of providing for young, and typically disperse to exploit areas far beyond their breeding colonies. During the non-breeding season, therefore, the birds present within an area of activity (i.e., Offshore Wind Array) may originate from sites that are further away than those considered in the breeding season.

3.4.11 Furness (2015) considered how non-breeding birds dispersed, defining the regions within which those populations would be distributed. For each region a biologically defined minimum population size ("BDMPS") was calculated. Screening uses these BDMPS regions and populations. Where the area of activity overlaps with a BDMPS region, connectivity is assumed by the tool with the population associated with that region (as defined by Furness, 2015), and the protected sites that contribute to that population are screened in.

3.4.12 This approach inevitably identifies a large number of protected sites with potential connectivity (due to the scale of the BDMPS regions). However, the density of birds from any specific protected site that are present in relation to the area of activity may be very low.

3.4.13 To avoid screening in protected sites and features for which an effect is likely to be de minimis, additional analysis is needed. Essentially, a view is taken on the magnitude of the potential impact on the BDMPS population and its component SPA populations and whether this could lead to LSE.

Second stage screening for breeding birds in the non-breeding season and migratory seabirds

3.4.14 For breeding birds in the breeding season and wintering seabirds it will be assumed that connectivity, established through application of the spatial criteria set out in the Round 4 HRA Principles report (2020a), will lead to an LSE.

3.4.15 For breeding birds in the non-breeding season and migratory waterbirds and seabirds a second stage will be applied to quantify the likely magnitude of any impact, before forming a judgement about LSE.

3.4.16 A worked example of this second stage screening is provided as Appendix B.

3.4.17 Once the tool has identified those BDMPS regions and populations for which there is connectivity, additional analysis to be completed, post running the tool, should consider the likely effect of either P5 (collision) or P7 (physical presence), depending on the specific vulnerability of the species as indicated by Wade *et al.,* (2016) and Bradbury *et al., (*2014). This is done using collision risk modelling or displacement analysis as required.

3.4.18 If the predicted magnitude of the impact exceeds 1% of the baseline mortality of the BDMPS population (and hence 1% of each of its component SPAs as those populations are represented in proportion within the BDMPS) then each of the component SPAs is screened in (with respect to the relevant feature and pressure considered).

3.4.19 If the predicted magnitude is between 0.5% and 1% of the baseline mortality of the BDMPS population, then further consideration is given to the magnitude of the likely effect, including likely impacts from other plans and projects, in combination. If it cannot be concluded that the combined magnitude of the potential impact will not exceed 1% then each of the component SPAs is screened in (with respect to the relevant feature and pressure considered).

3.4.20 Where the predicted magnitude is less than 0.5% of the baseline mortality of the BDMPS population then none of the component SPAs are screened in, on the basis that (in the absence of evidence to the contrary) the magnitude of the impact is too low for there to be any risk of LSE alone or in-combination. The exception to this is where the integrity of a protected site is already considered to be adversely affected.

3.4.21 If an LSE is identified for a feature for P5 or P7, then an LSE will also be assumed for pressures P1, 2, 3, 8, 9, 10, 12 and 14.

3.4.22 It should be noted that this aspect of screening is focused on identifying those protected sites and their features for which there is an LSE *only* during the non-breeding season. Where a population has already been screened in because a risk of LSE has been identified during the breeding season, then potential impacts during non-breeding season should also be considered in the subsequent assessment.

Non-breeding seabirds and waterbirds in the non-breeding season

3.4.23 There are a number of SPAs in the UK that are designated for non-breeding season (e.g. wintering) populations of birds that do not necessarily breed in the same region. This includes species that utilise the marine environment (e.g. red-throated diver) and those that may exploit intertidal areas for foraging opportunities, whether these areas are within an SPA or not (i.e. functionally linked habitat), e.g. pink footed geese, brent geese or knot. This category also includes the Irish Sea Front SPA which is designated because of the importance of its habitats for Manx shearwater.

3.4.24 Screening for these sites and their features is based on connectivity. To allow for effects at distance (such as disturbance) and indirect habitats effects, the tool applies a spatial criterion of 15 km for the purpose of screening.

Migratory seabirds

3.4.25 For this group, initial screening by the tool is followed by further analysis. Information on each step is provided below(see also Appendix B for a worked example of the additional analysis).

3.4.26 This category relates to certain species of migratory seabird that migrate through UK waters between protected sites that are designated for their breeding and wintering areas. The category therefore includes species of tern, skua, petrel, shearwater and little gull and their associated SPAs. Although other seabirds migrate through UK waters, these species are captured by the screening for other feature categories.

3.4.27 Connectivity is identified by the tool based on the migratory corridors defined for relevant species in WWT Consulting and MacArthur Green (2014). This report suggested five migration bands: 0-10 km; 0-20 km; 0-40 km; 0-60 km; and 1-60 km. Species were assigned to bands based upon observations from coastal watches, offshore surveys and information from Forrester *et al.*, (2007) and seabird/sea-watching experts.

3.4.28 Some seabird species also migrate overland, including terns and skuas, and this will be taken into account when identifying those species that migrate along the eastern and western coastlines of the UK.

3.4.29 Where there is direct overlap between the activity area and the migratory corridor for a species, connectivity is identified.

3.4.30 Only pressure P5 (collision) is considered relevant for this feature category. For those features for which connectivity is identified, collision risk modelling is required as an additional screening step.

3.4.31 The resulting collision risk estimates are compared to the 1% threshold of baseline mortality for the migratory population for relevant species to identify if an LSE will occur, using the same criteria as for breeding birds in the non-breeding season (this includes consideration of in-combination effects).

Migratory waterbirds and landbirds

3.4.32 For this group, initial screening by the tool is followed by further analysis. Information on each step is provided below (see also Appendix B for a worked example of the additional analysis).

3.4.33 Species of migratory waterbirds and landbirds that are features of protected sites may interact with offshore wind farms. The tool identifies connectivity based on the migratory corridors defined for relevant species by Wright *et al.,* (2012), which were defined using an extensive literature review. Where there is direct overlap between a wind farm area and the migratory corridor for a species, connectivity is assumed.

3.4.34 Only pressure P5 (collision) is considered relevant for this feature category. For those features for which connectivity is identified, collision risk modelling is required as an additional screening step.

3.4.35 The resulting collision risk estimates are compared to the 1% threshold of baseline mortality for the BDMPS population for relevant species to identify if an LSE will occur, using the same criteria as for breeding birds in the non-breeding season (this includes consideration of in-combination effects).

4. Screening Criteria for Floating Offshore Wind (and Co-located hydrogen)

4.1. Habitats

4.1.1 Habitat features occur only within protected sites, and the range of influence of each pressure is relevant to screening (Table 4.1).

4.1.2 Pressures excluded from the screening for floating offshore wind and co-located hydrogen production are:

- P4/5 Collision (marine mammals and fish/birds) - Pressure not relevant to habitats,
- P7 Physical presence - Pressure only relevant for mobile species,
- P8/9 Underwater/above water noise - Particle displacement through noise will physically interact with subtidal and intertidal habitats. Relevant species, such as biogenic reef forming species might be sensitive. However, there is no evidence that habitats or relevant species will be affected,
- P11 Electromagnetic Fields (EMF) - Believed not to be important for features or associated species and communities,
- P12 Light - Believed not to be important for features or associated species and communities,
- P16 Entanglement - Pressure not relevant to habitats.

Table 4.1 Pressures of floating offshore wind and co-located hydrogen used for screening in relation to habitats and associated spatial criteria.

Pressure	Spatial extent	Rationale
Offshore wind		
P1 Habitat loss/gain This relates to the loss of coastal/offshore seabed habitats due to installation of structures, including wind turbine generator (WTG) device foundations and cable/pipeline protection, and where relevant the associated introduction of new habitat. This is a permanent impact which occurs during the construction phase.	0 km	Impact is restricted to the footprint of physical structures, i.e. direct overlap.
P2 Direct physical damage This relates to the physical damage caused by, for example, pre-sweeping, abrasion from mooring lines, cable/pipeline burial, survey equipment deployment (e.g. cores, trawls), or anchors. This is	0 km	Impact is restricted to the footprint of physical structures, within the plan areas i.e. direct overlap.

Pressure	Spatial extent	Rationale
relevant to the construction, operation and decommissioning phases.		
P3 Indirect physical damage This relates to changes in hydrological energy, for example the Floating Offshore Wind Plans resulting in scour, changes to wave exposure etc. arising from the physical presence of structures in the marine environment or temporary seabed preparation works. Impacts could include: changes to wave characteristics such as wave height, period and direction, changes to tidal currents (speed and direction), changes to tidal and current wave interactions, changes to the magnitude and direction of sediment transport processes, erosion (scour) and deposition impacts. Damage/disturbance due to smothering by dredge disposal is also included. This is relevant to the construction, operation and decommissioning phases.	15 km	Environmental change induced through altered coastal processes is assumed to potentially occur up to a typical maximum tidal excursion distance of 15km.
P10 Toxic contamination This relates to reduced water quality from, for example, spillages or mobilisation of contaminated sediments resulting in toxic effects. This is relevant to the construction, operation and decommissioning.	15 km	Coastal and marine habitats are considered potentially sensitive to effects from contamination where they may be present below high water. Screening will be based on a typical maximum tidal excursion.
P13 Temperature Operating submarine power cables generate heat which can result in temperature changes to adjacent sediments where the cable is buried. The high heat capacity of water means that temperature changes experienced by fauna, other than those present as infauna, will be negligible and this pressure therefore relates only to subtidal habitats. This is relevant to the operational phase only.	0.01 km	Effect ranges are expected to be limited to the immediate vicinity of cables (OSPAR, 2009) and a buffer of 10m (0.01km) will be applied.
P14 Suspended sediments This relates to increased turbidity arising from disturbance of seabed sediments with potential	15 km	Subtidal habitats (other than estuaries and mudflats) are assumed to be potentially sensitive and a 15 km

Pressure	Spatial extent	Rationale
associated impacts such as reduction in dissolved oxygen levels, reduced light penetration and altered suspended sediment supply.		(tidal excursion, as for P3) buffer will be used for screening.
P15 Invasive non-native species (INNS) INNS can smother or replace existing habitats. This is relevant to the construction, operation and de-commissioning phases.	15 km	It is assumed that subtidal and other habitats below high water could be sensitive to effects arising from the presence of non-native species and a 15 km (tidal excursion) parameter will be used for screening.
Co-located H2 production		
P13 Temperature Hydrogen production may result in the discharge of heated water.	15 km	For hydrogen production, the scale of heating effect from the discharge of heated water after electrolysis will depend on a range of factors, including the degree of heating, volume and rate of discharge and dispersal conditions in the receiving water body. Evidence from satellite monitoring of thermal plumes from power stations indicates that plumes of up to 10 km in length (Sizewell power station: Faulkner (2020)) may occur. For the purposes of screening a conservative approach is to adopt a tidal excursion as indicative of the maximum likely extent of any significant effect.
P17 Salinity This relates to release of hypersaline brine following desalination of seawater for electrolysis where it is used for hydrogen production. It is relevant to the operational phase only.	15 km	Coastal and marine habitats are considered potentially sensitive to salinity increases where they are present below high water. Screening will be based on a typical maximum tidal excursion.

4.2. Marine mammals (including otters)

4.2.1 Pressures excluded from screening in relation to marine mammals (cetaceans, pinnipeds) are:

- P5 Collision (birds) - not relevant to marine mammals,

- P15 Invasive non-native species - believed not to represent risk of significant impact for marine mammals or prey they depend upon.

4.2.2 Pressures excluded from screening in relation to otters are:

- P5 Collision (birds) - not relevant for otters,
- P11 Electromagnetic Fields (EMF) - no evidence that otters are sensitive to EMF,
- P13 Temperature - any increase in water temperature over operational submarine power cabling will be negligible and not expected to be detectable by highly mobile species such as otter.
- P14 Suspended sediments - it is not anticipated that otters are sensitive to suspended sediment to the extent they may become elevated by activities associated with offshore wind.
- P15 Invasive non-native species - not believed to represent risk of any significant impact for otters.
- P17 (Entanglement/Entrainment) & P18 (Salinity) - not relevant to otter as they do not range near to the array areas.

4.2.3 Ranging behaviour is key for marine mammal screening. Assumptions are set out below and summarised in Table 4.2.

4.2.4 Grey seal may travel considerable distances from their breeding and haul out sites to forage and previous plan-level HRAs have commonly adopted a 100 km buffer for this species (e.g. NIRAS, 2019, ABPmer, 2017; MMO, 2013; 2015). This approach is based on evidence that most foraging occurs within this range (Jones *et al.,* 2015; SCOS, 2016). A 100 km buffer is therefore applied in relation to grey seal.

4.2.5 Harbour seal generally range less than grey seal and normally feed within 40-50 km of their haul out sites (Thompson, 1993; SCOS, 2017). A 50 km buffer is therefore applied for harbour seal.

4.2.6 Bottlenose dolphin and harbour porpoise may range over relatively large distances (e.g. ABPmer, 2014). Previous Plan-level HRAs (e.g. Wood Environmental, 2019), including the 2017 Project Extensions Plan-Level HRA (NIRAS, 2019) have adopted the approach of screening in all sites within the Marine Mammal Management Units (MMMUs) defined by the UK Inter-Agency Marine Mammal Working Group (IAMMWG, 2015). These include UK sites and any sites outside UK waters with interest features in the same MMMU as the plan area.

4.2.7 An alternative approach for these features has been to use a conservative distance-based criterion and to screen in all sites within this range. A common distance for marine mammals has been 100 km, although sometimes sites beyond this distance have subsequently been screened in where foraging is considered to occur at greater range or potential development sites are within a relevant management unit (e.g. ABPmer, 2019). This was the distance used for the R4 and R5 Plan-level HRAs (NIRAS, 2021a) (NIRAS, 2022) . Other HRAs have sought to consider whether animals make significant use of habitats outside European marine sites within their screening approaches; for example, BEIS (2019) screened in marine mammals from all UK SACs.

4.2.8 Otters are mobile and so are expected to occur both within and outside European sites. Therefore, both the potential range of each pressure and the animals' ranging behaviour are relevant to screening for impacts. An allowance of 10 km has been made for ranging behaviour, which is based on the 2017 Project Extensions HRA (NIRAS, 2019). Otters are territorial and guidance for surveys to assess impacts suggests distances of up to 200 m are appropriate (SNH, 2020). Standing advice in England notes that male otters may range up to 35 km (Natural England, 2018). Other plan-level HRAs, including in Scotland where otters tend to be more abundant, have noted that otters may utilise coastal waters out to approximately 10 m water depth (ABPmer, 2018) and have assumed a conservative buffer of 10 km (e.g. ABPmer, 2017). Although it is noted that individuals may on occasions dive deeper (e.g. Kruuk (1995) reported that otters had been observed diving to 14 m depth), or range more widely, the 10 km screening distance is adopted by the tool.

Table 4.2 Pressures used for screening of floating offshore wind and co-located hydrogen in relation to marine mammals (including otters) and associated spatial criteria. Table 3.2 is referred to where pressures are in common with fixed offshore wind.

Pressure	Group	Spatial extent	Rationale
Floating Offshore Wind			
P1 Habitat loss/gain See Table 3.2	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal.	Ranging behaviour will be used to consider potential impacts to prey species.
See Table 3.2.	Otter	0 km	Loss of habitat outside the designated site is expected to be of negligible consequence for otters, therefore screening is based on direct overlap.
P2 Direct physical damage See Table 3.2.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50km harbour seal	Ranging behaviour will be used to consider potential impacts to prey species.
See Table 3.2.	Otter	0 km	Direct damage to habitat outside the designated site is expected to be of negligible consequence for

			otters, therefore screening is based on direct overlap.
P3 Indirect physical damage See Table 3.2.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Ranging behaviour will be used to consider potential impacts to prey species. These markedly exceed the assumed range of impact (15 km, as per Annex I habitats).
See Table 3.2.	Otter	10 km	The potential range of disturbance is uncertain but assumed unlikely to be more than a few kilometres. Whilst the impact range is relatively small, it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P4 Collision See Table 3.2.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Collisions could occur within offshore wind farm areas, or along vessel transit routes. Vessel transit routes are unknown and the Plan area cannot therefore be buffered to encompass them; however, since marine mammals are wide-ranging, the incorporation of this behaviour into the screening process is considered a reasonable approach.
See Table 3.2.	Otter	10 km	Collisions could occur along vessel transit routes. Vessel transit routes are unknown; however, since otters are wide-ranging the incorporation of this behaviour into the screening process is considered a reasonable approach.
P7 Physical Presence See Table 3.2.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	The pressure would be expected to apply wholly within the Plan area (i.e. at or very close to the location of individual projects). Ranging behaviour used.
See Table 3.2.	Otter	10 km	The potential range of any impact, if occurring, is uncertain but considered likely to be limited to no more than a few kilometres. Whilst the impact range is

			relatively small, it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P8 Underwater Noise See Table 3.2	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Underwater noise could impact upon sensitive receptors such as marine mammals over considerable distances. Screening will therefore account for the ranging behaviour of marine mammals.
See Table 3.2.	Otter	10 km	The potential range of any impact, if occurring, is uncertain but considered likely to be limited to no more than a few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P9 Above Water Noise See Table 3.2.	Seals and cetaceans	100 km grey seal; 50 km harbour seal	Above water noise is considered potentially disturbing for some few kilometres. Ranging behaviour is therefore considered to be appropriate for screening purposes.
See Table 3.2.	Otter	10 km	Above water noise is considered potentially disturbing for some few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P10 Toxic contamination See Table 3.2.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Toxic contamination is considered potentially relevant for some few kilometres (15 km as per habitats). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, ranging behaviour is considered to be appropriate for screening purposes.

See Table 3.2.	Otter	10 km	Toxic contamination is considered potentially disturbing for some few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P11 Electromagnetic Field (EMF) See Table 3.2.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise	Submarine power cabling used by offshore wind farms typically results in elevations above the background level of the earth's geomagnetic field for distances of up to some tens of metres (Normandeau *et al.,* 2011); a very conservative potential impact range is 100 m (0.1km). Whilst the impact range is relatively small it can affect animals whilst they range, Therefore, ranging behaviour is appropriate for screening
P12 Light See Table 3.2.	Seals and cetaceans	100 km grey seal; 50 km harbour seal	The potential range of disturbance is uncertain but assumed unlikely to be more than a few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, ranging behaviour is appropriate for screening
See Table 3.2.	Otter	10 km	The potential range of disturbance is uncertain but assumed unlikely to be more than a few kilometres. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P13 Temperature See Table 3.2.	Seals and cetaceans	0.01 km	Effect ranges are expected to be limited to the immediate vicinity of cables (OSPAR, 2009) and a buffer of 10m (0.01 km) will be applied.

P14 Suspended sediments See Table 3.2.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	For suspended sediments effects a 15 km (tidal excursion) buffer has previously been adopted (e.g. for habitats). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P16 Entanglement This relates to entanglement with mooring lines associated with turbine infrastructure.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Entanglement could occur within wind farm array areas only. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
Co-Located H2 Production			
P13 Temperature Hydrogen production may result in the discharge of heated water.	Seals and cetaceans	100 km bottlenose dolphin, harbour porpoise and grey seal; 50 km harbour seal	Although not expected to be directly relevant for marine mammals the potential for indirect effects to occur via impacts to prey species is recognised. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.
P17 Salinity This relates to release of hypersaline brine following desalination of seawater for electrolysis where it is used for hydrogen production. It is relevant to the operational phase only.	Seals and cetaceans	100km bottlenose dolphin, harbour porpoise and grey seal; 50km harbour seal	Although not expected to be directly relevant for marine mammals, the potential for indirect effects to occur via impacts to prey species is recognised. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of marine mammals is considered to be appropriate for screening purposes.

4.3. Migratory fish and freshwater pearl mussels

4.3.1 Spatial criteria for migratory fish species have been determined based on their ranging behaviours (Table 4.3).

4.3.2 Pressures excluded from screening for fish in relation to floating offshore wind and co-located hydrogen production are:

- P4 Collision (marine mammals) - only relevant to marine mammals.
- P5 Collision (birds) - only relevant to birds.
- P13 Temperature - not included because the magnitude of any increase in water temperature in areas over operational submarine power cabling will be negligible and not expected even to be detectable by highly mobile species such as migratory fish, or the prey which they are dependent upon.
- P15 Invasive non-native species - believed not to represent risk of significant impact for migratory fish, or the prey they depend upon.

4.3.3 Previous plan-level HRAs have generally screened anadromous fish using broad scale approaches, e.g. screening in all sites within 100 km (NIRAS, 2019, ABPmer, 2011) or within large regions. This reflects that some species, notably Atlantic salmon, make long migrations and may potentially encounter offshore wind farm development activities well away from the relevant site during marine migrations. Such an approach may be over-precautionary for certain species such as river lamprey whose distributions are likely to be restricted to coastal areas; however, information on the marine distribution of these and other species is generally limited and therefore approaches adopted in previous plan-level HRA have been adopted here as follows:

- Atlantic salmon (and freshwater pearl mussel), regional areas (Figure 4.1)
- River lamprey and sea lamprey, 100 km.

4.3.4 Evidence is available to suggest that shad species can move very substantial distances through the marine environment. Nachón *et al.,* (2020) reported that both allis and twaite shad migrated up to 600 km from their natal rivers around the Bay of Biscay. Davies *et al.,* (2020) tagged fish from the River Severn and subsequently recorded individuals in rivers in southwest England and southeast Ireland, implying movements through the Celtic Sea.

4.3.5 A regional approach to screening would be optimal but there is insufficient evidence to define these regions, and so a ranging behaviour value of 600 km has been assumed for both shad species.

4.3.6 For Atlantic salmon, the screening tool uses polygons created based on the areas outlined in. Figure 4.1. UK sites with Atlantic salmon or freshwater pearl mussel as interest features are screened in by the tool if fish may pass through the relevant region during migration. Screening rules are defined in Table 4.3.

Table 4.3 Regional screening rules for Atlantic salmon (and freshwater pearl mussel).

Plan/Project in (Region)	Sites in these regions to be screened in						
	Shetland	North	NW	W	S	E	NE
Shetland	Y	Y	Y	Y	N	N	Y
North	N	Y	Y	Y	N	N	Y
North West (NW)	N	N	Y	Y	N	N	N
West (W)	N	N	N	Y	N	N	N
South (S)	N	N	N	N	Y	Y	Y
East (E)	N	N	N	N	N	Y	Y
North East (NE)	N	N	N	N	N	N	Y

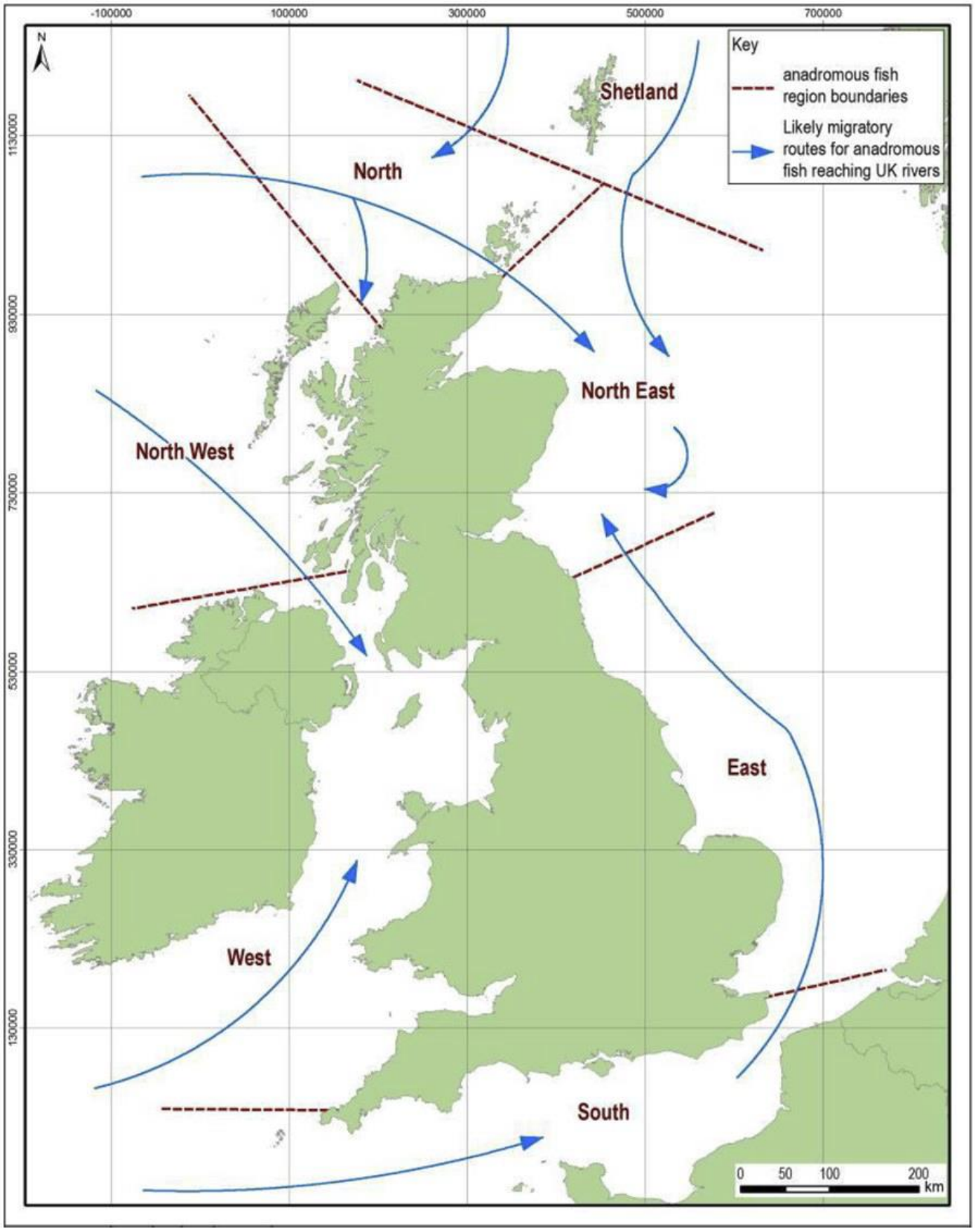

Figure 4.1 Proposed regional boundaries for Atlantic salmon (from ABPmer (2014), cited in ABPmer (2018)).

Table 4.4 Pressures used for screening of floating offshore wind and co-located hydrogen in relation to migratory fish (including freshwater pearl mussels) and associated spatial criteria. Table 3.4 is referred to where pressures are in common with fixed offshore wind.

Pressure	Group	Spatial extent	Rationale
Offshore wind			
P1 Habitat loss/gain See Table 3.4.	Migratory Fish and Freshwater Pearl Mussel	0 km	Loss of habitat outside the designated site is expected to be of negligible consequence for fish, therefore only direct overlap will be assessed.
P2 Direct physical damage See Table 3.4.	Migratory Fish and Freshwater Pearl Mussel	0 km	Direct damage to habitat outside the designated site is expected to be of negligible consequence for fish, therefore only direct overlap will be assessed.
P3 Indirect physical damage See Table 3.4.	Migratory Fish and Freshwater Pearl Mussel	15 km	Environmental change induced through altered coastal processes is assumed to potentially occur up to a typical maximum tidal excursion distance of 15 km. This is consistent with the spatial criteria in the Offshore Wind Leasing Round 4 Screening Report (NIRAS, 2021a).
P7 Physical Presence See Table 3.4.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	The pressure would be expected to apply wholly within the Plan area (i.e. at or very close to the location of individual projects). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of fish is considered to be appropriate for screening purposes.
P8 Underwater Noise See Table 3.4.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Based on Popper *et al.*, (2014) Atlantic salmon and lamprey are not hearing specialists and have low to intermediate sensitivity to underwater noise with low risk of behavioural effects in the far-field (beyond some hundreds of metres). The shad species are related to herring which are known to be hearing specialists and, potentially therefore, more sensitive to far field impacts. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore ranging

Pressure	Group	Spatial extent	Rationale
			behaviour is considered to be appropriate for screening purposes.
P10 Toxic contamination See Table 3.4.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Toxic contamination will have an effect at a relatively short range (15 km as per Annex I habitats). Ranging behaviour is therefore considered to be appropriate for screening purposes. The assessment will not cover accidental releases such as oil spills resulting from vessel collisions which could disperse over wider areas but are not planned.
P11 Electromagnetic Field (EMF) See Table 3.4.	Migratory Fish and Freshwater Pearl Mussel	100 km lamprey and region for salmon and freshwater pearl mussel	Submarine power cabling used by offshore wind farms typically results in elevations above the background level of the earth's geomagnetic field for distances of up to some tens of metres (Normandeau *et al.*, 2011); a very conservative potential impact range is 100 m (0.1 km). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, ranging behaviour is appropriate for screening.
P14 Suspended sediments See Table 3.4.	Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of fish is considered to be appropriate for screening purposes.
P16 Entanglement This relates to entanglement with mooring lines associated with turbine infrastructure, including secondary entanglement should fishing gear or other debris become entangled first which could make this pressure relevant for smaller species not likely to be at any risk	Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Whilst the impact range is relevant to the location of mooring lines only it can affect animals whilst they range. Therefore, ranging behaviour is appropriate for screening.

Pressure	Group	Spatial extent	Rationale
of entanglement with lines directly.			
Co-Located H2 Production			
P4 Collision Where seawater is abstracted prior to desalination for hydrogen production there is potential for fish to be entrained. This pressure relates only to hydrogen, underwater collision.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	The pressure would apply only where water abstraction infrastructure was located, i.e. assumed to be in offshore array areas. Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of fish species is considered to be appropriate for screening purposes.
P13 Temperature Hydrogen production may result in the discharge of heated water.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Whilst the impact range is relatively small it can affect animals whilst they range, therefore, the ranging behaviour of fish is considered to be appropriate for screening purposes.
P17 Salinity This relates to release of hypersaline brine following desalination of seawater for electrolysis where it is used for hydrogen production. It is relevant to the operational phase only.	Migratory Fish and Freshwater Pearl Mussel	600 km shad, 100 km lamprey and region for salmon and freshwater pearl mussel	Salinity changes would have an effect at a relatively short range (15 km as per Annex I habitats). Whilst the impact range is relatively small it can affect animals whilst they range. Therefore, the ranging behaviour of fish is considered to be appropriate for screening purposes.

4.4. Birds

4.4.1 Birds are highly mobile and can travel some distance from their breeding sites to forage or migrate to and from their non-breeding areas. There is, therefore, the potential for an impact to occur to bird features well beyond the protected site boundary. Furthermore, the extent and nature of their interaction with offshore wind farms can vary throughout their lifecycle. For the purposes of screening, bird features are grouped into four categories, reflecting these different potential interactions, each of which requires a different approach to screening:

- Breeding seabirds in the breeding season,
- Breeding seabirds in the non-breeding season,
- Non-breeding seabirds and waterbirds in the non-breeding season (includes Irish Sea Front SPA[2]),
- Migratory seabirds, and migratory waterbirds and landbirds.

4.4.2 The pressures relevant to birds in each of these categories are summarised in Table 4.5, along with the spatial screening criteria applied by the tool. Wade *et al.,* (2016) is referenced to determine the sensitivity of each species to these pathways, where necessary. It is considered that there is no potential for an LSE to arise for pressures not included in Table 4.55.

4.4.3 Reflecting the mobile nature of birds, each screening criterion is applied to the SPA boundary and the area within which birds are assumed to be potentially present beyond that boundary. In the case of breeding birds, for example, this is taken to be the area of sea within foraging range of the protected site (as defined by foraging range studies and summarised, in this case, by Woodward *et al.,* 2019). Other approaches are required for birds during the non-breeding season and during migration where the presence of birds is not linked to foraging range and these are described further below.

4.4.4 In some cases, establishing connectivity is considered sufficient to conclude LSE, on a precautionary basis (i.e. screen in). However, due to the considerable distances over which many birds range, this approach can lead to the screening in of a very large number of protected sites, even though the risk of LSE for a large number of these will in reality be very low. This is particularly the case when considering breeding birds in the non-breeding season (where birds may be dispersed over very large areas) and migratory birds. For these categories additional steps are required to complete screening after initial use of the tool (see Appendix B).

[2] The Irish Sea Front SPA was classified on the basis of its foraging habitat for Manx shearwater. For screening purposes it is treated in the same way as SPAs such as the Outer Thames Estuary and Liverpool Bay that are designated for non-breeding features.

Table 4.55 Pressures used for screening in relation to birds and associated spatial criteria.

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding seabirds and waterbirds in the non-breeding season	Migratory seabirds, waterbirds and landbirds
Floating offshore wind				
P1 Habitat loss/gain Development within the SPA boundary could result in the loss of those habitats that directly support the features of that site. This is relevant to the operational phase only.	Foraging range of each species	Included if feature screened in for P5/7/8	0 km	N/A
P2 Direct physical damage This relates to the physical damage caused by, for example, cable burial, survey equipment deployment (e.g. cores, trawls), or anchors. This is relevant to the construction, operation and decommissioning phases.	Foraging range of each species	Included if feature screened in for P5/7/8	0 km	N/A
P3 Indirect physical damage This relates to changes in hydrological energy flows resulting in scour, changes to wave exposure etc. arising from the physical presence of structures in the marine environment. Impacts could include: changes to wave characteristics such as wave height, period and direction, changes to tidal currents (speed and direction), changes to tidal and current wave interactions, changes to the magnitude and direction of sediment transport processes, erosion (scour), reduced availability of prey and deposition impacts. Damage/disturbance due to the smothering by suspended sediment deposition or dredge disposal are also included. This is relevant to the operational phase only.	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A
P5 Collision (birds)	Foraging range of		0 km	0 km from defined

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding seabirds and waterbirds in the non-breeding season	Migratory seabirds, waterbirds and landbirds
This pressure relates to the mortality arising from birds colliding with turbine structures. This only occurs within the wind farm area once operational.	each species	BDMPS+ Collision risk modelling		migration corridor + collision risk modelling
P7 Physical Presence (visual disturbance and barrier effects) This pressure relates to the displacement and barrier effect that could occur if birds avoid the area occupied by the wind farm during operation and/or the vessels and activities involved during construction/operation/decommissioning.	15 km + foraging range of each species	BDMPS+ Displacement analysis	15 km	N/A
P8 Underwater Noise Underwater noise may lead to disturbance and direct or indirect (e.g. through impacts upon prey) impacts to bird features. The pressure is considered in relation to all phases of development, although it is probable that the highest emissions of underwater noise in terms of the range of effect will occur during construction which could include foundation piling and/or UXO detonations.	15 km + foraging range of each species	BDMPS+ Displacement analysis	15 km	N/A
P9 Above water noise This pressure relates to the disturbance that could arise from the noise generated by construction and decommissioning activities or the movement of vessels during construction/operation/decommissioning.	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A
P10 Toxic contamination This relates to reduced water quality from, for example, spillages or mobilisation of contaminated sediments resulting in toxic effects. This is relevant to the construction, operation and decommissioning phases.	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A
P12 Light	15 km + foraging range	Included if feature	15 km	N/A

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding seabirds and waterbirds in the non-breeding season	Migratory seabirds, waterbirds and landbirds
The behaviour of birds could be affected by light pollution.	of each species	screened in for P5/7/8		
P14 Suspended sediments This relates to increased turbidity arising from disturbance of seabed sediments with potential associated impacts such as reduction in dissolved oxygen levels, reduced light penetration and altered suspended sediment supply. Whilst suspended sediment changes are not considered to have any potential to result in a direct impact to bird features, there is a potential for this pressure to affect their prey species. Therefore it is included in the screening assessment. This is relevant to the construction, operation and decommissioning phases.	15 km + foraging range of each species	Included if feature screened in for P5/7/8	15 km	N/A
P16 Entanglement This relates to entanglement with mooring lines associated with turbine infrastructure	15 km + foraging range of each species	Foraging range of each species	Included if feature screened in for P5/7	0 km
Co-located H2 production				
P13 Temperature Hydrogen production may have heating or cooling consequences with implications for seabird prey species.	15 km + foraging range of each species	15 km + foraging range of each species	Included if feature screened in for P5/7	15 km
P17 Salinity This relates to release of hypersaline brine following desalination of seawater for electrolysis where it is used for hydrogen production. It is relevant to the operational phase only.	15 km + foraging range of each species	15 km + foraging range of each species	Included if feature screened in for P5/7	15 km

Breeding seabirds in the breeding season

4.4.5 Breeding seabirds in the breeding season are screened in by the tool using the criteria detailed in Table 4.6 for foraging range, in addition to the pressure effect ranges explained in Table 4.55.

4.4.6 Using the absolute maximum foraging distance recorded for any species is considered to be over-precautionary as many species can exhibit extreme behaviours, particularly if individuals are unconstrained by provisioning for young. Conversely, using a simple mean or median foraging distance may underestimate foraging ranges and exclude important connectivity between a colony and foraging areas upon which that colony relies.

4.4.7 For the purposes of the screening tool, where possible, the mean-maximum foraging range plus an additional 1 standard deviation is used. This is considered precautionary whilst still excluding atypical extremes of foraging behaviour. Where this measure cannot be obtained from Woodward *et al*. (2019), the maximum value is used instead, except for Leach's petrel and Arctic skua where only a mean foraging range is the best available evidence. The use of the values in Table 3.6 has been checked against the detailed site-specific data reported in Woodward *et al.* (2019) to ensure that these ranges are suitably precautionary and do not result in the use of screening criteria that will discount LSE prematurely.

4.4.8 Separate rules are applied by the tool for certain categories of protected site:

- Sites designated to protect the sea areas used by features for foraging or other purposes (e.g. Northumberland Marine SPA). These sites are distinguished in the screening tool and screening is based on direct overlap between activity area (plus pressure buffer) and the protected site.
- Sites designated for breeding colonies and foraging areas (e.g. Skomer, Skokholm and Seas off Pembrokeshire SPA). The foraging ranges from Woodward *et al.,* (2019) are applied from the site boundary. Since foraging ranges are already included in SPA boundary calculations, this could potentially incorporate sea areas outside of the foraging range of certain features and, if relevant, this should be considered in subsequent assessment.

Table 4.6 Species-specific foraging ranges for breeding seabirds in the breeding season derived from Woodward et al., (2019)

Species	Foraging range (km)	Rationale
Common eider (*Somateria mollissima*)	21.5	Mean-maximum (standard deviation not available)
Red-throated diver (*Gavia stellata*)	9	Maximum (standard deviation not available)
European storm petrel (*Hydrobates pelagicus*)	336	Maximum (standard deviation not available)

Leach's petrel (*Oceanodroma leucorhoa*)	657	Mean (mean-maximum not available)
Northern fulmar (*Fulmarus glacialis*)	542.3 + 657.9	Mean-maximum plus one standard deviation
Manx shearwater (*Puffinus puffinus*)	1,346.8 + 1,018.7	Mean-maximum plus one standard deviation
Northern gannet (*Morus bassanus*)	315.2 + 194.2	Mean-maximum plus one standard deviation
European shag (*Phalacrocorax aristotelis*)	13.2 + 10.5	Mean-maximum plus one standard deviation
Cormorant (*Phalacrocorax carbo*)	25.6 + 8.3	Mean-maximum plus one standard deviation
Black-legged kittiwake (*Rissa tridactyla*)	156.1 + 144.5	Mean-maximum plus one standard deviation
Black-headed gull (*Chroicocephalus ridibundus*)	19	Maximum (standard deviation not available)
Mediterranean gull (*Ichthyaetus melanocephalus*)	20	Maximum (standard deviation not available)
Common gull (*Larus canus*)	50	Maximum (standard deviation not available)
Great black-backed gull (*Larus marinus*)	73	Maximum (standard deviation not available)
Herring gull (*Larus argentatus*)	58.8 + 26.8	Mean-maximum plus one standard deviation
Lesser black-backed gull (*Larus fuscus*)	127 + 109	Mean-maximum plus one standard deviation
Sandwich tern (*Thalasseus sandvicensis*)	34.3 + 23.2	Mean-maximum plus one standard deviation
Little tern (*Sternula albifrons*)	5	Maximum (standard deviation not available)
Roseate tern (*Sterna dougallii*)	12.6 + 10.6	Mean-maximum plus one standard deviation
Common tern (*Sterna hirundo*)	18.0 + 8.9	Mean-maximum plus one standard deviation

Arctic tern (*Sterna paradisaea*)	25.7 + 14.8	Mean-maximum plus one standard deviation
Great skua (*Stercorarius skua*)	443.3 + 487.9	Mean-maximum plus one standard deviation
Arctic skua (*Stercorarius parasiticus*)	63.3	Mean-maximum (from Woodward *et al.*, 2019 database)
Common guillemot (*Uria aalge*)	73.2 + 80.5	Mean-maximum plus one standard deviation
Razorbill (*Alca torda*)	88.7 + 75.9	Mean-maximum plus one standard deviation
Black guillemot (*Cepphus grylle*)	4.8 + 4.3	Mean-maximum plus one standard deviation
Atlantic puffin (*Fratercula arctica*)	137.10 + 128.3	Mean-maximum plus one standard deviation

Breeding seabirds in the non-breeding season

4.4.9 For this group, initial screening by the tool is followed by further analysis. Information on each step is provided below (see also Appendix B for a worked example of the additional analysis).

4.4.10 Breeding birds from SPAs and Ramsar sites in the non-breeding season are not constrained to specific areas by the necessity to provide for their young, and typically disperse to exploit areas far beyond their breeding colonies. During the non-breeding season, therefore, the birds present within an area of activity (i.e., Offshore Wind Array) may originate from sites that are further away than those considered in the breeding season.

4.4.11 Furness (2015) considered how non-breeding birds dispersed, defining the regions within which those populations would be distributed and for each region a biologically defined minimum population size ("BDMPS") was calculated. Screening uses these BDMPS regions and populations. Where the area of activity overlaps with a BDMPS region, connectivity is assumed by the tool with the population associated with that region (as defined by Furness, 2015), and the protected sites that contribute to that population are screened in.

4.4.12 This approach inevitably identifies a large number of protected sites with potential connectivity (due to the scale of the BDMPS regions). However, the density of birds from any specific protected site that are present in relation to the area of activity may be very low.

4.4.13 To avoid screening in protected sites and features for which an effect is likely to be de minimis, additional analysis is needed. Essentially, a view is taken on the magnitude of the potential impact on the BDMPS population and its component SPA populations and whether this could lead to LSE.

Second stage screening for breeding birds in the non-breeding season and migratory sea-birds

4.4.14 For breeding birds in the breeding season and wintering seabirds it will be assumed that connectivity, established through application of the spatial criteria set out in the Round 4 HRA Principles report (2020a), will lead to an LSE.

4.4.15 For breeding birds in the non-breeding season and migratory waterbirds and seabirds a second stage will be applied to quantify the likely magnitude of any impact, before forming a judgement about LSE.

4.4.16 A worked example of this second stage screening is provided as Appendix B.

4.4.17 Once the tool has identified those BDMPS regions and populations for which there is connectivity, additional analysis to be completed, post running the tool, should consider the likely effect of either P5 (collision) or P7 (physical presence), depending on the specific vulnerability of the species as indicated by Wade *et al.,* (2016) and Bradbury *et al.,* (2014). This is done using collision risk modelling or displacement analysis as required.

4.4.18 If the predicted magnitude of the impact exceeds 1% of the baseline mortality of the BDMPS population (and hence 1% of each of its component SPAs as those populations are represented in proportion within the BDMPS), then each of the component SPAs is screened in (with respect to the relevant feature and pressure considered).

4.4.19 If the predicted magnitude is between 0.5% and 1% of the baseline mortality of the BDMPS population, then further consideration is given to the magnitude of the likely effect, including likely impacts from other plans and projects, in combination. If it cannot be concluded that the combined magnitude of the potential impact will not exceed 1% then each of the component SPAs is screened in (with respect to the relevant feature and pressure considered).

4.4.20 Where the predicted magnitude is less than 0.5% of the baseline mortality of the BDMPS population, then none of the component SPAs are screened in, on the basis that (in the absence of evidence to the contrary) the magnitude of the impact is too low for there to be any risk of LSE alone or in-combination. The exception to this is where the integrity of a protected site is already considered to be adversely affected.

4.4.21 If an LSE is identified for a feature for P5 or P7 then an LSE will also be assumed for pressures P1, 2, 3, 8, 9, 10, 12 and 14.

4.4.22 It should be noted that this aspect of screening is focused on identifying those protected sites and their features for which there is an LSE *only* during the non-breeding season. Where a population has already been screened in because a risk of LSE has been identified during the breeding season, then potential impacts during non-breeding season should also be considered in the subsequent assessment.

Non-breeding seabirds and waterbirds in the non-breeding season

4.4.23 There are a number of SPAs in the UK that are designated for non-breeding season (e.g. wintering) populations of birds that do not necessarily breed in the same region. This includes species that utilise the marine environment (e.g. red-throated diver) and those that may exploit intertidal areas for foraging opportunities whether these areas are within an SPA or not

(i.e. functionally linked habitat), e.g. pink footed geese, brent geese or knot. This category also includes the Irish Sea Front SPA which is designated because of the importance of its habitats for Manx shearwater.

4.4.24 Screening for these sites and their features is based on connectivity. To allow for effects at distance (such as disturbance) and indirect habitats effects the tool applies a spatial criterion of 15 km for the purpose of screening.

Migratory seabirds

4.4.25 For this group, initial screening by the tool is followed by further analysis. Information on each step is provided below (see also Appendix B for a worked example of the additional analysis).

4.4.26 This category relates to certain species of migratory seabird that migrate through UK waters between protected sites that are designated for their breeding and wintering areas. The category therefore includes species of tern, skua, petrel, shearwater and little gull and their associated SPAs. Although other seabirds migrate through UK waters, these species are captured by the screening for other feature categories.

4.4.27 Connectivity is identified by the tool based on the migratory corridors defined for relevant species in WWT Consulting and MacArthur Green (2014). This report suggested five migration bands: 0-10 km; 0-20 km; 0-40 km; 0-60 km; and 1-60 km. Species were assigned to bands based upon observations from coastal watches, offshore surveys and information from Forrester *et al.,* (2007) and seabird/sea-watching experts.

4.4.28 Some seabird species also migrate overland including terns and skuas and this will be taken into account when identifying those species that migrate along the eastern and western coastlines of the UK.

4.4.29 Where there is direct overlap between the activity area and the migratory corridor for a species, connectivity is identified.

4.4.30 Only pressure P5 (collision) is considered relevant for this feature category. For those features for which connectivity is identified, collision risk modelling is required as an additional screening step.

4.4.31 The resulting collision risk estimates are compared to the 1% threshold of baseline mortality for the migratory population for relevant species to identify if an LSE will occur, using the same criteria as for breeding birds in the non-breeding season (this includes consideration of in-combination effects).

Migratory waterbirds and landbirds

4.4.32 For this group, initial screening by the tool is followed by further analysis. Information on each step is provided below (see also Appendix B for a worked example of the additional analysis).

4.4.33 Species of migratory waterbirds and landbirds that are features of protected sites may interact with offshore wind farms. The tool identifies connectivity based on the migratory corridors defined for relevant species by Wright *et al.*, (2012), which were defined from an extensive literature review. Where there is direct overlap between a wind farm area and the migratory corridor for a species, connectivity is assumed.

4.4.34 Only pressure P5 (collision) is considered relevant for this feature category. For those features for which connectivity is identified, collision risk modelling is required as an additional screening step.

4.4.35 The resulting collision risk estimates are compared to the 1% threshold of baseline mortality for the BDMPS population for relevant species to identify if an LSE will occur, using the same criteria as for breeding birds in the non-breeding season (this includes consideration of in-combination effects).

5. Screening Criteria for Marine Aggregates Extraction

5.1.1 Screening methods for marine aggregates extraction are based on the principles applied by ABPmer (2022) for their 2021/2022 marine aggregates plan-level HRA and MCZ assessments undertaken on behalf of The Crown Estate. These principles (screening criteria) have been adapted for the screening tool as summarised here. The ABPmer principles document is provided as Appendix C.

5.1.2 As a general rule, screening in relation to marine aggregates extraction is based on a combination of the expected effect range of individual pressures associated with dredging and the ranging behaviour of mobile features in relation to the protected site location.

5.1.3 Different criteria has been applied to marine aggregates extraction compared to screening for offshore wind. Ranging behaviour is prioritised over pressure effect distance in most cases (other than for birds), reflecting the relatively conservative distances assumed for such behaviour.

5.2. Habitats

5.2.1 Pressures considered in screening for marine aggregates extraction in relation to habitats are categorised as physical (habitat loss, damage or disturbance), and non-physical (pollution) effects.

Physical effects

5.2.2 Physical effects relate to pressures P1, P2, P3, P10, P14.

5.2.3 The physical effects of marine aggregates extraction activities on habitats are separated into different impact zones. A primary impact zone (PIZ) accounts for direct loss of and damage to habitat and smothering effects. The PIZ has been set as 500 m from the position of the draghead (JNCC and Natural England, 2011). Changes to the composition of seabed sediments and development of bedforms has been recorded at 0.52 km from the dredge area (JNCC and Natural England, 2011; Tillin *et al.,* 2011; Newell and Woodcock, 2013).

5.2.4 Physical effects of marine aggregate extraction activities on habitats in the near-field, or secondary impact zone (SIZ), are related to the suspended sediment plume of dredging activity. This has been set as 4 km (JNCC and Natural England, 2011).

5.2.5 Far-field secondary impacts relate to hydrological or geomorphological effects on receptors such as coastlines and sand bank features. These result from seabed lowering, leading to changes in the near bed sediment transport or changes to the wave climate. The specific spatial scales are however dependent on the particular location. There is no evidence that benthic features are impacted beyond 5 km from changes to sediment transport and/or wave climate as a result of dredging activities (ABPmer, 2022).

5.2.6 For the purposes of the screening tool, the above buffers are applied to the shapefile representing the aggregate extraction plan/project area without application of any tidal ellipse information. This is relatively conservative in that effects may not be expected in directions which are not tide-parallel.

Pollution events

5.2.7 Pollution events are related to P10 (Toxic contamination)

5.2.8 Accidental release of fuel or oil during dredging operations is a risk to benthic habitats. This could cause toxic pollution. The effects are assumed to be limited to the near-field SIZ of 4 km of the site boundary.

Table 5.1 Pressures used for screening in relation to marine aggregates extraction for habitats and associated spatial criteria (ABPmer, 2022).

Pressure	Effect distance	Range distance	Rationale
Marine Aggregates Extraction			
P1 Habitat loss/gain	0 km	0 km	Impact is restricted to the foot-print of physical structures, i.e. direct overlap. The primary im-pact zone (PIZ) accounts for di-rect loss of and damage to hab-itat and smothering effects.
P2 Direct physical damage	0.5 km	0 km	A primary impact zone (PIZ) ac-counts for direct loss of and damage to habitat and smoth-ering effects. The PIZ has been set as 500 m from the position of the draghead (JNCC and Natural England, 2011). Changes to the composition of seabed sediments and devel-opment of bedforms recorded at 0.52 km from the dredge area (JNCC and Natural Eng-land, 2011; Tillin *et al.*, 2011; Newell and Woodcock, 2013).
P3 Indirect physical damage	5 km	0 km	Far-field secondary impacts assumed to be limited to 5 km from the site boundary, relating to hydrological or geomorpho-logical effects on receptors such as coastlines and sand bank features. These result from seabed lowering, leading to changes in the nearbed sedi-ment transport or changes to the wave climate.

P10 Toxic contamination	4 km	0 km	The effects are assumed to be limited to the near-field SIZ, applied as a simple buffer by the screening tool) of 4 km of the site boundary.
P14 Suspended sediments	4 km	0 km	The effects are assumed to be limited to the near-field SIZ, applied as a simple buffer by the screening tool) of 4 km of the site boundary.
P15 Invasive non-native species (INNS)	0 km	0 km	Impact is restricted to the footprint of physical structures, i.e. direct overlap. Vectors of spread and introduction during marine aggregates extraction activities include biofouling, transfer in water and within sediments.

5.3. Marine mammals

5.3.1 Otter are not screened by the tool in relation to marine aggregates extraction since this species is not expected to occur in or around aggregate extraction areas.

5.3.2 The screening tool considers ranging behaviour of marine mammals, as they are highly mobile, in addition to the expected range of effects of pressures.

5.3.3 For Annex II species (harbour porpoise and bottlenose dolphin) a foraging distance of 100 km was assumed, based on NIRAS, 2020.

5.3.4 An expert working group convened for The Crown Estate's 2021/2022 marine aggregates plan-level HRA agreed foraging buffers of 135 km and 120 km for grey seal and harbour seal, respectively.

5.3.5 In relation to the expected effect range of pressures, for P8 (underwater noise) the criterion is based on the following.

5.3.6 Noise in relation to marine aggregates extraction can stem from vessels, centrifugal pumps, intake pipes and the draghead on the seabed.

5.3.7 Dredging activities are typically of low frequency below 1 kHz (de Jong *et al.,* 2010; de Jong, 2016), with hearing damage and permanent threshold shifts unlikely to occur at the sound frequencies and intensities associated with dredging. The near-field SIZ is used for the extent of significant noise impacts. In The Crown Estate's 2021/2022 marine aggregates plan-level HRA, this approach was deemed to be precautionary as the sound emissions from dredging activities were considered undetectable beyond 1 km from the vessel, with noise related to the plume extending out to 4 km from the dredge (ABPmer, 2022). For the purpose of screening a 12 km spatial criterion has been set in relation to underwater noise. This is the largest potential noise disturbance arising from seismic airguns (Thompson *et al.,* 2013 and Sarnocinska *et al.,* 2020). The 12 km spatial criteria has further been used in the designation of new harbour porpoise SACs in the UK (BEIS, 2020).

The screening criteria applied by the tool are summarised in *Table 5.2*

Table 5.2 Pressures used for screening in relation to marine mammals (seals and cetaceans) and associated spatial criteria for marine aggregates extraction (ABPmer, 2022).

Pressure	Group	Efect distance	Range distance	Rationale
Marine aggregates extraction				
P1 Habitat loss/gain	Seals and cetaceans	0 km	0 km (direct overlap)	Physical loss of habitat of prey species. Impact is restricted to the footprint of physical structures, i.e. direct overlap. The primary impact zone (PIZ) accounts for direct loss of and damage to habitat and smothering effects.
P2 Direct physical damage	Seals and cetaceans	0.5 km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	Primary impact zone (PIZ) is the direct loss of and damage to habitat and smothering effects. The PIZ has been set as 500 m from the position of the draghead (JNCC and Natural England, 2011; Tillin *et al.*, 2011; Newell and Woodcock, 2013).
P3 Indirect physical damage	Seals and cetaceans	5 km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	Physical damage to foraging habitats and habitats of prey (i.e., through smothering). Far-field secondary impacts assumed to be limited to 5 km from the site boundary, relating to hydrological or geomorphological effects on receptors such as coastlines and sand bank features. These result from seabed lowering, leading to changes in the nearbed sediment transport or changes to the wave climate.
P7 Physical Presence	Seals and cetaceans	2 km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	Allowance made for localised disturbance.

Pressure	Group	Efect distance	Range distance	Rationale
P8 Underwater Noise	Seals and cetaceans	12 km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	This is the largest potential noise disturbance arising from seismic airguns (Thompson *et al.,* 2013 and Sarnocinska *et al.,* 2020). The 12 km spatial criteria has further been used in the designation of new harbour porpoise SACs in the UK (BEIS, 2020).
P9 Above Water Noise	Seals	0km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	Allowance made for localised disturbance.
P10 Toxic contamination	Seals and cetaceans	4 km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	There is a risk of toxic pollution from fuel or oil release during dredging operations for marine mammals at the licence site. The screening spatial criteria has been set to the near-field SIZ, within 4 km.
P12 Light	Seals and cetaceans	2 km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	Allowance made for localised disturbance.
P14 Suspended sediments	Seals and cetaceans	4 km	100 km (dolphin and porpoise); 135 km (grey seal); 120 km (harbour seal)	Physical loss due to smothering of habitats of prey species and non-toxic contamination of foraging habitats. Physical effects of marine aggregate extraction activities on habitats in the near-field, or secondary impact zone (SIZ), are related to the suspended sediment plume of

Pressure	Group	Efect distance	Range distance	Rationale
				dredging activity. This has been set as 4 km (JNCC and Natural England, 2011).

5.4. Migratory fish (including freshwater pearl mussel)

5.4.1 The screening tool considers both the expected range of effect for each pressure and the ranging behaviour of fish, since all features are mobile and to some extent range away from protected sites. Criteria for ranging distances and effect distances are detailed below (Table 5.3).

5.4.2 Pressure effect distance criteria are detailed in Table 5.4.

Table 5.3 Ranging behaviour criteria for migratory fish (and freshwater pearl mussel) in relation to screening of marine aggregates extraction (ABPmer, 2022).

Species	Spatial criteria	Rationale
Atlantic salmon & Freshwater Pearl Mussel	Regional areas	Regional boundaries applied to Atlantic salmon, encountering of aggregate extraction activities during marine migrations (see also Figure 3.1).
River lamprey and sea lamprey	100 km for sea lamprey; 10 km for river lamprey	Screening buffer of 100 km applied to Sea lamprey as a migratory species. Might encounter marine aggregate extraction activities during marine migrations away from designated sites. Screening buffer of 10 km has been applied for River lamprey. It is a migratory species, but does not travel outside of freshwater and brackish areas.
Allis and twaite shad	100 km	A screening buffer of 100 km applied, reflecting encountering marine aggregates extraction activities during migration.

Table 5.4 Pressures used for screening in relation to migratory fish and freshwater pearl mussel and associated spatial criteria for marine aggregates extraction (ABPmer, 2022).

Pressure	Group	Effect distance	Range distance	Rationale
Marine aggregates extraction				
P1 Habitat loss/gain	Migratory Fish and Freshwater Pearl Mussel	0 km	0 km	Physical effects of activities on fish assumed to be the same as for habitats. Impact is restricted to the footprint of physical structures, i.e. direct overlap.
P2 Direct physical damage	Migratory Fish and Freshwater Pearl Mussel	0.5 km	Species specific; see Table 5.3.	Physical effects of activities on fish assumed to be the same as for habitats. The primary impact zone (PIZ) accounts for direct loss of and damage to habitat and smothering effects. Impact of potential smothering up to 500 m from draghead (JNCC and Natural England, 2011).
P3 Indirect physical damage	Migratory Fish and Freshwater Pearl Mussel	5 km	Species specific; see Table 5.3.	Far-field secondary impacts assumed to be limited to 5 km from the site boundary, relating to hydrological or geomorphological effects on receptors such as coastlines and sand bank features. These result from seabed lowering, leading to changes in the near bed sediment transport or changes to the wave climate.
P7 Physical Presence	Migratory Fish and Freshwater Pearl Mussel	2 km	Species specific; see Table 5.3.	No explanation given.

P8 Underwater Noise	Migratory Fish and Freshwater Pearl Mussel	10 km	Species specific; see Table 5.3.	Significant noise impact expected in the near-field. A 10 km buffer is applied to edge of Agreement Area for Screening purposes for fish species.
P10 Toxic contamination	Migratory Fish and Freshwater Pearl Mussel	4 km	Species specific; see Table 5.3.	Impacts of toxic contamination through, for example, the accidental release of fuel or oil, expected in the near field, within 4 km.
P14 Suspended sediments	Fish and Freshwater Pearl Mussel	4 km	Species specific; see Table 5.3.	Physical effects of marine aggregate extraction activities on habitats and habitats of prey species in the near-field, or secondary impact zone (SIZ), are related to the suspended sediment plume of dredging activity. This has been set as 4 km (JNCC and Natural England, 2011).

5.5. Birds

5.5.1 The screening tool considers ranging behaviour of birds as they are highly mobile, in addition to the expected range of effects of pressures.

5.5.2 Bird features are grouped into four categories for screening, mirroring the approach adopted for fixed and floating offshore wind:

- Breeding seabirds in the breeding season
- Breeding seabirds in the non-breeding season
- Non-breeding seabirds and waterbirds in the non-breeding season
- Migratory seabirds, and migratory waterbirds and landbirds

5.5.3 The pressures relevant to birds in each of these categories are summarised in Table 5.4. All criteria are detailed in Appendix A (Parameters Table) of the ABPmer (2022) Principles Document, appended to this document as Appendix C.

5.5.4 Screening assumes no mechanism for impact in relation to:

- Breeding seabirds in the non-breeding season- birds are not constrained to specific areas due to the necessity of providing for young, and typically disperse to exploit areas far beyond their breeding colonies.
- Migratory seabirds- this category relates to certain species of migratory seabird that migrate through UK waters between sites designated for their breeding and wintering areas. There is considered to be no potential for LSE.
- Migratory waterbirds and landbirds- given the offshore nature of aggregates extraction there is considered to be no potential for LSE.

Table 5.5 Pressures used for screening in relation to birds and associated spatial criteria.

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding coastal	Migratory seabirds, waterbirds and landbirds	Rationale
Marine aggregates extraction					
P1 Habitat loss/gain	0 km	N/A	0 km	N/A	Physical effects of activities on seabirds (habitats of prey species) assumed to be the same as for habitats. Impact is restricted to the footprint of physical

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding coastal	Migratory seabirds, waterbirds and landbirds	Rationale
					structures, i.e. direct overlap.
P2 Direct physical damage	0.5 km + foraging range of each species	N/A	0.5 km	N/A	Physical impact on habitat of prey. Impact of potential smothering up to 500 m from draghead (JNCC and Natural England, 2011).
P3 Indirect physical damage	5 km + foraging range of each species	N/A	5 km	N/A	Far-field secondary impacts assumed to be limited to 5 km from the site boundary, relating to hydrological or geomorphological effects on receptors such as coastlines and sand bank features. These result from seabed lowering, leading to changes in the nearbed sediment transport or changes to the wave climate.
P4/5/6 Collision	0 km + foraging range of each species	N/A	0 km	N/A	
P7 Physical Presence (visual disturbance	2 km + foraging range of	N/A	2 km	N/A	Visual disturbance effects from dredger operation have been set to 2

Pressure	Breeding seabirds in the breeding season	Breeding seabirds in the non-breeding season (BDMPS)	Non-breeding coastal	Migratory seabirds, waterbirds and landbirds	Rationale
and barrier effects)	each species				km (Reach *et al.*, 2013).
P10 Toxic contamination	4 km + foraging range of each species	N/A	4 km	N/A	Accidental release of fuel or oil leading to pollution, restricted to the near-field SIZ, i.e. within 4km.
P12 Light	2 km + foraging range of each species	N/A	2 km	N/A	Visual disturbance effects from dredger operation have been set to 2 km (Reach *et al.*, 2013).
P14 Suspended sediments	4 km + foraging range of each species	N/A	4 km	N/A	Physical loss due to smothering of habitats of prey species and non-toxic contamination of foraging habitats. Physical effects of marine aggregate extraction activities on habitats in the near-field, or secondary impact zone (SIZ), are related to the suspended sediment plume of dredging activity. This has been set as 4 km (JNCC and Natural England, 2011).

6. Summary and Conclusion

6.1.1 This Principles Report brings together the core assumptions, evidence base, and feature-specific criteria that underpin The Protected Sites Screening Tool. The principles set out here define how the tool identifies potential connectivity between marine development activities and protected sites and features, ensuring that screening is undertaken in a robust, consistent and precautionary manner.

6.1.2 The tool operates on the fundamental premise that connectivity alone is sufficient to screen features in, unless a clear absence of a pressure-effect pathway can be established. As such, the outputs represent a precautionary long-list of sites, features, and pressures for consideration. These results should be viewed as a structured starting point for HRA or MCZ screening, and should not be a substitute for professional judgement or statutory consultation.

6.1.3 While this report outlines the default principles and assumptions that drive the tool, it is essential to note that:

- Screening outcomes remain connectivity-based, and do not constitute an assessment of impact magnitude or ecological significance.
- SNCB consultation is still required, as screening decisions may need refinement in light of site-specific advice, updated evidence, or regulator input.
- The tool does not automate all aspects of screening. Additional analysis for breeding birds in the non-breeding season and migratory birds should be undertaken to quantify the likely magnitude impact, before forming a judgement about LSE, see sections 3.4 and 4.4 for details.
- Users may adjust the screening parameters using the "Test new parameters" function where justified, allowing flexibility to incorporate emerging evidence or alternative scenario testing.

6.1.4 Practical instructions on using the tool, including how to adapt screening distances, interpret outputs, and complete steps for features requiring additional analysis, are provided in the accompanying User Guide (NIRAS, 2025b). Together, this Principles Report and the User Guide support the need for the Protected Sites Screening Tool to have a transparent, repeatable, and defensible screening process, while ensuring that decision making continues to be underpinned by expert judgement and appropriate statutory engagement.

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Appendix A

The following matrix relates Pressures considered in relation to management advice for European sites (Natural England, 2020) with impact pathways used to categorise impacts in the screening tool, in relation to fixed offshore wind.

Pressure Code	Pressure Name	Pressure Description (edited to focus on offshore wind)	Impact Pathway					
			I	II	III	IV	V	VI
B1	Visual disturbance	The disturbance of biota by anthropogenic activities, e.g. increased vessel movements, such as during construction phases for new infrastructure, increased personnel movements, increased vehicular movements on shore etc. disturbing bird roosting areas, seal haul out areas etc.			X			
B2	Genetic modification & translocation of indigenous species	Pressure not associated with offshore wind						X
B3	Introduction or spread of invasive non-indigenous species (INIS)	The direct or indirect introduction of invasive non-indigenous species, e.g. Chinese mitten crabs, slipper limpets, Pacific oyster and their subsequent spreading and out-competing of native species. Ballast water, hull fouling, stepping stone effects (e.g. offshore wind farms) may facilitate the spread of such species.						X
B4	Introduction of microbial pathogens	Pressure not associated with offshore wind						X
B5	Removal of target species	Pressure not associated with offshore wind		X				
B6	Removal of non-target species (fisheries)	Pressure not associated with offshore wind		X				
D1	Habitat structure changes - removal of substratum (extraction)	Unlike the "physical change" pressure type where there is a permanent change in sea bed type (e.g. sand to gravel, sediment to a hard artificial substratum) the "habitat structure change" pressure type relates to temporary and/or reversible change, e.g. where a proportion of seabed sands or gravels are removed but a residual layer of seabed is similar to the pre-dredge structure and as such biological communities could re-colonize. The sediment typology is not changed.		X				
D2	Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion	Physical disturbance of sediments where there is limited or no loss of substratum from the system. This pressure is associated with activities such as anchoring, taking of sediment/geological cores, cone penetration tests, cable burial (ploughing or jetting), propeller wash from vessels. Compression of sediments, e.g. from the legs of a jack-up barge could also fit into this pressure type. Abrasion relates to the damage of the sea bed surface layers (typically up to 50cm depth). Loss, removal or modification of the substratum is not included within this pressure (see the physical loss pressure theme). Penetration and damage to the soft rock substrata are considered, however the penetration into hard bedrock is deemed unlikely.		X				
D3	Changes in suspended solids (water clarity)	Changes water clarity (or turbidity) due to changes in sediment & organic particulate matter and chemical concentrations. It is related to activities disturbing sediment and/or organic particulate matter and mobilizing it into the water column. E.G. all forms of dredging, disposal at sea, cable and pipeline burial. Particle size, hydrological energy (current speed & direction) and tidal excursion are all influencing factors on the spatial extent and temporal duration. Salinity, turbulence, pH and temperature may result in flocculation of suspended organic matter. Anthropogenic sources are mostly short lived and over relatively small spatial extents. Changes in suspended sediment loads can also alter the scour experienced by species and habitats. Therefore, the effects of scour are also addressed here.					X	
D4	Smothering and siltation rate changes (Heavy)	"Heavy" smothering also relates to the deposition of layers of sediment on the seabed but is associated with activities such as sea disposal of dredged materials where sediments are deliberately deposited on the sea bed. This accumulation of sediments relates to the depth of vertical overburden where the sediment type of the existing and deposited sediment has similar physical characteristics because, although most species of marine biota are unable to adapt, e.g. sessile organisms unable to make their way to the surface, a similar biota could, with time, re-establish. If the sediments were physically different this would fall under L2.		X				
D5	Smothering and siltation rate changes (Light)	When the natural rates of siltation are altered (increased or decreased). Siltation (or sedimentation) is the settling out of silt/sediments suspended in the water column. Activities associated with this pressure type include disposal at sea, cable and pipeline laying and various construction activities. It can result in short lived sediment concentration gradients and the accumulation of sediments on the sea floor. This accumulation of sediments is synonymous with "light" smothering, which relates to the depth of vertical overburden. "Light" smothering relates to the deposition of layers of sediment on the seabed. It is associated with activities such as sea disposal of dredged materials where sediments are deliberately deposited on the sea bed. For "light" smothering most benthic biota may be able to adapt, i.e. vertically migrate through the deposited sediment.		X				

Pressure Code	Pressure Name	Pressure Description (edited to focus on offshore wind)	Impact Pathway					
			I	II	III	IV	V	VI
D6	Abrasion/disturbance of the substrate on the surface of the seabed	Physical disturbance or abrasion at the surface of the substratum in sedimentary or rocky habitats. The effects are relevant to epiflora and epifauna living on the surface of the substratum. In intertidal and sublittoral fringe habitats, surface abrasion is likely to result from vehicular access, moorings (ropes, chains), activities that increase scour and grounding of vessels (deliberate or accidental). In the sublittoral, surface abrasion is likely to result from cables and chains associated with fixed gears and moorings, anchoring of vessels, and objects placed on the seabed such as the legs of jack-up barges. In sublittoral habitats, passing bottom gear (e.g. fishing survey gear) may also cause surface abrasion to epifaunal and epifloral communities, including epifaunal biogenic reef communities. Activities associated with surface abrasion can cover relatively large spatial areas e.g. bottom trawls, or be relatively localized activities.		X				
H1d	Temperature decrease	Pressure not associated with offshore wind					X	
H1i	Temperature increase	Events or activities increasing local water temperature. This could relate to temperature changes in the vicinity of operational sub-sea power cables.					X	
H2d	Salinity decrease	Pressure not associated with offshore wind					X	
H2i	Salinity increase	Pressure not associated with offshore wind					X	
H3	Water flow (tidal current) changes, including sediment transport considerations	Changes in water movement associated with tidal streams. The pressure is associated with activities that have the potential to modify hydrological energy flows. The pressure extremes are a shift from a high to a low energy environment (or vice versa). The biota associated with these extremes will be markedly different as will the substratum, sediment supply/transport and associated seabed/ground elevation changes. The potential exists for profound changes (e.g. coastal erosion/deposition) to occur at long distances from the construction itself if an important sediment transport pathway was disrupted. As such these pressures could have multiple and complex impacts associated with them.		X				
H4	Emergence regime changes, including tidal level change considerations	Pressure not associated with offshore wind		X				
H5	Wave exposure changes	Local changes in wave length, height and frequency. Exposure on an open shore is dependent upon the distance of open seawater over which wind may blow to generate waves (the fetch) and the strength and incidence of winds. A dense network of wind turbines may have the potential to influence wave exposure, depending upon their location relative to the coastline.		X				
L1	Physical loss (to land or freshwater habitat)	The permanent loss of marine habitats. Associated activities are the footprint of a wind turbine on the seabed, dredging if it alters the position of the halocline. This excludes changes from one marine habitat type to another marine habitat type.	X					
L2sb	Physical change (to another seabed type)	The permanent change of one marine habitat type to another marine habitat type, through the change in substratum, including to artificial (e.g. concrete). This therefore involves the permanent loss of one marine habitat type but has an equal creation of a different marine habitat type which may be colonised by different species/communities to the original habitat. Associated activities include the installation of infrastructure (e.g. surface of platforms or wind farm foundations and cables), the placement of scour protection where soft sediment habitats are replaced by hard/coarse substratum habitats. This is measured as change from sedimentary or soft rock substrata to hard rock or artificial substrata or vice-versa.	X					
L2sed	Physical change (to another sediment type)	The permanent change of one marine habitat type to another marine habitat type, through the change in substratum, by change in sediment type by one Folk class. This therefore involves the permanent loss of one marine habitat type but has an equal creation of a different marine habitat type.	X					
O1	Litter	Marine litter is any manufactured or processed solid material from anthropogenic activities discarded, disposed or abandoned (excluding legitimate disposal) once it enters the marine and coastal environment including: plastics, metals, timber, rope etc. and their degraded components, e.g. microplastic particles. Ecological effects can be physical (smothering), biological (ingestion, including uptake of microplastics; entangling; physical damage; accumulation of chemicals) and/or chemical (leaching, contamination).					X	

Pressure Code	Pressure Name	Pressure Description (edited to focus on offshore wind)	Impact Pathway					
			I	II	III	IV	V	VI
O2	Electromagnetic changes	Localized electric and magnetic fields associated with operational power cables. Such cables may generate electric and magnetic fields that could alter behaviour and/or migration patterns of sensitive species (e.g. salmonids, cetaceans, lamprey).			X			
O3	Underwater noise changes	Increases over and above background noise levels (consisting of environmental noise (ambient) and incidental man-made/anthropogenic noise (apparent)) at a particular location. Species known to be affected are marine mammals and fish but could potentially include diving birds and crustaceans. The theoretical zones of noise influence are temporary or permanent hearing loss; discomfort and injury; response; and masking. In extreme cases noise pressures may lead to physical injury and death. The physical or behavioural effects are dependent on a number of variables, including the sound pressure level and frequency of the noise. High amplitude low and mid-frequency impulsive sounds and low frequency continuous sound are of greatest concern for effects on marine organisms. Some species may be responsive to the associated particle motion rather than the usual concept of noise (i.e. pressure wave). Noise propagation can be over large distances (tens of kilometres) but transmission losses can be attributed to factors such as water depth and sea bed topography. Noise levels associated with construction activities, such as pile-driving, are typically significantly greater than operational phases (i.e. shipping, operation of a wind farm).			X			
O4	Introduction of light	Direct inputs of light from anthropogenic activities, i.e. lighting on structures during construction or operation to allow 24 hour working; new tourist facilities, e.g. promenade or pier lighting, lighting on oil & gas facilities etc. Ecological effects may be the diversion of bird species from migration routes if they are disorientated by or attracted to the lights.			X			
O5	Barrier to species movement	The physical obstruction of species movements and including local movements (within & between roosting, breeding, feeding areas) and regional/global migrations (e.g. birds, eels, salmon, and whales). Both include movements across open waters (e.g. offshore wind farm). Species affected are mostly highly mobile birds, fish, and mammals.			X			
O6a	Collision ABOVE water with static or moving objects not naturally found in the marine environment (e.g., boats, machinery, and structures)	This pressure relates to the injury or mortality of biota from collisions with both static and/or moving structures. Examples include collisions with wind turbine blades (e.g. birds).		X				
O6b	Collision BELOW water with static or moving objects not naturally found in the marine environment	This pressure relates to the injury or mortality of biota from collisions with both static and/or moving structures. Examples include collisions with shipping (e.g. fish and mammals). Activities increasing number of vessels transiting areas, e.g. construction works, will influence the scale and intensity of this pressure.		X				
O7	Above water noise	This pressure relates to any loud noise made onshore or offshore by construction, vehicles (including aircraft), vessels etc. that may disturb birds and reduce time spent in feeding or breeding area. Pinnipeds (whilst hauled out) may also be sensitive to this pressure.			X			
O8	Vibration	Aquatic animals are sensitive to particle motion therefore vibration alone will present a significant direct disturbance to some species. In addition to direct vibration sources (e.g. drilling, trawling, piling, etc.) energy from substrate vibrations can enter the water column as sound waves which are likely to produce pressure components of sound and cause similar effects as those discussed in 'O3 underwater noise'. (In the HRA particle displacement will therefore be considered in relation to Underwater Noise.)			X			
P1	Transition elements & organo-metal (e.g. TBT) contamination	The increase in transition elements levels compared with background concentrations, due to their input from land/riverine sources, by air or directly at sea. For marine sediments the main elements of concern are Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead and Zinc Organo-metallic compounds such as the butyl tins (Tri butyl tin and its derivatives) can be highly persistent and chronic exposure to low levels has adverse biological effects, e.g. Imposex in molluscs.				X		
P2	Hydrocarbon & PAH contamination	Increases in the levels of these compounds compared with background concentrations. Naturally occurring compounds, complex mixtures of two basic molecular structures: - straight chained aliphatic hydrocarbons				X		

Pressure Code	Pressure Name	Pressure Description (edited to focus on offshore wind)	Impact Pathway					
			I	II	III	IV	V	VI
		(relatively low toxicity and susceptible to degradation) - multiple ringed aromatic hydrocarbons (higher toxicity and more resistant to degradation) These fall into three categories based on source (includes both aliphatics and polyaromatic hydrocarbons): - petroleum hydrocarbons (from natural seeps, oil spills and surface water run-off) - pyrogenic hydrocarbons (from combustion of coal, woods and petroleum) - biogenic hydrocarbons (from plants & animals) Ecological consequences include tainting, some are acutely toxic, carcinomas, growth defects.						
P3	Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	Increases in the levels of these compounds compared with background concentrations. Synthesised from a variety of industrial processes and commercial applications. Chlorinated compounds include polychlorinated biphenols (PCBs), dichlor-diphenyl-trichloroethane (DDT) & 2,3,7,8-tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD) are persistent and often very toxic. Pesticides vary greatly in structure, composition, environmental persistence and toxicity to non-target organisms. Includes: insecticides, herbicides, rodenticides & fungicides. Pharmaceuticals and Personal Care Products originate from veterinary and human applications compiling a variety of products including, Over the counter medications, fungicides, chemotherapy drugs and animal therapeutics, such as growth hormones. Due to their biologically active nature, high levels of consumption, known combined effects, and their detection in most aquatic environments they have become an emerging concern. Ecological consequences include physiological changes (e.g. growth defects, carcinomas).				X		
P4	Introduction of other substances (solid, liquid or gas)	The 'systematic or intentional release of liquids, gases ' (from MSFD Annex III Table 2) is being considered e.g. in relation to produced water from the oil industry. It should therefore be considered in parallel with P1, P2 and P3.				X		
P5	Radionuclide contamination	Pressure not associated with offshore wind				X		
P6	Nutrient enrichment	Pressure not associated with offshore wind					X	
P7	Organic enrichment	Pressure not associated with offshore wind					X	
P8	Deoxygenation	Pressure not associated with offshore wind					X	

Appendix B

Birds – Stage 2 Screening Worked Examples, produced for the Round 4 Plan-level HRA provided as a separate .PDF.

Appendix C

ABPmer 2022 Marine Aggregates Plan-Level HRA and MCZ assessment provided as a separate .PDF