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

Glycera lapidum, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly 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/1136]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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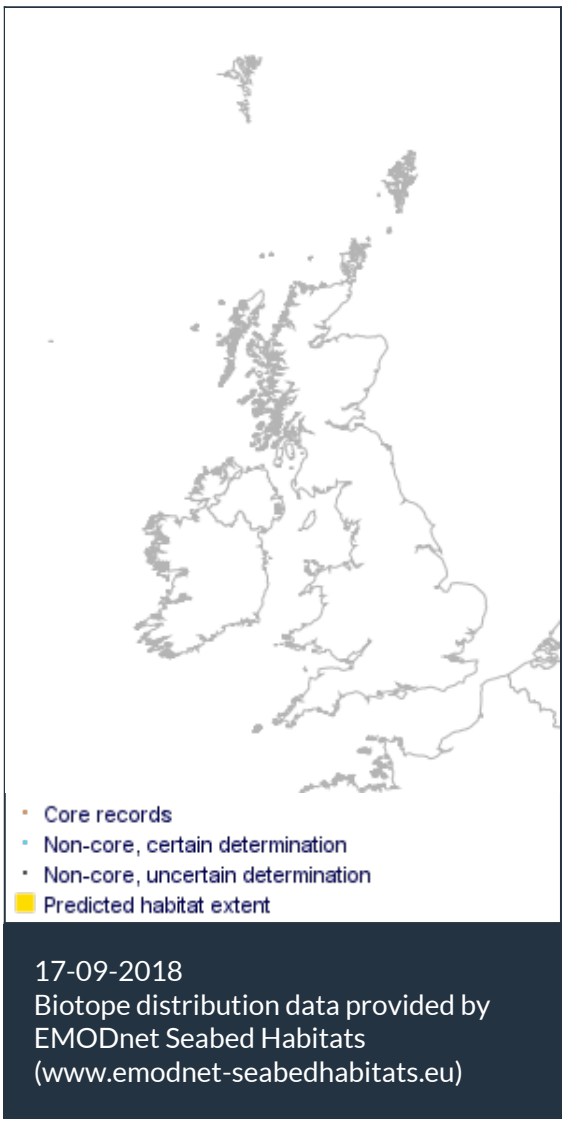

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by Dr Heidi Tillin **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A5.151	*Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand
JNCC 2015	SS.SCS.OCS.GlapThyAmy	*Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand
JNCC 2004	SS.SCS.OCS.GlapThyAmy	*Glycera lapidum*, *Thyasira spp.* and *Amythasides macroglossus* in offshore gravelly sand
1997 Biotope		

Description

Offshore (deep) circalittoral habitats with coarse sands and gravel, stone or shell and occasionally a little silt (<5%) may be characterized by the polychaetes *Glycera lapidum* and *Amythasides macroglossus* with the bivalve *Thyasira* spp. (particularly *Thyasira succisa*). Other taxa include

polychaetes such as *Exogone verugera*, *Notomastus latericeus*, *Spiophanes kroyeri*,*Aphelochaeta marioni* (*Tharyx marioni*) and *Lumbrineris gracilis* and occasional numbers of the bivalve *Timoclea ovata*. This biotope bears some resemblance to the shallow SCS.Glap and also to the circalittoral and offshore venerid biotopes (SCS.MedLumVen and SMX.PoVen) but differs by the range of polychaete and bivalve fauna present. This biotope is notable for the presence of the rarely recorded ampharetid polychaete *Amythasides macroglossus* and also for the small ear file clam *Limatula subauriculata* which is common in some examples of this biotope (JNCC, 2015).

Depth range

-

Additional information

-

Listed By

- none -

Further information sources

Search on:

Google JNCC

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 coarse sands and gravel. The biological assemblage is characterized by the polychaetes *Glycera lapidum* and *Amythasides macroglossus* with the bivalve *Thyasira* spp. (particularly *Thyasira succisa*). Other taxa include polychaetes such as *Exogone verugera*, *Notomastus latericeus*, *Spiophanes kroyeri*, *Aphelochaeta marioni* (*Tharyx marioni*) and *Lumbrineris gracilis* and occasional numbers of the bivalve *Timoclea ovata*.

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 mobile polychaetes *Glycera lapidum* . 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. For immobile species or where depopulation has occurred over a large area, recovery will depend on recolonization by pelagic larvae.

Longer lived species that may represent a more developed and stable assemblage include the polychaete *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, with high densities of *Spisula subtruncata* , although most of these recruits did not survive summer. However, *Glycera* spp. had not recovered within two years (Sardá *et al.*, 2000).

Aphelochaeta marioni can live up to 2-3 years and its lifecycle varies according to environmental conditions (Rayment, 2007a). In Stonehouse Pool, Plymouth Sound, *Aphelochaeta marioni* (studied as *Tharyx marioni*) spawned in October and November (Gibbs, 1971) whereas in the Wadden Sea, Netherlands, spawning occurred from May to July (Farke, 1979). Laboratory observation reported spawning occurring at night, with females that rose up into the water column with their tail end in the burrow, and shed eggs within a few seconds that sank to form puddles on the sediment (Farke, 1979). Fertilization was not observed, probably because the male does not leave the burrow. The embryos developed lecithotrophically and hatched in about 10 days (Farke, 1979). The newly hatched juveniles were ca 0.25 mm in length and immediately dug into the sediment. Where the sediment depth was not sufficient for digging, the juveniles swam or crawled in search of a suitable substratum (Farke, 1979). In the laboratory, juvenile mortality was high (ca 10% per month) and most animals survived for less than a year (Farke, 1979). In the Wadden Sea, the majority of the cohort reached maturity and spawned at the end of their first year, although, some slower developers did not spawn until the end of their second year (Farke, 1979). However, the population of *Aphelochaeta marioni* in Stonehouse Pool spawned for the first time at the end of their second year (Gibbs, 1971). There was no evidence of a major post-spawning mortality and it was suggested that individuals may survive to spawn over several years. Gibbs (1971) found that the number of eggs laid varied from 24-539 (mean=197) and was correlated with the female's number of genital segments and, hence, female size and age.

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. 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). 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 larval development of *Thyasira equalis* is lecithotrophic and the pelagic stage is very short or suppressed. This agrees with the reproduction of other *Thyasira* sp., and in some cases (e.g. *Thyasira gouldi*) no pelagic stage occurs at all (Thorson 1946, 1950). This means that larval dispersal is limited. If mortality of *Thyasira* sp. occurs, there would have to be nearby populations for recovery to occur. Where some individuals survive, due to the fact that larvae spend little or no time in the water column, post-settlement survival may be higher, and the population may be able to recover. It is also possible that adults could be brought into the area by bed load transport, enabling colonization. Sparks-McConkey and Watling (2001) found that a population of *Thyasira flexuosa* in Penobscot Bay, Maine recovered rapidly (within 3.5 months) following trawler disturbance that resulted in a decrease in the population. Benthic reproduction allows recolonization of nearby disturbed sediment and leads to rapid recovery where a large proportion of the population remains to repopulate the habitat.

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 (Gilklinson *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 are therefore likely to recover rapidly.

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 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

	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 reflect 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 characterizing species and the assessment relies on information on larvae in the plankton or monitoring of settlement and records of species distribution. Species from different areas may be acclimated to prevailing conditions and life histories may vary, e.g. *Chamelea gallina* longevity varies between populations (Gaspar *et al.*, 2004) as does the longevity of *Amphipholis squamata* in different locations and habitats (Emson *et al.*, 1989).

Glycera lapidum is found in the north-eastern Atlantic, Mediterranean, North Sea, Skagerrak and Kattegat (Marine Species Identification Portal).

Aphelochaeta marioni is distributed over a wide temperature range. It has been recorded from the Mediterranean Sea and Indian Ocean (Farke, 1979). Therefore, the species must be capable of tolerating higher temperatures than it experiences in Northern Europe. For example, Covazzi Harriague *et al.* (2007) reported *Aphelochate marioni* occurring in the Rapallo Harbour (Ligurian Sea, NW Mediterranean) at 24°C. Furthermore, *Aphelochaeta marioni* lives infaunally and so is

likely to be insulated from rapid temperature change. An increase in temperature would be expected to cause some physiological stress but no mortality. Murina (1997) categorized *Polydora ciliata* as a eurythermal species because of its ability to spawn in temperatures ranging from 10.6-19.9°C. This is consistent with a wide distribution in north-west Europe which extends into the warmer waters of Portugal and Italy (Pardal *et al.*, 1993; Sordino *et al.*, 1989). In the western Baltic Sea, Gulliksen (1977) recorded high abundances of *Polydora ciliata* in temperatures of 7.5 to 11.5°C and in Whitstable in Kent, where sea temperatures varied between 0.5 and 17°C (Dorsett, 1961). Growth rates may increase if temperature rises. For example at Whitstable in Kent, Dorsett (1961) found that a rapid increase in growth of *Polydora ciliata* coincided with the rising temperature of the seawater during March.

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 & Pe□as, 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).

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.

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Aphelochaeta marioni is distributed over a wide temperature range. It has been recorded from the western Baltic Sea, South Atlantic Ocean and North Sea (Farke, 1979). Therefore the species must

be capable of tolerating low temperatures. *Aphelochaeta marioni* lives buried in sediment and is therefore well insulated from decreases in temperature. In the Wadden Sea, the population was apparently unaffected by a short period of severe frost in I973 (Farke, 1979). Kędra *et al.* (2010) reported *Aphelochaete marioni* occurring in the Svalbard Archipelago where temperatures below zero may be experienced in the winter. A decrease in temperature would be likely to cause some physiological stress but no mortality.

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

This biotope occurs in full salinity. No directly relevant evidence was found to assess this pressure. 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).

Populations of *Aphelochaeta marioni* inhabit the open coast where seawater is at full salinity. Covazzi Harriague *et al.* (2007) reported *Aphelochate marioni* in the Rapallo Harbour (Ligurian Sea, NW Mediterranean) at salinities above 38 psu. Farke (1979) studied the effects of changing salinity on *Aphelochaeta marioni* (studied as *Tharyx marioni*) in a microsystem in the laboratory. Over several weeks, the salinity in the microsystem was increased from 25-40 psu and no adverse reaction was noted. However, when individuals were removed from the sediment and displaced to a new habitat, they only dug into their new substratum if the salinities in the two habitats were similar. If the salinities differed by 3-5 psu, the worms carried out random digging movements, failed to penetrate the sediment and died at the substratum surface after a few hours. This would suggest that *Aphelochaeta marioni* can tolerate salinity changes when living infaunally but may not resist an increase in salinity when removed from its habitat.

Sensitivity assessment. High saline effluents alter the structure of biological assemblages. Polychaete species may be more tolerant than bivalves so that an increase in salinity may lead to a shift in community composition. 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'.

Salinity decrease (local)	Low Q: High A: Medium C: Medium	Medium Q: High A: Low C: Medium	Medium Q: High A: Low C: Medium

Aphelochaeta marioni thrives in estuaries and is therefore likely to be tolerant of decreases in salinity. It has been recorded from brackish inland waters in the Southern Netherlands with a salinity of 16 psu, but not in areas permanently exposed to lower salinities (Wolff, 1973). However, it also penetrates into areas exposed to salinities as low as 4 psu for short periods at low tide when freshwater discharge from rivers is high (Farke, 1979). In the Severn Estuary, *Aphelochaeta marioni* (studied as *Tharyx marioni*) characterized the faunal assemblage of very poorly oxygenated, poorly sorted mud with relatively high interstitial salinity (Broom *et al.*, 1991).

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

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. 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. The topography of this habitat is shaped by currents and wave action that influence the formation of ripples in the sediment. Specific fauna may be associated with troughs and crests of these bedforms and may form following an increase in water flow, or disappear following a reduction in flow.

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).

Aphelochaeta marioni has been recorded in the Wadden Sea with flow rates up to 0.45 m/s (Compton *et al.*, 2013), and in the Westerscheld estuary (SW Netherlands) where spring current velocities vary between 0.1-0.58 m/s (Van Colen *et al.*, 2010a).

Sensitivity assessment. This biotope occurs in areas subject to moderately strong water flows and these are a key factor maintaining the clean sand habitat. Changes in water flow may alter the topography of the habitat and may cause some shifts in abundance. However, a change at the pressure benchmark (increase or decrease) is unlikely to affect biotopes that occur in mid-range flows 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: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: NR C: NR

As this biotope occurs in infralittoral 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 would 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.

Sensitivity assessment. Based on lack of exposure, the biotope is assessed as having '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.

Aphelochaeta marioni is tolerant of heavy metal contamination occurring in the heavily polluted Restronguet Creek (Bryan & Gibbs, 1983) and it is also an accumulator of arsenic (Gibbs *et al.*, 1983). *Polydora ciliata* occurs in an area of the southern North Sea polluted by heavy metals but was absent from sediments with very high heavy metal levels (Diaz-Castaneda *et al.*, 1989).

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 Efflam beach in France. It was estimated that the delayed mortality effects on sand and mud biotas were 1.4 times as large as the immediate effects. *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 a*nd *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. Prior to the spill, *Aphelochaeta marioni* (studied as *Tharyx marioni*) was present in very low numbers in the Bay of Morlaix, western English Channel. Following the spill, the level of hydrocarbons in the sediment increased from 10 mg/kg dry sediment to 1443 mg/kg dry sediment 6 months afterwards. In the same period, *Aphelochaeta marioni* increased in abundance to a mean of 76 individuals/m^2, which placed it among the top five dominant species in the faunal assemblage. It was suggested that the population explosion occurred due to the increased food availability because of accumulation of organic matter resulting from high mortality of browsers. Six years later, abundance of *Aphelochaeta marioni* began to fall away again, accompanied by gradual decontamination of the sediments.

Other studies support the conclusion that polychaetes are generally a tolerant taxa. Hiscock *et al*. (2004, 2005 from 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. Diaz-Castaneda *et al*. (1989) looked at colonization of defaunated and polluted sediments in Dunkerque harbour. The sediment was polluted with both heavy metals and oil. *Capitella capitata* was generally the first polychaete to colonize the polluted sediment. *Spio filicornis* took between 7 weeks and 3 months to appear in the sediment, suggesting it is tolerant of oil pollution.

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.

There is little evidence directly relating to the effects of synthetic chemicals on *Aphelochaeta marioni*. Waldock *et al*. (1999) reported that the species diversity of polychaete infauna, including *Aphelochaeta marioni*, in the Crouch estuary increased in the three years after the use of TBT was banned within the estuary, suggesting that TBT had suppressed their abundance previously.

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 m/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/m^2.

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	Medium Q: High A: High C: NR	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. In general 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.

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)) led to the emergence of *Lumbrineris* sp. from the substrate, which then lied 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). Nierman *et al*. (1990) reported changes in a fine sand community in the German Bight, in an area with regular seasonal hypoxia. In 1983, oxygen levels were exceptionally low (<3 mg O_2/l) in large areas and <1mg O_2/l in some areas. Species richness decreased by 30-50% and overall biomass fell. *Owenia fusiformis* were significantly reduced in abundance by the hypoxia and *Spiophanes bombyx* was found in small numbers at some, but not all areas, during the period of hypoxia. Once oxygen levels returned to normal, *Spiophanes bombyx* increased in abundance; the evidence suggests that at least some individuals would survive hypoxic conditions.

Connor *et al*. (1997a) described sediments in which *Aphelochaeta marioni* is commonly found as usually with a "black anoxic layer close to the sediment surface". Broom *et al*. (1991) recorded that *Aphelochaeta marioni* (studied as *Tharyx marioni*) characterized the faunal assemblage of very poorly oxygenated mud in the Severn Estuary. They found *Aphelochaeta marioni* to be dominant where the redox potential at 4 cm sediment depth was 56 mV and, therefore, concluded that the species was tolerant of very low oxygen tensions. It is likely that feeding, growth and reproduction would be impaired under sustained low oxygen conditions.

Dando & Spiro (1993) found that numbers of the congeners *Thyasira equalis* and *Thyasira sarsi* decreased rapidly following the de-oxygenation of bottom water in the deep basin of Gullmar fjord in 1979-80.

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. Biotope resistance is assessed as 'Medium' 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.

Sensitivity assessment. As this biotope is structured by the sediments and water flow rather than nutrient enrichment and is not characterized by macroalgae, 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 areas experiencing frequent sediment disturbance, which leads to particle sorting, so in-situ primary production is likely to be restricted to microphytobenthos and some macroalgae. An input of organic matter would provide a food subsidy to the deposit feeding polychaetes.

Borja *et al.* (2000) and Gittenberger & Van Loon (2011) assigned *Glycera alba*, *Glycera lapidum* and *Spiophanes bombyx* 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)'.

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'.

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 polychaetes and bivalves 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 coarse sand 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). For coarse 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 indicate likely patterns in change if the sediment were to alter. 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).

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).

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 *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), biotope resilience is assessed as 'Very low (the pressure is a permanent change), and biotope sensitivity is assessed as 'High'.

Habitat structure changes - removal of substratum (extraction)	None	Medium	Medium
	Q: High A: High C: High	Q: High A: High C: Medium	Q: High A: High C: Medium

A number of studies assess the impacts of aggregate extraction on sand and gravel habitats. 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	Q: High A: Medium C: High	Q: High A: Medium C: Low

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. Venerid bivalves, such as the characterizing species *Timoclea ovata*, live close to the surface (Morton, 2009) and a proportion of the population may be damaged by abrasion. Burrowing species such as *Glycera lapidum* and *Lumbrineris gracilis* may be unaffected by surface abrasion. The congener *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).

De Biasi & Pacciardi (2008) compared macrobenthic communities in a commercial fishing ground exploited by otter trawling with an area closed to fishing for over 10 years in the Adriatic Sea. The authors found that polychaetes, including *Aphelochaeta* spp. were among the species dominating the disturbed areas, which is likely to result from the ability of the species to recolonize disturbed areas rapidly, rather than indicate that the polychaetes are resistant to disturbance of the seabed surface.

Sensitivity assessment. Abrasion 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	Q: High A: High C: High	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 brittlestars.

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. Ball *et al*. (2000) reported on the short-term effects of fishing on benthos from a mud patch in the northwestern part of the Irish Sea investigated in 1994–1996 by means of samples taken both before and shortly after (ca. 24 hr) fishing activity. The direct mortality (percentage of initial density) of *Thyasira flexuosa* was estimated as 0-28%, based on samples taken with a Day grab before and 24 hours after trawling (Ball *et al*., 2000).

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, including *Timoclea ovata* appeared to have increased (Capasso *et al*., 2010).

These results are supported by experiments in shallow wave disturbed areas using a toothed, clam dredge that found that some polychaete taxa without external protection and with a carnivorous feeding mode were enhanced by fishing. *Nephtys* sp. were one of these species; 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. The persistence of disturbance will benefit these, increasing their abundance (Frid *et al*., 2000).

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 biotope sensitivity is therefore assessed as 'Low'.

Changes in suspended solids (water clarity)	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low 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).

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 may have difficulty sorting organic materials in high levels of suspended sediment. As *Thyasira flexuosa* are buried within the sediment and are fed by symbiotic bacteria they are considered insensitive to a change in suspended solids.

Changes in turbidity and seston are not predicted to directly affect *Glycera* spp. and *Lumbrineris gracilis* which live within sediments.*Aphelochaeta marioni* lives infaunally and is a surface deposit feeder (Rayment, 2007a), therefore relying on a supply of nutrients at the sediment surface. An increased rate of siltation may result in an increase in food availability and therefore growth and reproduction of *Aphelochaeta marioni*. However, food availability would only increase if the additional suspended sediment contained a significant proportion of organic matter and the population would only be enhanced if food was previously limiting. A decrease in the suspended sediment would result in a decreased rate of deposition on the substratum surface and therefore a reduction in food availability for *Aphelochaeta marioni*. This would be likely to impair growth and reproduction.

Sensitivity assessment. No direct evidence was found to assess impacts on the characterizing and associated species. 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 for bivalves but the characterizing polychaetes are unliekly to be affected. Biotope resistance is assessed as 'High' and resilience is assessed as 'High' (be default) and the biotope is considered to be 'Not sensitive'.

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.

Gittenberger & Van Loon (2011) *assessed Spiophanes bombyx* in their index of sedimentation tolerance as a 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).

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.

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.

Aphelochaeta marioni lives infaunally in soft sediments and moves by burrowing. It deposit feeds at the surface by extending contractile palps from its burrow. An additional 5 cm layer of sediment would result in a temporary cessation of feeding activity, and therefore growth and reproduction are likely to be compromised. However, *Aphelochaeta marioni* would be expected to quickly relocate to its favoured depth, with no mortality. Kędra *et al.* (2010) reported *Aphelochaeta mariori* to occur in the Hornsundfjord, Svalbard, where sedimentation rates can vary between 0.1-35 cm/yr.

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. This suggests that *Thyasira* spp. may be able to re-borrow through similar overburdens. *Thyasira flexuosa* have 'highly extensible feet' (Dando & Southward, 1986) allowing them to construct channels within the sediment and to burrow to 8 cm depth.

Sensitivity assessment. The 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

The character of the overburden is an important factor determining the degree of vertical

migration of buried bivalves and polychaetes. 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 within fine sediments at the pressure benchmark. 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

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

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

'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

Burrowing 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: NR	Not relevant (NR) Q: NR A: NR C: NR

Not relevant.

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

'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

'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

Few invasive non-indigenous species may be able to colonize mobile sands, due to the high-levels of sediment disturbance. However, two species may be of concern. 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). Bohn *et al*. (2015) report that in the Milford Haven Waterway (MHW), south west Wales, UK, highest densities were found in areas of high gravel content (grain sizes 16-256 mm), suggesting that the availability of this substrata type is beneficial for its establishment.

The colonial ascidian *Didemnum vexillum* is present in the UK but appears to be restricted to artificial surfaces such as pontoons, this species may, however, have the potential to colonize and smother offshore gravel habitats. Valentine *et al*. (2007) describe how *Didemnum* sp. appear to have rapidly colonized gravel areas on the Georges Bank (US/Canada boundary). Colonies can coalesce to form large mats that may cover more than 50% of the seabed in parts. Areas of mobile sand bordered communities of *Didemnum* sp. and these, therefore, do not appear to be suitable habitats (Valentine *et al*., 2007).

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 the characterizing 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. *Didemnum* sp. and non-native predatory gastropods may also emerge as a threat to this biotope, although more mobile sands may exclude *Didemnum*. 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

Little information was found regarding microbial infection of polychaetes, although Gibbs (1971) recorded that nearly all of the population of *Aphelochaeta marioni* in Stonehouse Pool, Plymouth Sound, was infected with a sporozoan parasite belonging to the acephaline gregarine genus *Gonospora*, which inhabits the coelom of the host. No evidence was found to suggest that gametogenesis was affected by *Gonospora* infection and there was no apparent reduction in fecundity.

Populations of the characterizing bivalve species may be subject to a variety of diseases and parasites, but evidence for the characterizing bivalves is limited. Symbionts affecting clams include viruses, fungi, prokaryotes, protozoans and metazoans (López-Flores *et al*., 2004). In general, no obvious host response was described associated to ciliates (López-Flores *et al*., 2004). Bacterial diseases are frequently found in molluscs during their larval stages, but seem to be relatively insignificant in populations of adult animals (López-Flores *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 (Sinderman, 1990 from López-Flores *et al*., 2004).

Sensitivity assessments. Pathogens may cause mortality in bivalves 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	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

Not relevant, characterizing species are not targeted.

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 juveniles by reducing competition for space and consumption of larvae. Animals caught as by-catch may be returned to the sea but may be stressed or have died from exposure on the deck (Gaspar & Monteiro, 1999), or be returned to unsuitable habitats reducing survival and/or altering the distribution of species (Gaspar *et al*., 2002).

Shellfish dredges targeting *Spisula solida* also remove crustaceans and other bivalves including *Donax vittatus* and *Tellina tenuis* as well as undersized juveniles as by-catch (Leitão *et al*., 2009). Loss of the characterizing and associated species as by-catch would alter the character of the biotope, for example the removal of the characterizing bivalves; tube-dwelling polychaetes such as *Lanice conchilega* and macroalgae from surface sediments could lead to reclassification of the biotope as a disturbed, polychaete dominated type such as SS.SCS.ICS.CumCset.

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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