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Marine Information Network

Information on the species and habitats around the coasts and sea of the British Isles

Polychaete-rich deep Venus community in offshore gravelly muddy sand

MarLIN – Marine Life Information Network
Marine Evidence-based Sensitivity Assessment (MarESA) Review

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Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [<https://www.marlin.ac.uk/habitats/detail/1117>]. All terms and the MarESA methodology are outlined on the website (<https://www.marlin.ac.uk>)

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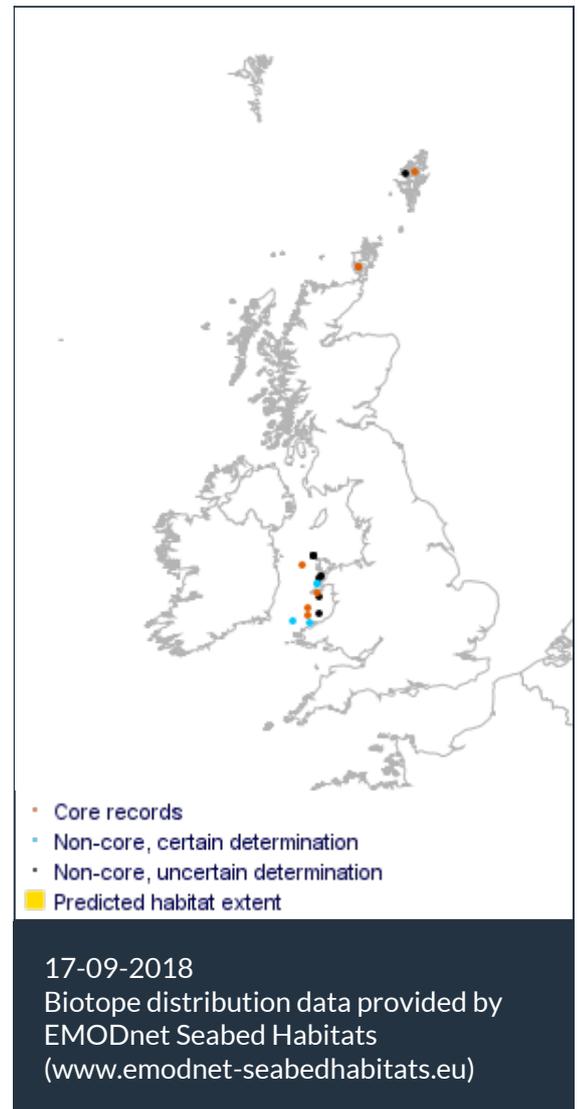
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Researched by Dr Heidi Tillin Referred by This information is not refereed.

Summary

☰ UK and Ireland classification

EUNIS 2008	A5.451	Polychaete-rich deep <i>Venus</i> 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

- none -

🔗 Further information sources

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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 Dalssen *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 recover 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

	Resistance	Resilience	Sensitivity
Temperature increase (local)	Medium Q: High A: Low C: Medium	High Q: High A: Low C: Medium	Low Q: High A: Low C: Medium

Davenport & Davenport (2005) demonstrated that the limits of thermal tolerance to high and low temperatures relate to the distribution of intertidal macroinvertebrate species. Species that occur highest on the shore are more tolerant of a wider range of temperatures than species that occurred low on the shore or subtidally. As subtidal biotopes are less exposed to temperature fluctuations, the characterizing species may be less able to tolerate temperature fluctuations.

No direct evidence was found to support assessment of this pressure. Very few laboratory studies have been carried out on the monitoring of settlement and recruitment and records of species distribution.

Kröncke *et al.* (1998) examined long-term changes in the macrofauna in the subtidal zone off Norderney, one of the East Frisian barrier islands. The analysis suggested that macrofauna were severely affected by cold winters whereas storms and hot summers have no impact on the benthos. However, long-term analysis of the North Sea pelagic system has identified yearly variations in larval abundance of Echinodermata, Arthropoda, and Mollusca larvae that correlate with sea surface temperatures. Larvae of benthic echinoderms and decapod crustaceans increased after the mid-1980s, coincident with a rise in North Sea sea surface temperature, whereas bivalve

larvae underwent a reduction (Kirby *et al.*, 2008). An increase in temperature may alter larval supply and in the long-term, and over large spatial scales, may result in changes in community composition.

Temperature cues influence the timing of gametogenesis and spawning in several species present in the biotope. Many polychaete species including *Mediomastus fragilis* recruit in Spring/early Summer recruitment (Sardá *et al.*, 1999).

The characterizing bivalve *Timoclea ovata* has a wide distribution from northern Norway and Iceland south to west Africa. It is also recorded from the Canary Islands, the Azores and the Mediterranean and Black Sea (Morton, 2009). *Goodallia triangularis* also has a widespread distribution in the Atlantic coasts of Europe to the Mediterranean and north-western Africa (Giribet & Peñas, 1999). Polychaetes and other species associated with the biotope may also have wide global distributions. *Mediomastus fragilis* has been recorded throughout the British Isles (NBN, 2015) and in the Mediterranean (Serrano *et al.*, 2011). *Glycera lapidum* is found in the north-eastern Atlantic, Mediterranean, North Sea, Skagerrak and Kattegat (Marine Species Identification Portal).

Sensitivity assessment. Little evidence was available to assess this pressure. Assemblages in fine sands that contain many of the characterizing species occur in the Mediterranean (see resilience section Sardá *et al.*, 1999; Sardá *et al.*, 2000), where temperatures are higher than experienced in the UK. It is considered likely, therefore, that a chronic change in temperature at the pressure benchmark would be tolerated by species with a wide distribution or that some species or groups of species would be resistant. An acute change may exceed thermal tolerances or lead to spawning or other biological effects. These effects may be sub-lethal or result in the removal of only a proportion of less tolerant species. Biotope resistance is therefore assessed as 'Medium' and resilience is assessed as 'High'. Biotope sensitivity is therefore assessed as 'Low'.

Temperature decrease (local)

Medium

Q: High A: Medium C: Medium

High

Q: High A: Low C: Medium

Low

Q: High A: Low C: Medium

Davenport & Davenport (2005) demonstrated that the limits of thermal tolerance to high and low temperatures reflect the distribution of intertidal macroinvertebrate species. Species that occur highest on the shore are more tolerant of a wider range of temperatures than species that occurred low on the shore or subtidally. As subtidal biotopes are less exposed to temperature fluctuations the characterizing species may be less able to tolerate temperature fluctuations.

The characterizing bivalve *Timoclea ovata* has a wide distribution from northern Norway and Iceland south to west Africa. It is also recorded from the Canary Islands, the Azores and the Mediterranean and Black Sea (Morton, 2009). *Goodallia triangularis* also has a widespread distribution in the Atlantic coasts of Europe to the Mediterranean and north-western Africa (Giribet & Peñas, 1999). Polychaetes and other species associated with the biotope may also have wide global distributions. *Mediomastus fragilis* has been recorded throughout the British Isles (NBN, 2015) and in the Mediterranean (Serrano *et al.*, 2011). *Glycera lapidum* is found in the north-eastern Atlantic, Mediterranean, North Sea, Skagerrak and Kattegat (Marine Species Identification Portal, <http://species-identification.org/>).

Long-term analysis of the North Sea pelagic system has identified yearly variations in larval abundance of Echinodermata, Arthropoda, and Mollusca larvae that correlate with sea surface temperatures. Larvae of benthic echinoderms and decapod crustaceans increased after the mid-

1980s, coincident with a rise in North Sea sea surface temperature, whereas bivalve larvae underwent a reduction (Kirby *et al.*, 2008). A decrease in temperature may alter larval supply and in the long-term, and over large spatial scales, may result in changes in community composition.

Sensitivity assessment. Many of the characterizing species are found in more northern waters than the UK and may be adapted to colder temperatures. Plankton studies suggest that colder waters may favour bivalve larvae. An acute change may exceed thermal tolerances or lead to spawning or other biological effects. These effects may be sub-lethal or remove only a proportion of less tolerant species. Biotope resistance is therefore assessed as 'Medium' and resilience is assessed as 'High'. Biotope sensitivity is therefore assessed as 'Low'.

Salinity increase (local)

Low

Q: High A: Low C: NR

Medium

Q: High A: Low C: Medium

Medium

Q: High A: Low C: Low

This biotope occurs in full salinity. A study from the Canary Islands indicates that exposure to high salinity effluents (47- 50 psu) from desalination plants alter the structure of biological assemblages, reducing species richness and abundance (Riera *et al.*, 2012). Bivalves and amphipods appear to be less tolerant of increased salinity than polychaetes and were largely absent at the point of discharge. Polychaetes, including species or genera that occur in this biotope, such as *Glycera* spp. and *Lumbrineris* sp. were present at the discharge point (Riera *et al.*, 2012).

The ophiuroid *Amphipholis squamata* has been recorded in areas of high salinity (52-55 ppt) in the Arabian Gulf (Price, 1982), indicating local acclimation may be possible.

Sensitivity assessment. High saline effluents alter the structure of biological assemblages. Polychaete species may be more tolerant than bivalves but an increase in salinity is likely to result in declines in species richness and abundance based on Riera *et al.*, (2012). Biotope resistance is assessed as 'Low' and resilience as 'Medium', as bivalve recovery may depend on episodic recruitment. Biotope sensitivity is assessed as 'Medium'.

Salinity decrease (local)

Low

Q: High A: Medium C: Medium

Medium

Q: High A: Low C: Medium

Medium

Q: High A: Low C: Medium

No evidence was found to assess the sensitivity of key characterizing species.

Sensitivity assessment. A reduction in salinity may result in changes in biotope composition as some sensitive species are lost and replaced by typical estuarine species more tolerant of the changed conditions, such as *Nephtys cirrosa*, *Limecola balthica*, and *Bathyporeia* spp. so that the biotope may be reclassified as SS.SSa.SSaVS.NcirLim. Biotope resistance is therefore assessed as 'Low' and resilience as 'Medium', as bivalve recovery may depend on episodic recruitment. Biotope sensitivity is assessed as 'Medium'.

Water flow (tidal current) changes (local)

High

Q: Low A: NR C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

This biotope is recorded in areas where tidal flows are weak (>0.5 m/s) (JNCC, 2015). Sands are less cohesive than mud sediments and a change in water flow at the pressure benchmark may alter sediment transport patterns within the biotope resulting in some changes in sediment

composition. Hjulström (1939) concluded that fine sand (particle diameter of 0.3-0.6 mm) was easiest to erode and required a mean velocity of 0.2 m/s. Erosion and deposition of particles greater than 0.5 mm require a velocity >0.2 m/s to alter the habitat. As this biotope is found in a range of sediment types; from gravelly sand to muddy mixed sediment (JNCC,2015) changes in sediment type and some alteration in the identity or abundance of characterizing species may occur but the biotope may still be present.

Many of the species occur in a range of sediment types, which, given the link between hydrodynamics and sediment type, suggests that these species are not sensitive to changes in water flow at the pressure benchmark. *Timoclea ovata* occur in muddy sands in areas that are sheltered and where fine sediments are deposited. *Glycera* spp. are found in areas with strong tidal streams where sediments are mobile (Roche *et al.*, 2007) and in extremely sheltered areas (Connor *et al.*, 2004).

Sensitivity assessment. Changes in water flow may result in sediment changes in the habitat and may cause some shifts in abundance. However, a change at the pressure benchmark (increase or decrease) is unlikely to affect biotope classification and biotope sensitivity is therefore assessed as 'High' and resilience is assessed as 'High', so the biotope is considered to be 'Not sensitive'.

Emergence regime changes

Not relevant (NR)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

Changes in emergence are not relevant to this biotope which is restricted to fully subtidal habitats.

Wave exposure changes (local)

High

Q: High A: Low C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

As this biotope occurs in circalittoral habitats, it is not directly exposed to the action of breaking waves. Associated polychaete species that burrow are protected within the sediment but the characterizing bivalves could be exposed to oscillatory water flows at the seabed. They and other associated species may be indirectly affected by changes in water movement where these impact the supply of food or larvae or other processes. No specific evidence was found to assess this pressure. As the biotope occurs in habitats that are sheltered and moderately exposed to wave action (JNCC, 2015) it is considered that the weak tidal currents and substratum, rather than wave action, are significant factors determining species composition

Sensitivity assessment. The range of wave exposures experienced by SS.SMx.OMx.PoVen is considered to indicate, by proxy, that the biotope would have 'High' resistance and by default 'High' resilience to a change in significant wave height at the pressure benchmark. The biotope is therefore classed as 'Not sensitive'.

Chemical Pressures

Resistance

Resilience

Sensitivity

Transition elements & organo-metal contamination

Not Assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

This pressure is **Not assessed** but evidence is presented where available.

The capacity of bivalves to accumulate heavy metals in their tissues, far in excess of environmental levels, is well known. Reactions to sub-lethal levels of heavy metal stressors include siphon retraction, valve closure, inhibition of byssal thread production, disruption of burrowing behaviour, inhibition of respiration, inhibition of filtration rate, inhibition of protein synthesis and suppressed growth (see review by Aberkali & Trueman, 1985). Stirling (1975) investigated the effect of exposure to copper on *Tellina tenuis*. The 96 hour LC50 for Cu was 1000 µg/l. Exposure to Cu concentrations of 250 µg/l and above inhibited burrowing behaviour and would presumably result in greater vulnerability to predators. Similarly, burial of the venerid bivalve, *Venerupis senegalensis*, was inhibited by copper spiked sediments, and at very high concentrations, clams closed up and did not bury at all (Kaschl & Carballeira, 1999). The copper 10 day LC50 for *Venerupis senegalensis* was found to be 88 µg/l in sandy sediments (Kaschl & Carballeira, 1999).

Rygg (1985) classified *Lumbrineris* spp. as non-tolerant of Cu (species only occasionally found at stations in Norwegian fjords where Cu concentrations were >200 ppm (mg/kg)).

Hydrocarbon & PAH contamination

Not Assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

This pressure is **Not assessed** but evidence is presented where available.

Suchanek (1993) reviewed the effects of oil on bivalves. Generally, contact with oil causes an increase in energy expenditure and a decrease in feeding rate, resulting in less energy available for growth and reproduction. Sublethal concentrations of hydrocarbons also reduce byssal thread production (thus weakening attachment) and infaunal burrowing rates. Conan (1982) investigated the long-term effects of the *Amoco Cadiz* oil spill at St Eflam beach in France. *Fabulina fabula* (studied as *Tellina fabula*) started to disappear from the intertidal zone a few months after the spill and from then on was restricted to subtidal levels. In the following 2 years, recruitment of *Fabulina fabula* was very much reduced. The author commented that, in the long-term, the biotas most severely affected by oil spills are low energy sandy and muddy shores, bays and estuaries. In such places, populations of species with long and short-term life expectancies (e.g. *Fabulina fabula*, *Echinocardium cordatum* and *Ampelisca* sp.) either vanished or displayed long-term decline following the *Amoco Cadiz* oil spill. Polychaetes, however, including *Nephtys hombergii*, cirratulids and capitellids were largely unaffected. *Mediomastus fragilis* increased in abundance (Dauvin, 2000). Other studies support the conclusion that polychaetes are generally a tolerant taxa. Hiscock *et al.* (2004; 2005, based on Levell *et al.* 1989) described *Glycera* spp. as a very tolerant taxa, found in enhanced abundances in the transitional zone along hydrocarbon contamination gradients surrounding oil platforms.

The amphipods, *Ampelisca* sp. are also 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 (Poggiale & Dauvin, 2001).

Synthetic compound contamination

Not Assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

This pressure is **Not assessed** but evidence is presented where available.

The anti-parasite compound Ivermectin is highly toxic to benthic polychaetes and crustaceans (Black *et al.*, 1997; Collier & Pinn, 1998; Grant & Briggs, 1998, cited in Wildling & Hughes, 2010). OSPAR (2000) stated that, at that time, Ivermectin was not licensed for use in mariculture but was incorporated into the feed as a treatment against sea lice at some farms. Ivermectin has the potential to persist in sediments, particularly fine-grained sediments at sheltered sites. Data from a farm in Galway, Ireland indicated that Ivermectin was detectable in sediments adjacent to the farm at concentrations up to 6.8 µm/kg and to a depth of 9 cm (reported in OSPAR, 2000). Infaunal polychaetes have been affected by deposition rates of 78-780 mg Ivermectin/m².

Radionuclide contamination

No evidence (NEv)

Q: NR A: NR C: NR

No evidence (NEv)

Q: NR A: NR C: NR

No evidence (NEv)

Q: NR A: NR C: NR

No evidence was found to support an assessment at the pressure benchmark. Following the Fukushima Dai-ichi nuclear power plant accident in August 2013, radioactive cesium concentrations in invertebrates collected from the seabed were assessed. Concentrations in bivalves and gastropods were lower than in polychaetes (Sohtome *et al.*, 2014). The data does not indicate that there were mortalities.

Introduction of other substances

Not Assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

Not assessed (NA)

Q: NR A: NR C: NR

This pressure is **Not assessed**.

De-oxygenation

Low

Q: High A: High C: High

High

Q: High A: Low C: Medium

Low

Q: High A: Low C: Low

Riedel *et al.*, 2012 assessed the response of benthic macrofauna to hypoxia advancing to anoxia in the Mediterranean. The hypoxic and anoxic conditions were created for 3-4 days in a box that enclosed in-situ sediments. In general, molluscs were more resistant than polychaetes, with 90% surviving hypoxia and anoxia, whereas only 10% of polychaetes survived. Exposed individual *Timoclea ovata* and *Tellina serrata* survived the experiment but the exposed *Glycera* spp. died. Generally, epifauna were more sensitive than infauna, mobile species more sensitive than sedentary species and predatory species more sensitive than suspension and deposit feeders. The test conditions did not lead to the production of Hydrogen sulphide which may have reduced mortalities compared to some observations (Riedel *et al.*, 2012).

Further evidence of sensitivity was available for some of the polychaete species associated with this biotope. Rabalais *et al.* (2001) observed that hypoxic conditions in the North Coast of the Gulf of Mexico (oxygen concentrations from 1.5 to 1 mg/L (1 to 0.7 ml L⁻¹)) led to the emergence of *Lumbrineris* sp. from the substrate these then lie motionless on the surface. *Glycera alba* was found to be able to tolerate periods of anoxia resulting from inputs of organic rich material from a wood pulp and paper mill in Loch Eil (Scotland) (Blackstock & Barnes, 1982).

Sensitivity assessment. Riedel *et al.* (2012) provide evidence on general sensitivity trends. The characterizing bivalves are likely to survive hypoxia at the pressure benchmark although the polychaetes present, particularly the mobile predatory species such as *Glycera* and *Nephtys* may be less tolerant. As the biotope is characterized by polychaetes, resistance is assessed as 'Low' and

resilience as 'High' based on migration, water transport of adults and recolonization by pelagic larvae. Biotope sensitivity is assessed as 'Low'.

Nutrient enrichment

High

Q: Low A: NR C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

This pressure relates to increased levels of nitrogen, phosphorus and silicon in the marine environment compared to background concentrations. The pressure benchmark is set at compliance with Water Framework Directive (WFD) criteria for good status, based on nitrogen concentration (UKTAG, 2014).

The bivalves, polychaetes and other associated invertebrate species are unlikely to be directly affected by changes in nutrient enrichment. The biotope is found in the circalittoral zone (JNCC, 2015) where light penetration is limited.

Sensitivity assessment. As this biotope is structured by the sediments and water flow rather than nutrient enrichment, the biotope is considered to have 'High' resistance to this pressure and 'High' resilience, (by default) and is assessed as 'Not sensitive'.

Organic enrichment

High

Q: High A: Medium C: High

High

Q: High A: High C: High

Not sensitive

Q: High A: Medium C: High

The biotope occurs in mobile sand sediments where sediment disturbance leads to particle sorting, and in-situ primary production is restricted to microphytobenthos and some macroalgae (JNCC, 2015). An input of organic matter would provide a food subsidy to the deposit feeding polychaetes and may be utilized by amphipods.

Borja *et al.* (2000) and Gittenberger & Van Loon (2011) assigned *Glycera alba* and *Glycera lapidum* to their AMBI Group III, defined as: 'Species tolerant to excess organic matter enrichment. These species may occur under normal conditions, but their populations are stimulated by organic enrichment (slight unbalance situations)'. *Lumbrineris latreilli* was characterized as AMBI Group II- 'Species indifferent to enrichment, always present in low densities with non-significant variations with time (from initial state, to slight unbalance)' (Borja *et al.*, 2000, Gittenberger & Van Loon, 2011).

Simboura & Zenetos (2002) assigned *Timoclea ovata* to their Ecological Group II (GII) category for the biotic index that they developed, called BENTIX. Ecological Group II is defined as: 'Species tolerant to disturbance or stress whose populations may respond to enrichment or other source of pollution by an increase of densities (slight unbalanced situations)'.

Sensitivity assessment. At the pressure benchmark, organic inputs are likely to represent a food subsidy for the associated deposit feeding species and are unlikely to significantly affect the structure of the biological assemblage or impact the physical habitat. Biotope sensitivity is therefore assessed as 'High' and resilience as 'High' (by default), and the biotope is therefore considered to be 'Not sensitive'.

A Physical Pressures

Resistance

Resilience

Sensitivity

Physical loss (to land or freshwater habitat)**None**

Q: High A: High C: High

Very Low

Q: High A: High C: High

High

Q: High A: High C: High

All marine habitats and benthic species are considered to have a resistance of 'None' to this pressure and to be unable to recover from a permanent loss of habitat (resilience is 'Very Low'). Sensitivity within the direct spatial footprint of this pressure is therefore 'High'. Although no specific evidence is described, confidence in this assessment is 'High' due to the incontrovertible nature of this pressure.

Physical change (to another seabed type)**None**

Q: High A: High C: High

Very Low

Q: High A: High C: High

High

Q: High A: High C: High

The biotope is characterized by the sedimentary habitat (JNCC, 2015), so a change to an artificial or rock substratum would alter the character of the biotope leading to reclassification and the loss of the sedimentary community including the characterizing bivalves, polychaetes and echinoderms that live buried within the sediment.

Sensitivity assessment. Based on the loss of the biotope, resistance is assessed as 'None', recovery is assessed as 'Very low' (as the change at the pressure benchmark is permanent), and sensitivity is assessed as 'High'.

Physical change (to another sediment type)**Low**

Q: High A: High C: High

Very Low

Q: High A: High C: High

High

Q: High A: High C: High

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

Q: High A: High C: High

Medium

Q: High A: High C: Medium

Medium

Q: High A: High C: Medium

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 will 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

Q: High A: High C: NR

High

Q: High A: Medium C: High

Low

Q: High A: Medium C: Low

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

Q: High A: High C: Medium

High

Q: High A: High C: High

Low

Q: High A: High C: Medium

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

Q: High A: Medium C: Low

High

Q: High A: Low C: Medium

Low

Q: High A: Low C: Low

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 is 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

Q: High A: High C: Medium

High

Q: High A: Low C: Medium

Low

Q: High A: Low C: Medium

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

Q: High A: High C: NR

Medium

Q: High A: Low C: Medium

Medium

Q: High A: Low C: Low

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) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR
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Not assessed.

Electromagnetic changes	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR
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No evidence.

Underwater noise changes	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR
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Not relevant.

Introduction of light or shading	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR
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Invertebrate species such as the bivalves and polychaetes may possess rudimentary eyes and be able to perceive light and dark. Changes in light levels are not considered likely to affect adult stages, although little evidence is available to support this conclusion. This pressure is therefore assessed as 'Not relevant'.

Barrier to species movement	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: High	Not relevant (NR) Q: NR A: NR C: NR
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Not relevant to off-shore habitats.

Death or injury by collision	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR
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'Not relevant' to seabed habitats. NB. Collision by grounding vessels is addressed under 'surface abrasion'.

Visual disturbance	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR
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'Not relevant'.

Biological Pressures

	Resistance	Resilience	Sensitivity
Genetic modification & translocation of indigenous species	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Key characterizing species within this biotope are not cultivated or translocated. This pressure is therefore considered 'Not relevant' to this biotope group.

Introduction or spread of invasive non-indigenous species

None

Q: High A: High C: High

Very Low

Q: High A: High C: High

High

Q: High A: High C: High

The slipper limpet *Crepidula fornicata* may settle on stones in substrates and hard surfaces such as bivalve shells and can sometimes form dense carpets which can smother bivalves and alter the seabed, making the habitat unsuitable for larval settlement. Dense aggregations trap suspended silt, faeces and pseudofaeces altering the benthic habitat. Where slipper limpet stacks are abundant, few other bivalves can live amongst them (Fretter & Graham, 1981; Blanchard, 1997). Muddy and mixed sediments in wave sheltered areas are probably optimal, but *Crepidula fornicata* has been recorded from a wide variety of habitats including clean sands and areas subject to moderately strong tidal streams (Blanchard, 1997; De Montaudouin & Sauriau, 1999).

Although not currently established in UK waters, the whelk *Rapana venosa* may spread to UK habitats from Europe. Both *Rapana venosa* and the introduced oyster drill *Urosalpinx cinerea* predate on bivalves and could therefore negatively affect bivalve species.

Sensitivity assessment. The sediments characterizing this biotope are likely to be too mobile or otherwise unsuitable for most of the recorded invasive non-indigenous species currently recorded in the UK. The slipper limpet may colonize this habitat resulting in habitat change and potentially classification to the biotope which is found in similar habitats SS.SMx.IMx.CreAsAn. Non-native predatory gastropods may also emerge as a threat to this biotope. Based on *Crepidula fornicata*, biotope resistance is assessed as 'None' and resilience as 'Very Low' (as removal of established non-native is unlikely), so biotope sensitivity is assessed as 'High'.

Introduction of microbial pathogens

High

Q: High A: High C: Medium

High

Q: High A: High C: High

Not sensitive

Q: High A: High C: Medium

No evidence was found for the characterizing polychaete species. Populations of bivalve species may be subject to a variety of diseases and parasites but evidence for the characterizing bivalves is limited. Berilli *et al.*, (2000) conducted a parasitological survey of the bivalve *Chamelea gallina* in natural beds of the Adriatic Sea, where anomalous mortalities had been observed in 1997-1999. The occurrence of protozoans belonging to the families Porosporidae, Hemispeiridae and Trichodinidae was recorded. Bacterial diseases are frequently found in molluscs during their larval stages, but seem to be relatively insignificant in populations of adult animals (López *et al.*, 2004). This may be due to the primary defence mechanisms of molluscs, phagocytosis and encapsulation, which fight against small-sized pathogens, and whose resistance may be age related (Sindermann, 1990, from López-Flores *et al.*, 2004).

Sensitivity assessments. Pathogens may cause mortality and there may be a minor decline in species richness or abundance in the biotope. As there is no evidence for mass mortalities of characterizing species that would alter biotope classification biotope resistance is assessed as 'Medium'. Biotope resilience is assessed as 'High' as changes may fall within natural population variability and a recognisable biotope is likely to be present after two years. Biotope sensitivity is therefore assessed as 'Low'.

Removal of target species**High**

Q: Low A: NR C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

The characterizing polychaete species are not directly targeted by fishers. However, the small venerid bivalve *Timoclea ovata* may be fished. The direct physical effects of species removal is assessed through the abrasion and penetration and abrasion pressures. As the removal of the bivalves is unlikely to have direct or indirect ecological effects on the other characterizing species or to alter biotope classification biotope resilience is assessed as 'High', resilience is assessed as 'High' (by default) and the biotope is considered to be 'Not sensitive'.

Removal of non-target species**Low**

Q: High A: High C: High

High

Q: High A: High C: High

Low

Q: High A: High C: High

Species within the biotope are not functionally dependent on each other, although biological interactions will play a role in structuring the biological assemblage through predation and competition. Removal of adults may support recruitment of juvenile bivalves by reducing competition for space and consumption of larvae.

Removal of species would also reduce the ecological services provided by these species such as secondary production and nutrient cycling.

Sensitivity assessment. Species within the biotope are relatively sedentary or slow moving, although the infaunal position may protect some burrowing species from removal. Biotope resistance is therefore assessed as 'Low' and resilience as 'High', as the habitat is likely to be directly affected by removal and some species will recolonize rapidly. Some variability in species recruitment, abundance and composition is natural and therefore a return to a recognizable biotope should occur within 2 years. Repeated chronic removal would, however, impact recovery.

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