From:	Dominika Phillips
To:	Kay Sully; KJ Johansson; Hornsea Project Three
Cc:	Andrew Guyton; Stuart Livesey
Subject:	Hornsea Project Three (UK) Ltd response to Deadline 5 (Part 3)
Date:	23 January 2019 21:05:08
Attachments:	image001.png D5_HOW03_Appendix 6_Immature apportioning.pdf D5_HOW03_Appendix 7_IOGP AMG.PDF D5_HOW03_Appendix 9.pdf D5_HOW03_Appendix 10_Article 6(4) Guidance.pdf D5_HOW03_Appendix 11_MarLIN.pdf D5_HOW03_Appendix 12_Ornithology Roadmap_vB.pdf D5_HOW03_Appendix 13 _Anatec.pdf D5_HOW03_Appendix 14_HCA_BeatriceA.pdf

Dear Kay, K-J

Please find attached the 3rd instalment of documents.

Best regards,
Dr Dominika Chalder PIEMA
Environment and Consent Manager

[redacted]

Environmental Management UK| Wind Power
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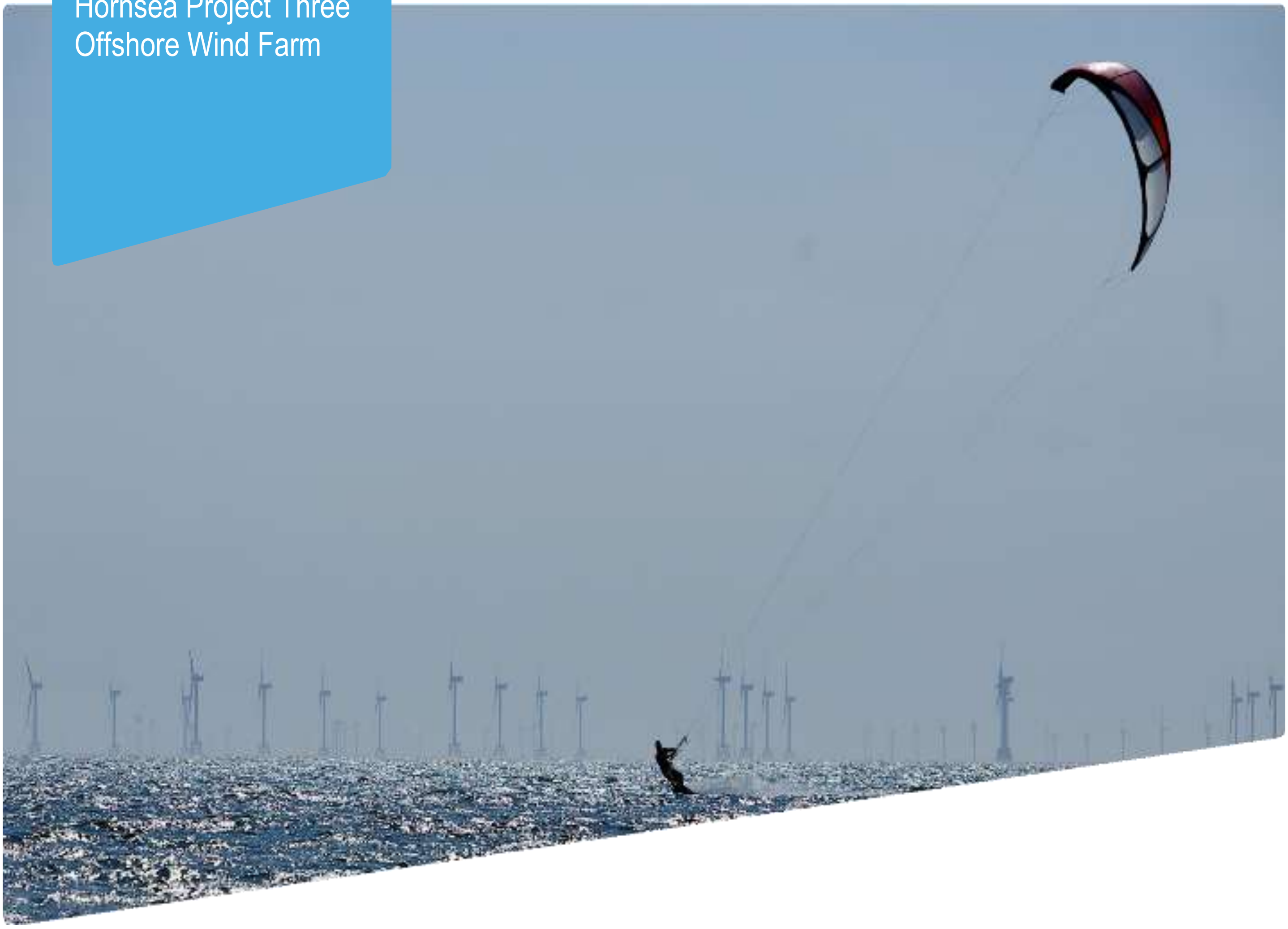
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Appendix 11 to Deadline 5 submission - MarESA Summaries EpusOborApri and PoVen biotopes

Date: 23rd January 2019

Hornsea 3
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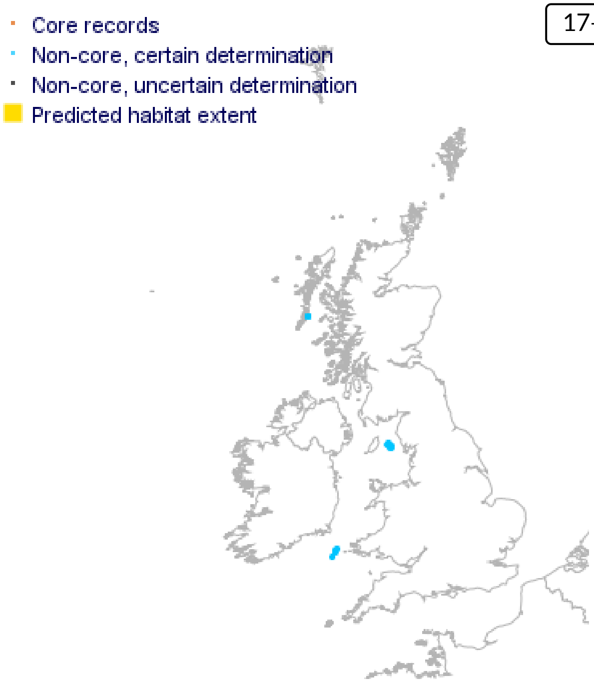
Front cover picture: Kite surfer near a UK offshore wind farm © Ørsted Hornsea Project Three (UK) Ltd., 2019.

Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand★

17-09-2018

No image available



(https://www.marlin.ac.uk/map_explanation)

Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu (http://www.emodnet-seabedhabitats.eu))

Only coastal and marine records shown

Researched by	Dr Heidi Tillin	**Refereed by**	This information is not refereed.

Summary

UK and Ireland classification

UK and Ireland classification

EUNIS 2008	A5.251	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand
JNCC 2015	SS.SSa.CFiSa.EpusOborApri	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand
JNCC 2004	SS.SSa.CFiSa.EpusOborApri	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand
1997 Biotope		

Description

Circalittoral and offshore medium to fine sand (from 40m to 140m) characterized by the pea urchin *Echinocyamus pusillus*, the polychaete *Ophelia borealis* and the bivalve *Abra prismatica*. Other species may include the polychaetes *Spiophanes bombyx*, *Pholoe* sp., *Exogone* spp., *Sphaerosyllis bulbosa*, *Goniada maculata*, *Chaetozone setosa*, *Owenia fusiformis*, *Glycera lapidum*, *Lumbrineris latreilli* and *Aricidea cerrutii* and the bivalves *Thracia phaseolina* and *Moerella pygmaea* and to a lesser extent *Spisula elliptica* and *Timoclea ovata*. This biotope has been found in the central and northern North Sea (JNCC, 2015).

Depth range

-

Additional information

-

Listed By

HPI
(https://www.marlin.ac.uk/marine-designations#hpi)

HCI
(https://www.marlin.ac.uk/marine-designations#hci)

PMF (https://www.marlin.ac.uk/marine-designations#pmf)

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

The initial project scoping exercise to update the existing MarLIN assessments with the MarESA approach grouped biotopes where sensitivities were likely to be similar. The biotopes SS.SSa.IMuSa.FfabMag; SS.SSa.IMuSa.SsubNhom; SS.SSa.CFiSa.EpusOborApri; SS.SSa.CFiSa.ApriBatPo and SS.SSa.CMuSa.AalbNuc represent a continuum along depth and sediment gradients and were grouped as their responses to pressures are probably similar, given the presence of similar species and functional groups. These biotopes have been reviewed as a group, although the resultant reviews and sensitivity assessments are presented separately for each biotope. The specific biotope assessments have been updated with information on characterizing species, where this was readily available, however, the assessments are relatively generic for this group.

Resilience and recovery rates of habitat

This biotope may recover from impacts via *in-situ* repair of damaged individuals, migration of adults of mobile species such as the errant polychaetes *Glycera lapidum* and *Nephtys cirrosa*, amphipods and echinoderms. Adults may also be transported in the water column following washout from sediments.Storm events may lead to the displacement of large numbers of individuals. Most bivalves will be able to reposition within the sediment and some, such as *Glycymeris glycymeris*, are also able to move and to relocate following displacement and disturbance (Thomas, 1975). For immobile species or where depopulation has occurred over a large area, recovery will depend on recolonization by pelagic larvae.

A large number of species are recorded in the biotopes within the assessed group and there may be large natural variation in species abundance over the course of a year or between years (see Dauvin, 1985 for *Timoclea ovata*; Fahy *et al*., 2003 for *Spisula solida*; Sardá *et al*., 1999 multispecies). These variations may not alter the biotope classification where habitat parameters, such as sediment type, remain as described in the classification and many of the characteristic species groups are present. For many of the bivalve species studied, recruitment is sporadic and depends on a successful spat fall but recruitment by the characterizing polychaetes may be more reliable. However, due to the large number of pre- and post-recruitment factors such as food supply, predation, and competition, recruitment of venerid bivalves and other species is unpredictable (Olafsson *et al*., 1994).

The life history characteristics of the characterizing bivalves and polychaetes and other species were reviewed. Little information was found for *Moerella* spp. Morton (2009) noted that despite the wide global distribution of the characterizing venerid bivalve, *Timoclea ovata*, little was known about its anatomy or basic biology. This appears to be the case for many of the other characterizing venerid bivalves and much more information was available for the polychaete species that occur in this biotope. Two linked factors that may explain this are the greater research effort in soft sediments with higher mud contents where sampling is easier than in coarse sediments. Venerid bivalves are also considered to be under-represented in grab samples (JNCC, 2015), so less is known of their occurrence over ecological and impact gradients.

The venerid bivalves in the biotope reach sexual maturity within two years, spawn at least once a year and have a pelagic dispersal phase (Guillou & Sauriau, 1985; Dauvin, 1985). No information was found concerning number of gametes produced, but the number is likely to be high as with other bivalves exhibiting planktotrophic development (Olafsson *et al.*, 1994). Recruitment in venerids is likely to be episodic, some species such as *Chamelea gallina* may be long-lived (11-20 years). The long lifespan & slow growth rate suggest that this group is likely to take several years, even if initial recolonization were to occur rapidly (MES, 2010). Dauvin (1985) reported that *Timoclea ovata* (studied as *Venus ovata*) recruitment occurred in July-August in the Bay of Morlaix. However, the population showed considerable pluriannual variations in recruitment, which suggests that recruitment is patchy and/or post settlement processes are highly variable.

The species that are present in the biotope can be broadly characterized as either opportunist species that rapidly colonize disturbed habitats and increase in abundance, or species that are larger and longer-lived and that may be more abundant in an established, mature assemblage.

Species with opportunistic life strategies (small size, rapid maturation and short lifespan of 1-2 years with production of large numbers of small propagules), include the bivalve *Spisula solida;* and the polychaetes *Spiophanes bombyx*, *Spio filicornis*, and *Chaetozone setosa;* also cumaceans; barnacles *Balanus crenatus;* and the tube worm *Spirobranhchus* (formerly *Pomatoceros*) *lamarckii*. These are likely to recolonize disturbed areas first, although the actual pattern will depend on recovery of the habitat, season of occurrence and other factors. The recovery of bivalves that recruit episodically and the establishment of a representative age-structured population for larger, longer lived organisms may require longer than two years. In an area that had been subjected to intensive aggregate extraction for

30 years, abundances of juvenile and adults *Nephtys cirrosa* had greatly increased three years after extraction had stopped (Mouleaert & Hostens, 2007). An area of sand and gravel subject to chronic working for 25 years had not recovered after 6 years when compared to nearby reference sites unimpacted by operations (Boyd *et al*., 2005). The characterizing *Moerella* (now *Tellina*) spp. are a relatively long-lived genus (6-10 years; MES, 2008, 2010) and the number of eggs is likely to be fewer than genera that have planktotrophic larvae. Similarly, *Chamelea* sp. and *Dosinia* sp. are long lived (11-20 years and up to 20 years, respectively; MES, 2008, 2010). While recruitment may be rapid, restoration of the biomass by growth of the colonizing individuals is likely to take many years.

Other longer lived species that may represent a more developed and stable assemblage include the polychaete *Owenia fusiformis* which lives for 4 years and reproduces annually (Gentil *et al*., 1990). *Nepthys* species and *Glycera* spp. are also longer-lived. *Glycera* are monotelic having a single breeding period towards the end of their life but may recover through migration and may persist in disturbed sediments through their ability to burrow (Klawe & Dickie, 1957). *Glycera* spp. have a high potential rate of recolonization of sediments, but the relatively slow growth-rate and long lifespan suggests that recovery of biomass following initial recolonization by post-larvae is likely to take several years (MES, 2010). Following dredging of subtidal sands in summer and autumn to provide material for beach nourishment in the Bay of Blanes, (north-west Mediterranean sea, Spain) recovery was tracked by Sardá *et al.* (2000). Recolonization in the dredged habitats was rapid, with high densities of *Spisula subtruncata* and *Owenia fusiformis* in the spring following dredging, although most of these recruits did not survive summer. However, *Glycera* spp. and *Protodorvillea kefersteini* had not recovered within two years (Sardá *et al*., 2000).

A number of studies have tracked recovery of sand and coarse sand communities following disturbance from fisheries (Gilkinson *et al*., 2005) and aggregate extraction (Boyd *et al*., 2005). The available studies confirm the general trend that, following severe disturbance, habitats are recolonized rapidly by opportunistic species (Pearson & Rosenberg, 1978). Experimental deployment of hydraulic clam dredges on a sandy seabed on Banquereau, on the Scotian Shelf, eastern Canada showed that within 2 years of the impact, polychaetes and amphipods had increased in abundance after 1 year (Gilkinson *et al.*, 2005). Two years after dredging, abundances of opportunistic species were generally elevated relative to pre-dredging levels while communities had become numerically dominated (50-70%) by *Spiophanes bombyx* (Gilkinson *et al.*, 2005). Van Dalfsen *et al*. (2000) found that polychaetes recolonized a dredged area within 5-10 months (reference from Boyd *et al.*, 2005), with biomass recovery predicted within 2-4 years. The polychaete and amphipods are therefore likely to recover more rapidly than the characterizing bivalves and the biotope classification may revert, during recovery, to a polychaete dominated biotope.

Sardá *et al*. (1999) tracked annual cycles within a *Spisula* community in Bay of Blanes (north west Mediterranean sea, Spain) for 4 years. Macroinfaunal abundance peaked in spring, decreased sharply throughout the summer, with low density in autumn and winter. The observed trends were related to a number of species, including *Owenia fusiformis* and *Glycera* sp. that characterize the biotope SS.SSa.CFiSa.EpusOborApri. Inter-annual differences in recruitment of *Owenia fusiformis* were apparent and this species showed spring/summer increases. *Mediomastus fragilis* also had spring population peaks but more individuals persisted throughout the year. *Protodorvillea kefersteini* exhibited a similar pattern with spring recruitment and a population that persisted throughout the year.

Where impacts also alter the sedimentary habitat, recovery of the biotope will also depend on recovery of the habitat to the former condition to support the characteristic biological assemblage. Recovery of sediments will be site-specific and will be influenced by currents, wave action and sediment availability (Desprez, 2000). Except in areas of mobile sands, the process tends to be slow (Kenny & Rees, 1996; Desprez, 2000 and references therein). Boyd *et al*. (2005) found that in a site subject to long-term extraction (25 years), extraction scars were still visible after six years and sediment characteristics were still altered in comparison with reference areas, with ongoing effects on the biota.

Resilience assessment. Where resistance is 'None' or 'Low' and an element of habitat recovery is required, resilience is assessed as 'Medium' (2-10 years), based on evidence from aggregate recovery studies in similar habitats including Boyd *et al*. (2005). Where resistance of the characterizing species is 'Low' or 'Medium' and the habitat has not been altered, resilience is assessed as 'High' as, due to the number of characterizing species and variability in recruitment patterns, it is likely that the biotope would be considered representative and hence recovered after two years although some parameters such as species richness, abundance and biotopes may be altered . Recovery of the seabed from severe physical disturbances that alter sediment character may also take up to 10 years or longer (Le Bot *et al*., 2010), although extraction of gravel may result in more permanent changes and this will delay recovery.

NB: The resilience and the ability to recover from human induced pressures is a combination of the environmental conditions of the site, the frequency (repeated disturbances versus a one-off event) and the intensity of the disturbance. Recovery of impacted populations will always be mediated by stochastic events and processes acting over different scales including, but not limited to, local habitat conditions, further impacts and processes such as larval-supply and recruitment between populations. Full recovery is defined as the return to the state of the habitat that existed prior to impact. This does not necessarily mean that every component species has returned to its prior condition, abundance or extent but that the relevant functional components are present and the habitat is structurally and functionally recognisable as the initial habitat of interest. It should be noted that the recovery rates are only indicative of the recovery potential.

Hydrological Pressures

Use ⊞ / ⊟ to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistanceranking)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilienceranking)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
⊞ Temperature increase (local)	Medium	High	Low

	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Temperature decrease (local)	Medium	High	Low
	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Salinity increase (local)	Low	Medium	Medium
	Q: High A: Low C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Salinity decrease (local)	Low	Medium	Medium
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Water flow (tidal current) changes (local)	High	High	Not sensitive
	Q: High A: Low C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Emergence regime changes	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Wave exposure changes (local)	High	High	Not sensitive

Q: Low A: NR C: NR	Q: High A: High C: High	Q: Low A: Low C: Low

(https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)(https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)(https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

Chemical Pressures

Use ⊞ / ⊟ to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistance)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilience)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
⊞ Transition elements & organo-metal contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR
⊞ Hydrocarbon & PAH contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR
⊞ Synthetic compound contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR
⊞ Radionuclide contamination	No evidence (NEv)	No evidence (NEv)	No evidence (NEv)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR
⊞ Introduction of other substances	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)

(https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence) links follow each Q/A/C row.

	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
De-oxygenation	Low	High	Low
	Q: High A: Medium C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
Nutrient enrichment	High	High	Not sensitive
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
Organic enrichment	High	High	Not sensitive
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

Physical Pressures

Use + / − to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistance)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilience)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
Physical loss (to land or freshwater habitat)	None	Very Low	High
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
Physical change (to another seabed type)	None	Very Low	High

	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
Physical change (to another sediment type)	Low	Very Low	High
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

This biotope is found in medium to very fine sand with some silt (JNCC, 2015). The change referred to at the pressure benchmark is a change in sediment classification (based on Long, 2006) rather than a change in the finer-scale original Folk categories (Folk, 1954). For sand sediments, resistance is assessed based on a change to either mixed sediments or mud and sandy muds.

Sediment type is a key factor structuring the biological assemblage present in the biotope. Surveys over sediment gradients and before-and-after impact studies from aggregate extraction sites where sediments have been altered indicate patterns in change. The biotope classification (JNCC, 2015) provides information on the sediment types where biotopes are found and indicates likely patterns in change if the sediment were to alter.

Differences in biotope assemblages in areas of different sediment type are likely to be driven by pre and post recruitment processes. Sediment selectivity by larvae will influence levels of settlement and distribution patterns. Snelgrove *et al.* (1999) demonstrated that *Spisula solidissima*, selected coarse sand over muddy sand, and capitellid polychaetes selected muddy sand over coarse sand, regardless of site. Both larvae selected sediments typical of adult habitats, however, some species were nonselective (Snelgrove *et al.*, 1999) and presumably in unfavourable habitats post recruitment, mortality will result for species that occur in a restricted range of habitats. Some species may, however, be present in a range of sediments. Post-settlement migration and selectivity also occurred on small scales (Snelgrove *et al.*, 1999).

Cooper *et al*. (2011) found that characterizing species from sand dominated sediments were equally likely to be found in gravel dominated sediments, and an increase in sediment coarseness may not result in loss of characterizing species but biotope classification may revert to the biotope SS.SCS.CCS.MedLumVen, which occurs in gravels (JNCC, 2015).

Desprez (2000) found that a change of habitat to fine sands from coarse sands and gravels (from deposition of screened sand following aggregate extraction) changed the biological communities present. *Tellina pygmaea* and *Nephtys cirrosa* dominated the fine sand community. Dominant species of coarse sands, *Echinocyamus pusillus* and *Amphipholis squamata*, were poorly represented and the characteristic species of gravels and shingles were absent (Desprez, 2000).

Sensitivity assessment. A change to finer, muddy and mixed sediments is likely to reduce the abundance of the characterizing *Tellina* spp., venerid bivalves and other bivalves such as *Spisula solida*, and favour polychaetes. Such changes would lead to biotope reclassification. Biotope resistance is therefore assessed as 'Low' (as some species may remain), resilience is Very low (the pressure is a permanent change) and sensitivity is assessed as High.

Habitat structure changes - removal of substratum (extraction)	None	Medium	Medium
	Q: High A: High C: High	Q: High A: Low C: Medium	Q: High A: High C: High
	(https://www.marlin.ac.uk/glossarydefinition/habitatsensitivity)	(https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	(https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Most of the animals that occur in this biotope are shallowly buried and extraction of the sediment will remove the biological assemblage.

Sensitivity assessment. Resistance is assessed as 'None' as extraction of the sediment swill remove the characterizing and associated species present. Resilience is assessed as 'Medium' as some species may require longer than two years to re-establish (see resilience section) and sediments may need to recover (where exposed layers are different). Biotope sensitivity is therefore assessed as 'Medium'.

Pressure	Resistance	Resilience	Sensitivity
Abrasion/disturbance of the surface of the substratum or seabed	Medium	High	Low
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

Abrasion is likely to damage epifauna and flora and may damage a proportion of the characterizing species, biotope resistance is therefore assessed as 'Medium'. Resilience is assessed as 'High' as opportunistic species are likely to recruit rapidly and some damaged characterizing species may recover or recolonize. Biotope sensitivity is assessed as 'Low'.

Pressure	Resistance	Resilience	Sensitivity
Penetration or disturbance of the substratum subsurface	Medium	High	Low
	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Medium C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

The epifauna and infaunal assemblages of both stable and dynamic fine sands are susceptible to direct physical disturbance from towed demersal gears and dredges which penetrate and disturb the sediment e.g. Eleftheriou & Robertson, 1992; Kaiser *et al*., 1998; Robinson & Richardson, 1998; Schwinghamer *et al*., 1996; Freese *et al*., 1999; Prena *et al*,. 1999; Bergman & Van Santbrick 2000a,b; Tuck *et al*., 2000;

Kenchington *et al*., 2001; Gilkinson *et al*., 2005). In general, fishing using towed gears results in the mortality of non-target organisms either through physical damage inflicted by the passage of the trawl or indirectly by disturbance, damage, exposure and subsequent predation. Beam trawling, for example, decreases the density of common echinoderms, polychaetes and molluscs (Bergman & Hup, 1992) and decreases the density and diversity of epifauna in stable sand habitats (Kaiser & Spencer, 1996).

Gilkinson *et al*. (1998) simulated the physical interaction of otter trawl doors with the seabed in a laboratory test tank using a full-scale otter trawl door model. Between 58% and 70% of the bivalves in the scour path that were originally buried were completely or partially exposed at the test bed surface. However, only two out of a total of 42 specimens showed major damage. The pressure wave associated with the otter door pushes small bivalves out of the way without damaging them. Where species can rapidly burrow and reposition (typically within species occurring in unstable habitats) before predation mortality rates will be relatively low. These experimental observations are supported by diver observations of fauna dislodged by a hydraulic dredge used to catch *Ensis* spp. Small bivalves were found in the trawl tracks that had been dislodged from the sediments, including the venerid bivalves *Dosinia exoleta*, *Chamelea striatula* and the hatchet shell *Lucinoma borealis*. These were usually intact (Hauton *et al*., 2003a) and could potentially reburrow.

Larger, fragile species are more likely to be damaged by sediment penetration and disturbance than smaller species (Tillin *et al*., 2006). Bergman & van Santbrink (2000) suggested that the megafauna were amongst the species most vulnerable to direct mortality due to bottom trawling in sandy sediments. Stomach analysis of fish caught scavenging in the tracks of beam trawls found parts of *Spatangus purpureus* and *Ensis* spp. indicating that these had been damaged and exposed by the trawl (Kaiser & Spencer, 1994a). Capasso *et al*. (2010) compared benthic survey datasets from 1895 and 2007 for an area in the English Channel. Although methodological differences limit direct comparison, the datasets appear to show that large, fragile urchin species including *Echinus esculentus*, *Spatangus purpureus* and *Psammechinus miliaris* and larger bivalves had decreased in abundance. Small, mobile species such as amphipods and small errant and predatory polychaetes (*Nephtys*, *Glycera*, *Lumbrineris*) appeared to have increased (Capasso *et al*., 2010). The area is subject to beam trawling and scallop dredging and the observed species changes would correspond with predicted changes following physical disturbance. Two small species: *Timoclea ovata* and *Echinocyamus pusillus* had increased in abundance between the two periods.

Sensitivity assessment. The trawling studies and the comparative study by Capasso *et al.* (2010) suggest that the biological assemblage present in this biotope is characterized by species that are relatively tolerant of penetration and disturbance of the sediments. Either species are robust or buried within sediments or are adapted to habitats with frequent disturbance (natural or anthropogenic) and recover quickly. The results suggest that a reduction in physical disturbance may lead to the development of a community with larger, more fragile species including large bivalves. Biotope resistance is assessed as 'Medium' as some species will be displaced and may be predated or injured and killed. Biotope resilience is assessed as 'High' as most species will recover rapidly and the biotope is likely to still be classified as the same type following disturbance. Biotope sensitivity is therefore assessed as 'Low'.

Changes in suspended solids (water clarity)	Medium	High	Low
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

A change in turbidity at the pressure benchmark is assessed as an increase from intermediate 10-100 mg/l to medium (100-300 mg/l) and a change to clear (<10 mg/l). An increase or decrease in turbidity may affect primary production in the water column and indirectly alter the availability of phytoplankton food available to species in filter feeding mode. However, phytoplankton will also be transported from distant areas and so the effect of increased turbidity may be mitigated to some extent. According to Widdows *et al*. (1979), growth of filter-feeding bivalves may be impaired at suspended particulate matter (SPM) concentrations >250 mg/l.

Sensitivity assessment. No direct evidence was found to assess impacts on the characterizing and associated species. The characterizing, suspension feeding bivalves are not predicted to be sensitive to decreases in turbidity and may be exposed to, and tolerant of, short-term increases in turbidity following sediment mobilization by storms and other events. An increase in suspended solids, at the pressure benchmark may have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing. Biotope resistance is assessed as 'Medium' as there may be some shift in the structure of the biological assemblage and resilience is assessed as 'High' (following restoration of typical conditions). Biotope sensitivity is assessed as 'Low'.

Smothering and siltation rate changes (light)	Medium	High	Low
	Q: High A: Medium C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Addition of fine material will alter the character of this habitat by covering it with a layer of dissimilar sediment and will reduce suitability for the species associated with this feature. Recovery will depend on the rate of sediment mixing or removal of the overburden, either naturally or through human activities. Recovery to a recognisable form of the original biotope will not take place until this has happened. In areas where the local hydrodynamic conditions are unaffected, fine particles will be removed by wave action moderating the impact of this pressure. The rate of habitat restoration would be site-specific and would be influenced by the type of siltation and rate. Long-term or permanent addition of fine particles would lead to re-classification of this biotope type (see physical change pressures). The additions of silts to a *Spisula solida* bed in Waterford Harbour (Republic of Ireland) from earthworks further upstream, for example, reduced the extent of the bed (Fahy *et al.*, 2003). No information was provided on the depth of any deposits.

Most bivalve species are capable of burrowing through sediment to feed, e.g. *Abra alba* are capable of upwardly migrating if lightly buried by additional sediment (Schafer, 1972). There may be an energetic cost expended by species to either re-establish burrow openings, to self-clean feeding apparatus or to move up through the sediment, though this is not likely to be significant. Most animals will be able to reburrow or move up through the sediment within hours or days. Bijkerk (1988, results cited from Essink, 1999) indicated that the maximal overburden through which small bivalves could migrate was 20 cm in sand for *Donax* and approximately 40 cm in mud for *Tellina* sp. and approximately 50 cm in sand. No further information was available on the rates of survivorship or the time taken to reach the surface. Little direct evidence was found to assess the impact of this pressure at the benchmark level. Powilleit *et al.* (2009) studied the response of the polychaete *Nephtys hombergii* to smothering. This species successfully migrated to the surface of 32-41 cm deposited sediment layer of till or sand/till mixture and restored contact with the overlying water. The high escape potential could partly be explained by the heterogeneous texture of the till and sand/till mixture with 'voids'. While crawling upward to the new sediment surfaces burrowing velocities of up to 20 cm/day were recorded for *Nephtys hombergii*. Similarly, Bijkerk (1988, results cited from Essink 1999) indicated that the maximal overburden through which species could migrate was 60 cm through mud for *Nephtys* and 90 cm through sand. No further information was available on the rates of survivorship or the time taken to reach the surface.

Sensitivity assessment. Bivalves and polychaetes and other species are likely to be able to survive short periods under sediments and to reposition. However, as the pressure benchmark refers to fine material, this may be cohesive and species characteristic of sandy habitats may be less adapted to move through this than sands. Biotope resistance is assessed as 'Medium' as some mortality of characterizing and associated species may occur. Biotope resilience is assessed as 'High' and biotope sensitivity is assessed as 'Low'.

Smothering and siltation rate changes (heavy)	Low	Medium	Medium
	Q: High A: Medium C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Bijkerk (1988, results cited from Essink, 1999) indicated that the maximal overburden through which small bivalves could migrate was 20 cm in sand for *Donax* and approximately 40 cm in mud for *Tellina* sp. and approximately 50 cm in sand. No further information was available on the rates of survivorship or the time taken to reach the surface.

Sensitivity assessment. The character of the overburden is an important factor determining the degree of vertical migration of buried bivalves. Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type. Resistance is assessed as ‘Low’ as few individuals are likely to reposition. Resilience is assessed as ‘Medium’ and sensitivity is assessed as ‘Medium’.

Litter	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Electromagnetic changes	No evidence (NEv)	No evidence (NEv)	No evidence (NEv)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Underwater noise changes	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Introduction of light or shading	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Barrier to species movement	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Death or injury by collision	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Visual disturbance	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Biological Pressures

Use ⊞ / ⊟ to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistance)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilience)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
⊞ Genetic modification & translocation of indigenous species	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
⊞ Introduction or spread of invasive non-indigenous species	None	Very Low	High
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
⊞ Introduction of microbial pathogens	Medium	High	Low
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
⊞ Removal of target species	Low	Medium	Medium
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
⊞ Removal of non-target species	Low	High	Low
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

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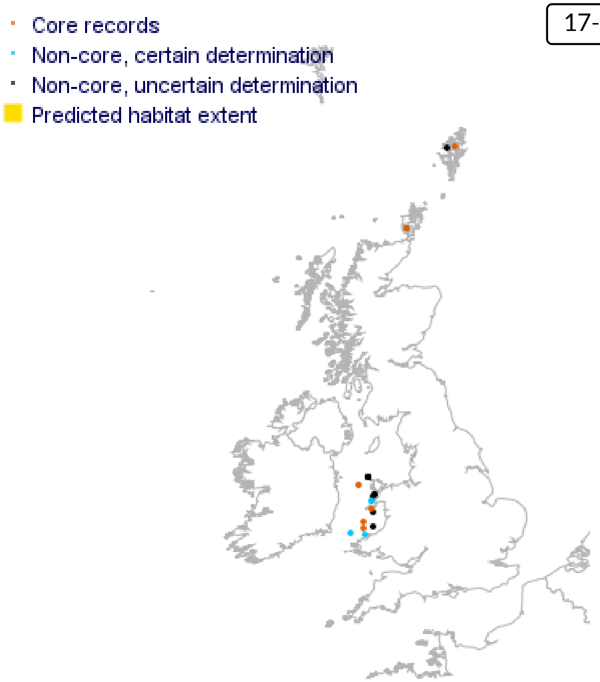
Last Updated: 01/07/2016

Polychaete-rich deep Venus community in offshore gravelly muddy sand★

17-09-2018

No image available



(https://www.marlin.ac.uk/map_explanation)

Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu (http://www.emodnet-seabedhabitats.eu))

Only coastal and marine records shown

Researched by	Dr Heidi Tillin	**Refereed by**	This information is not refereed.

Summary

UK and Ireland classification

UK and Ireland classification

EUNIS 2008	A5.451	Polychaete-rich deep *Venus* community in offshore mixed sediments
JNCC 2015	SS.SMx.OMx.PoVen	Polychaete-rich deep Venus community in offshore gravelly muddy sand
JNCC 2004	SS.SMx.OMx.PoVen	Polychaete-rich deep Venus community in offshore gravelly muddy sand
1997 Biotope		

Description

In offshore circalittoral slightly muddy mixed sediments, a diverse community particularly rich in polychaetes with a significant venerid bivalve component may be found. Typical species include the polychaetes *Glycera lapidum*, *Aonides paucibranchiata*, *Laonice bahusiensis*, *Mediomastus fragilis*, *Lumbrineris gracilis*, *Pseudomystides limbata*, *Protomystides bidentata* and syllid species and bivalves such as *Timoclea ovata*, *Glycymeris glycymeris*, *Spisula elliptica* and *Goodallia triangularis*. This biotope has been recorded on surveys of the Lambay and Codling Deeps and other areas of the Irish Sea and collectively with MedLumVen comprise the 'Deep *Venus* Community' and the 'Boreal Off-Shore Gravel Association' as defined by other workers (Ford 1923; Jones 1950). Some examples of this biotope may have abundant juvenile *Modiolus modiolus* .

Depth range

20-30 m, 30-50 m, 50-100 m

Additional information

-

Listed By

HPI (https://www.marlin.ac.uk/marine-designations#hpi)

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

The biotope description and characterizing species are taken from JNCC (2015). This sedimentary biotope is characterized by circalittoral slightly muddy mixed sediments, the biological assemblage is characterized by polychaetes and venerid bivalves. Typical species include the polychaetes *Glycera* *lapidum*, *Aonides paucibranchiata*, *Laonice bahusiensis*, *Mediomastus fragilis*, *Lumbrineris gracilis*, *Pseudomystides limbata*, *Protomystides bidentata* and syllid species and bivalves such as *Timoclea ovata*, *Glycymeris glycymeris*, *Spisula elliptica* and *Goodallia triangularis*. The sensitivity assessments focus on *Glycera lapidum*, *Mediomastus fragilis* and *Lumbrineris* spp. as little information is available for the other polychaetes. The bivalves *Timoclea ovata*, *Glycymeris glycymeris* and *Spisula elliptica* are assessed as information is available for these species. The assessments also consider the associated species *Amphipholis squamata* and *Ampelisca* spp.

Resilience and recovery rates of habitat

This biotope may recover from impacts via *in-situ* repair of damaged individuals. Adults may also be transported in the water column following washout from sediments. Storm events may lead to the displacement of large numbers of individuals. Most bivalves will be able to reposition within the sediment and some, such as *Glycymeris glycymeris*, are also able to move and to relocate following displacement and disturbance (Thomas, 1975). For immobile species or where depopulation has occurred over a large area, recovery will depend on recolonization by pelagic larvae.

A large number of species are recorded in the biotope and there may be large natural variation in species abundance over the course of a year or between years (see Dauvin, 1985 for *Timoclea ovata*). These variations may not alter the biotope classification where habitat parameters, such as sediment type, remain as described in the classification and many of the characteristic species groups are present. For many of the bivalve species studied, recruitment is sporadic and depends on a successful spat fall but recruitment by the characterizing polychaetes may be more reliable. However, due to the large number of pre- and post-recruitment factors such as food supply, predation, and competition, recruitment of venerid bivalves and other species is unpredictable (Olafsson *et al.*, 1994).

The life history characteristics of the characterizing polychaetes and other species were reviewed. The species that are present in the biotope can be broadly characterized as either opportunist species that rapidly colonize disturbed habitats and increase in abundance, or species that are larger and longer-lived and that may be more abundant in an established, mature assemblage. Species with opportunistic life strategies (small size, rapid maturation and short lifespan of 1-2 years with production of large numbers of small propagules), include the characterizing polychaetes *Mediomastus fragilis.* These are likely to recolonize disturbed areas first, although the actual pattern will depend on recovery of the habitat, season of occurrence and other factors. The recovery of bivalves that recruit episodically and the establishment of a representative age-structured population for larger, longer-lived organisms may require longer than two years. Other longer lived species that may represent a more developed and stable assemblage include *Glycera* spp. *Glycera* are monotelic having a single breeding period towards the end of their life but may recover through migration and may persist in disturbed sediments through their ability to burrow (Klawe & Dickie, 1957). *Glycera* spp. Have a high potential rate of recolonization of sediments, but the relatively slow growth-rate and long lifespan suggests that recovery of biomass following initial recolonization by post-larvae is likely to take several years (MES, 2010). Following dredging of subtidal sands in summer and autumn to provide material for beach nourishment in the Bay of Blanes, (north west Mediterranean sea, Spain) recovery was tracked by Sardá *et al.* (2000). Recolonization in the dredged habitats was rapid, however, *Glycera* spp. Had not recovered within two years (Sardá *et al.*, 2000).

Morton (2009) noted that despite the wide global distribution of the characterizing venerid bivalve, *Timoclea ovata*, little was known about its anatomy or basic biology. This appears to be the case for many of the other characterizing venerid bivalves and much more information was available for the polychaete species that occur in this biotope. Two linked factors that may explain this are the greater research effort in soft sediments with higher mud contents where sampling is easier than in coarse sediments. Venerid bivalves are also considered to be under-represented in grab samples (JNCC, 2015), so less is known of their occurrence on ecological and impact gradients. Dauvin (1985) reported that *Timoclea ovata* (studied as *Venus ovata*) recruitment occurred in July-August in the Bay of Morlaix. However, the population showed considerable pluriannual variations in recruitment, which suggests that recruitment is patchy and/or post settlement processes are highly variable.

A number of studies have tracked recovery of sand and coarse sand communities following disturbance from fisheries (Gilkinson *et al*., 2005) and aggregate extraction (Boyd *et al*., 2005). The available studies confirm the general trend that, following severe disturbance, habitats are recolonized rapidly by opportunistic species (Pearson & Rosenberg, 1978). Experimental deployment of hydraulic clam dredges on a sandy seabed on Banquereau, on the Scotian Shelf, eastern Canada showed that within 2 years of the impact, polychaetes and amphipods had increased in abundance after 1 year (Gilkinson *et al*., 2005). Two years after dredging, abundances of opportunistic species were generally elevated relative to pre-dredging levels while communities had become numerically dominated (50-70 %) by *Spiophanes bombyx* (Gilkinson *et al*., 2005). Van Dalfsen *et al*. (2000) found that polychaetes recolonized a dredged area within 5-10 months (reference from Boyd *et al*., 2005), with biomass recovery predicted within 2-4 years. The polychaete and amphipods are therefore likely to recover more rapidly than the characterizing bivalves and the biotope classification may revert, during recovery, to a polychaete dominated biotope.

The amphipod genus *Ampelisca* has some life history traits that allow them to recovery quickly where populations are disturbed. They do not produce large numbers of offspring but reproduce regularly and the larvae are brooded, giving them a higher chance of survival within a suitable habitat than free-living larvae. *Ampelisca* has a short lifespan and reaches sexual maturity in a matter of months allowing a population to recover abundance and biomass in a very short period of time (MES, 2010). Experimental studies have shown *Ampelisca abdita* to be an early colonizer, in large abundances of defaunated sediments where local populations exist to support recovery (McCall, 1977) and *Ampelisca abdita* have been shown to migrate to, or from, areas to avoid unfavourable conditions (Nichols & Thompson, 1985). *Ampelisca* sp. are very intolerant of oil contamination and the recovery of the *Ampelisca* populations in the fine sand community in the Bay of Morlaix took up to 15 years following the Amoco Cadiz oil spill, probably due to the amphipods' low fecundity, lack of pelagic larvae and the absence of local unperturbed source populations (Poggiale & Dauvin, 2001).

Where impacts also alter the sedimentary habitat, recovery of the biotope will also depend on recovery of the habitat to the former condition to support the characteristic biological assemblage. Recovery of sediments will be site-specific and will be influenced by currents, wave action and sediment availability (Desprez, 2000). Except in areas of mobile sands, the process tends to be slow (Kenny & Rees, 1996; Desprez, 2000 and references therein). Boyd *et al*. (2005) found that in a site subject to long-term extraction (25 years), extraction scars were still visible after six years and sediment characteristics were still altered in comparison with reference areas, with ongoing effects on the biota.

Resilience assessment. Where resistance is 'None' or 'Low' and an element of habitat recovery is required, resilience is assessed as 'Medium' (2-10 years), based on evidence from aggregate recovery studies in similar habitats including Boyd *et al*. (2005). Where resistance of the characterizing species is 'Low' or 'Medium' and the habitat has not been altered, resilience is assessed as 'High' as, due to the number of characterizing species and variability in recruitment patterns, it is likely that the biotope would be considered representative and hence recovered after two years although some parameters such as species richness, abundance and biotopes may be altered . Recovery of the seabed from severe physical disturbances that alter sediment character may also take up to 10 years or longer (Le Bot *et al*., 2010), although extraction of gravel may result in more permanent changes and this will delay recovery.

NB: The resilience and the ability to recover from human induced pressures is a combination of the environmental conditions of the site, the frequency (repeated disturbances versus a one-off event) and the intensity of the disturbance. Recovery of impacted populations will always be mediated by stochastic events and processes acting over different scales including, but not limited to, local habitat conditions, further impacts and processes such as larval supply and recruitment between populations.

Full recovery is defined as the return to the state of the habitat that existed prior to impact. This does not necessarily mean that every component species has returned to its prior condition, abundance or extent but that the relevant functional components are present and the habitat is structurally and functionally recognizable as the initial habitat of interest. It should be noted that the recovery rates are only indicative of the recovery potential.

Hydrological Pressures

Use ⊞ / ⊟ to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistanceranking)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilienceranking)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
⊞ Temperature increase (local)	Medium	High	Low
	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
⊞ Temperature decrease (local)	Medium	High	Low
	Q: High A: Medium C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
⊞ Salinity increase (local)	Low	Medium	Medium
	Q: High A: Low C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
⊞ Salinity decrease (local)	Low	Medium	Medium

	Q: High A: Medium C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Water flow (tidal current) changes (local)	High	High	Not sensitive
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Emergence regime changes	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Wave exposure changes (local)	High	High	Not sensitive
	Q: High A: Low C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Chemical Pressures

Use + / − to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistanceranking)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilienceranking)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
Transition elements & organo-metal contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Hydrocarbon & PAH contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Synthetic compound contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Radionuclide contamination	No evidence (NEv)	No evidence (NEv)	No evidence (NEv)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Introduction of other substances	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
De-oxygenation	Low	High	Low
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Nutrient enrichment	High	High	Not sensitive
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Pressure	Resistance	Resilience	Sensitivity
Organic enrichment	High	High	Not sensitive
	Q: High A: Medium C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Medium C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

Physical Pressures

Use / to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistance)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilience)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
Physical loss (to land or freshwater habitat)	None	Very Low	High
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
Physical change (to another seabed type)	None	Very Low	High
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)
Physical change (to another sediment type)	Low	Very Low	High
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

This biotope is found in muddy mixed sediments and gravelly sand (JNCC, 2015). The change referred to at the pressure benchmark is a change in sediment classification (based on Long, 2006) rather than a change in the finer-scale original Folk categories (Folk, 1954). Based on the range of habitats that this biotope occurs in, a change between coarse sediments and mixed sediments is not assessed.

Surveys over sediment gradients and before-and-after impact studies from aggregate extraction sites where sediments have been altered indicate patterns in change. Long-term alteration of sediment type to finer more unstable sediments was observed six years after aggregate dredging at moderate energy sites (Boyd *et al.*, 2005). The on-going sediment instability was reflected in a biological assemblage composed largely of juveniles (Boyd *et al.*, 2005). Holme (1966), observed that *Glycymeris glycymeris* was absent from areas of the English Channel with finer sediments but was abundant in tidally-swept coarse areas. Some species may, however, be present in a range of sediments. Desprez (2000), found that a change of habitat to fine sands, from coarse sands and gravels (from deposition of screened sand following aggregate extraction), changed the biological communities present. *Tellina pygmaea* and *Nephtys cirrosa* dominated the fine sand community. Dominant species of coarse sands, *Echinocyamus pusillus* and *Amphipholis squamata*, were poorly represented and the characteristic species of gravels and shingles were absent (Desprez, 2000).

Sensitivity assessment. Changes in the sediment type may lead to biotope reclassification. Biotope resistance is, therefore, assessed as 'Low' (as some species may remain), as resilience is Very low (the pressure is a permanent change), and sensitivity is, therefore, High.

Habitat structure changes - removal of substratum (extraction)	None	Medium	Medium
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

A number of studies assess the impacts of aggregate extraction on sand and gravel habitats. Most of the animals that occur in this biotope are shallowly buried, for example, Glycymerids occur at the surface with the mantle margins exposed at the surface (Thomas, 1975).

Recovery of sediments will be site-specific and will be influenced by currents, wave action and sediment availability (Desprez, 2000). Except in areas of mobile sands, the process tends to be slow (Kenny & Rees, 1996; Desprez, 2000 and references therein). Boyd *et al*., (2005) found that in a site subject to long-term extraction (25 years), extraction scars were still visible after six years and sediment characteristics were still altered in comparison with reference areas with ongoing effects on the biota. The strongest currents are unable to transport gravel. A further implication of the formation of these depressions is a local drop in current strength associated with the increased water depth, resulting in deposition of finer sediments than those of the surrounding substrate (Desprez *et al*., 2000 and references therein). See the physical change pressure for assessment

Sensitivity assessment. Resistance is assessed as 'None' as extraction of the sediment swill remove the characterizing and associated species present. Resilience is assessed as 'Medium' as some species may require longer than two years to re-establish (see resilience section) and sediments may need to recover (where exposed layers are different). Biotope sensitivity is therefore assessed as 'Medium'.

Abrasion/disturbance of the surface of the substratum or seabed	Medium	High	Low
	Q: High A: High C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Medium C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)	Q: High A: Medium C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsncbconfidence)

Comparative studies between disturbed and undisturbed areas indicate that abrasion and disturbance from bottom trawling on gravels and sands reduce abundance of organisms, biomass and species diversity (Collie *et al*., 1997). Undisturbed sites contain more calcareous tube worms, bryozoans and hydroids and small fragile polychaetes and brittle stars. Thick-shelled bivalves, hermit crabs and gastropods appeared unaffected by dredging. *Glycymeris* is a mobile burrower (Thomas, 1975). Venerid bivalves, such as the characterizing species *Timoclea ovata*, live close to the surface (Morton, 2009). Burrowing species such as *Glycera lapidum* and *Lumbrineris latreilli* may be unaffected by surface abrasion. *Lumbrineris latreilli* was characterized as AMBI Fisheries Review Group III-Species insensitive to fisheries in which the bottom is disturbed. Their populations do not show a significant decline or increase (Gittenberger & Van Loon, 2011).

Sensitivity assessment. Abrasion is likely to damage epifauna and may damage a proportion of the characterizing species, biotope resistance is therefore assessed as 'Medium'. Resilience is assessed as 'High' as opportunistic species are likely to recruit rapidly and some damaged characterizing species may recover or recolonize. Biotope sensitivity is assessed as 'Low'.

Penetration or disturbance of the substratum subsurface	Medium	High	Low
	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Comparative studies between disturbed and undisturbed areas indicate that abrasion and disturbance from bottom trawling on coarse gravels and sands, reduce abundance of organisms, biomass and species diversity (Collie *et al*., 1997). Undisturbed sites contain more calcareous tube worms, bryozoans and hydroids and small fragile polychaetes and brittle stars.

Capasso *et al.* (2010) compared benthic survey datasets from 1895 and 2007 for an area in the English Channel. Although methodological differences limit direct comparison, the datasets appear to show that large, fragile urchin species including *Echinus esculentus*, *Spatangus purpureus* and *Psammechinus miliaris* and larger bivalves had decreased in abundance. Small, mobile species such as amphipods and small errant and predatory polychaetes (*Nephtys*, *Glycera*, *Lumbrineris*) and the small bivalve *Timoclea ovata* appeared to have increased (Capasso *et al*., 2010). The area is subject to beam trawling and scallop dredging and the observed species changes would correspond with predicted changes following physical disturbance.

Experiments in shallow, wave disturbed areas, using a toothed, clam dredge, found that deposit feeding polychaetes were more impacted than carnivorous species. Dredging resulted in reductions of >90% of *Spiophanes bombyx* immediately post dredging compared with before impact samples and the population reduction persisting for 90 days (although results may be confounded by storm events within the monitoring period which caused sediment mobility). Some predatory polychaete taxa were enhanced by fishing. *Protodorvillea kefersteini* was one of these: large increases in abundance in samples were detected post dredging and persisting over 90 days. The passage of the dredge across the sediment floor will have killed or injured some organisms that will then be exposed to potential predators/scavengers (Frid *et al*., 2000; Veale *et al*., 2000) providing a food source to mobile scavengers including these species. *Protodorvillia kefersteini* also showed a rapid increase in abundance at 21 days after sediment disturbance (Thrush, 1986).

Gilkinson *et al.* (1998) simulated the physical interaction of otter trawl doors with the seabed in a laboratory test tank using a full-scale otter trawl door model. Between 58 % and 70 % of the bivalves in the scour path that were originally buried were completely or partially exposed at the test bed surface. However, only two out of a total of 42 specimens showed major damage. The pressure wave associated with the otter door pushes small bivalves out of the way without damaging them. Where species can rapidly burrow and reposition (typically within species occurring in unstable habitats) before predation mortality rates will be relatively low. These experimental observations are supported by diver observations of fauna dislodged by a hydraulic dredge used to catch *Ensis* spp. Small bivalves were found in the trawl tracks that had been dislodged from the sediments, including the venerid bivalves *Dosinia exoleta*, *Chamelea striatula* and the hatchet shell *Lucinoma borealis*. These were usually intact (Hauton *et al*., 2003a) and could potentially reburrow.

Sensitivity assessment. The trawling studies and the comparative study by Capasso *et al.* (2010) suggest that the biological assemblage present in this biotope is characterized by species that are relatively tolerant of penetration and disturbance of the sediments. Either species are robust or buried within sediments or are adapted to habitats with frequent disturbance (natural or anthropogenic) and recover quickly. Biotope resistance is assessed as 'Medium' as some species will be displaced and may be predated or injured and killed. Biotope resilience is assessed as 'High' as most species will recover rapidly and the biotope is likely to still be classified as SS.SMx.OMx.PoVen following disturbance. Biotope sensitivity is therefore assessed as 'Low'.

Changes in suspended solids (water clarity)	Medium	High	Low
	Q: High A: Medium C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

A change in turbidity at the pressure benchmark is assessed as an increase from intermediate 10-100 mg/l to medium (100-300 mg/l) and a change to clear (<10 mg/l). An increase or decrease in turbidity may affect primary production in the water column and indirectly alter the availability of phytoplankton food available to species in filter feeding mode. However, phytoplankton will also be transported from distant areas and so the effect of increased turbidity may be mitigated to some extent. According to Widdows *et al.* (1979), growth of filter-feeding bivalves may be impaired at suspended particulate matter (SPM) concentrations >250 mg/l.

The venerid bivalves are active suspension feeders, trapping food particles on their gill filaments (ctenidia). An increase in suspended sediment is, therefore, likely to affect both feeding and respiration by potentially clogging the ctenidia. The characterizing species *Timoclea ovata*, generally occurs in areas with low suspended solids and has ‘ tiny' palps and a short, narrow, mid-gut, as there is little need for particle sorting (Morton, 2009). This suggests this species and other venerids may have difficulty sorting organic materials in high levels of suspended sediment.*Glycymeris glycymeris* is intolerant of turbidity as the palps are very simple and fine sediments or inorganic solids are not tolerated (Thomas, 1975). Changes in turbidity and seston are not predicted to directly affect *Glycera* spp. and *Lumbrineris latreilli* which live within sediments.

Sensitivity assessment. No direct evidence was found to assess impacts on the characterizing and associated species. The characterizing, suspension feeding bivalves are not predicted to be sensitive to decreases in turbidity and may be exposed to, and tolerant of, short-term increases in turbidity following sediment mobilization by storms and other events. An increase in suspended solids, at the pressure benchmark may have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing. Biotope resistance is assessed as ‘Medium’ as there may be some shift in the structure of the biological assemblage although the biotope uis likely to still be characterized as SS.SMx.OMx.PoVen. Biotope resilience is assessed as ‘High’ (following restoration of typical conditions) and sensitivity is assessed as ‘Low’.

Smothering and siltation rate changes (light)	Medium	High	Low
	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Addition of fine material will alter the character of this habitat by covering it with a layer of dissimilar sediment and will reduce suitability for the species associated with this feature. Recovery will depend on the rate of sediment mixing or removal of the overburden, either naturally or through human activities.

Recovery to a recognisable form of the original biotope will not take place until this has happened. In areas where the local hydrodynamic conditions are unaffected, fine particles will be removed by wave action moderating the impact of this pressure. The rate of habitat restoration would be site-specific and would be influenced by the type of siltation and rate. Long-term or permanent addition of fine particles would lead to re-classification of this biotope type (see physical change pressures). The additions of silts to a *Spisula solida* bed in Waterford Harbour (Republic of Ireland) from earthworks further upstream, for example, reduced the extent of the bed (Fahy *et al.*, 2003). No information was provided on the depth of any deposits.

Bijkerk (1988, results cited from Essink, 1999) indicated that the maximal overburden through which small bivalves could migrate was 20 cm in sand for *Donax* and approximately 40 cm in mud for *Tellina* sp. and approximately 50 cm in sand. No further information was available on the rates of survivorship or the time taken to reach the surface. Little direct evidence was found to assess the impact of this pressure at the benchmark level. Powilleit *et al.*, (2009) studied the response of the polychaete *Nephtys hombergii* to smothering. This species successfully migrated to the surface of 32-41 cm deposited sediment layer of till or sand/till mixture and restored contact with the overlying water. The high escape potential could partly be explained by the heterogeneous texture of the till and sand/till mixture with 'voids'. While crawling upward to the new sediment surfaces burrowing velocities of up to 20 cm/day were recorded for *Nephtys hombergii*. Similarly, Bijkerk (1988, results cited from Essink 1999) indicated that the maximal overburden through which species could migrate was 60 cm through mud for *Nephtys* and 90 cm through sand. No further information was available on the rates of survivorship or the time taken to reach the surface.

The venerid bivalves are shallow burrowing infauna and active suspension feeders and therefore require their siphons to be above the sediment surface in order to maintain a feeding and respiration current. Kranz (1972, cited in Maurer *et al.*, 1986) reported that shallow burying siphonate suspension feeders are typically able to escape smothering with 10-50 cm of their native sediment and relocate to their preferred depth by burrowing. Smothering will result in temporary cessation of feeding and respiration. The energetic cost may impair growth and reproduction but is unlikely to cause mortality.

The characterizing bivalve *Tellina pygmaea* was characterized by Gittenberger & Van Loon (2011) in their index of sedimentation tolerance as Group IV species: 'Although they are sensitive to strong fluctuations in sedimentation, their populations recover relatively quickly and even benefit. This causes their population sizes to increase significantly in areas after a strong fluctuation in sedimentation' (Gittenberger & Van Loon, 2011). *Lumbrineris latreilli* was characterized as AMBI sedimentation Group III: 'Species insensitive to higher amounts of sedimentation, but don't easily recover from strong fluctuations in sedimentation' (Gittenberger & Van Loon, 2011). *Glycera alba* and *Glycera lapidum* were categorized as AMBI sedimentation Group II: 'Species sensitive to high sedimentation. They prefer to live in areas with some sedimentation, but don't easily recover from strong fluctuations in sedimentation' (Gittenberger & Van Loon, 2011).

Sensitivity assessment. Bivalves and polychaetes are likely to be able to survive short periods under sediments and to reposition. However, as the pressure benchmark refers to fine material, this may be cohesive and species characteristic of sandy habitats may be less adapted to move through this than sands. Biotope resistance is assessed as 'Medium' as some mortality of characterizing and associated species may occur. Biotope resilience is assessed as 'High' and biotope sensitivity is assessed as 'Low'.

Smothering and siltation rate changes (heavy)	Medium	Medium	Medium
	Q: High A: High C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: High A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Bijkerk (1988, results cited from Essink, 1999) indicated that the maximal overburden through which small bivalves could migrate was 20 cm in sand for *Donax* and approximately 40 cm in mud for *Tellina* sp. and approximately 50 cm in sand. No further information was available on the rates of survivorship or the time taken to reach the surface.

Sensitivity assessment. The character of the overburden is an important factor determining the degree of vertical migration of buried bivalves. Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type. Resistance is assessed as 'Low' as few individuals are likely to reposition. Resilience is assessed as 'Medium' and sensitivity is assessed as 'Medium'.

Litter	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Electromagnetic changes	No evidence (NEv)	No evidence (NEv)	No evidence (NEv)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Underwater noise changes	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Introduction of light or shading	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)

	Resistance	Resilience	Sensitivity
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Barrier to species movement	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Death or injury by collision	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Visual disturbance	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

Biological Pressures

Use ⊞ / ⊟ to open/close text displayed	Resistance (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresistance)	Resilience (https://www.marlin.ac.uk/glossarydefinition/habitatsncbresilience)	Sensitivity (https://www.marlin.ac.uk/glossarydefinition/habitatsncbsensitivityranking)
Genetic modification & translocation of indigenous species	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)	Q: NR A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Introduction or spread of invasive non-indigenous	None	Very Low	High

species	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Introduction of microbial pathogens	High	High	Not sensitive
	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: High C: Medium (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Removal of target species	High	High	Not sensitive
	Q: Low A: NR C: NR (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: Low A: Low C: Low (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)
Removal of non-target species	Low	High	Low
	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatsconfidence)	Q: High A: High C: High (https://www.marlin.ac.uk/glossarydefinition/habitatssncbconfidence)

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