Glycera lapidum in impoverished infralittoral mobile gravel and sand

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

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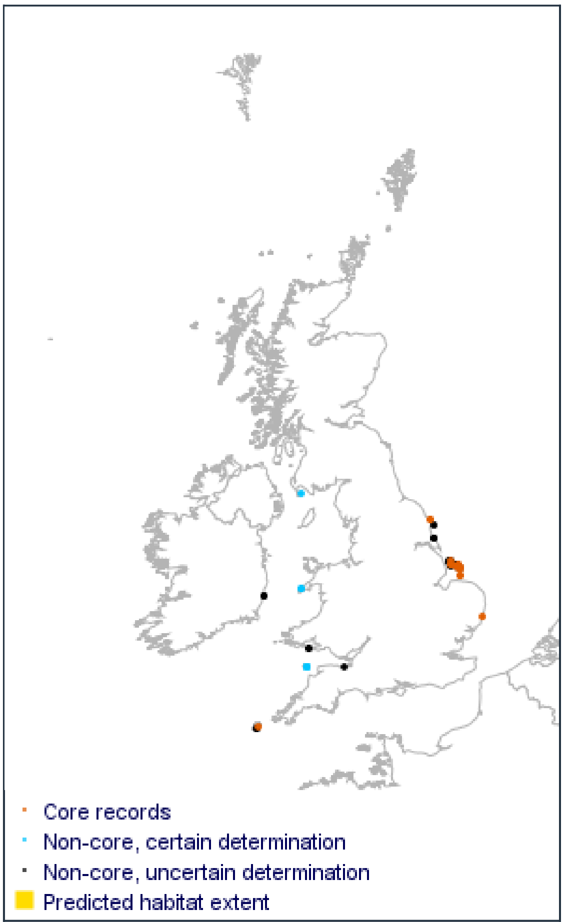

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

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

Summary

UK and Ireland classification

EUNIS 2008	A5.135	*Glycera lapidum* in impoverished infralittoral mobile gravel and sand
JNCC 2015	SS.SCS.ICS.Glap	*Glycera lapidum* in impoverished infralittoral mobile gravel and sand
JNCC 2004	SS.SCS.ICS.Glap	*Glycera lapidum* in impoverished infralittoral mobile gravel and sand
1997 Biotope		

Description

In infralittoral mixed slightly gravelly sands on exposed open coasts impoverished communities characterized by the polychaete *Glycera lapidum* (agg.) may be found. *Glycera lapidum* is a species complex and as such some variability in identification may be found in the literature. It is also quite widespread, may occur in a variety of coarser sediments and is often present in other SCS biotopes. However, it is rarely considered a characteristic species and where this is the case it is normally due to the exclusion of other species. Consequently, it is considered that habitats containing this biotope may be subject to continual or periodic sediment disturbance from wave action, which prevents the establishment of a more stable community. Other taxa include spionid polychaetes such as *Spio martinensis* and *Spiophanes bombyx*, *Nephtys* spp. and in some areas the bivalve *Spisula elliptica*. It is possible that SS.SCS.ICS.Glap is not a true biotope, rather an impoverished, transitional community, which in more settled conditions develops into other more stable communities (Information taken from Connor *et al*., 2004).

Depth range

-

Additional information

-

Listed By

- none -

Further information sources

Search on:

G G G JNCC

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

The biotope description and characterizing species are taken from JNCC (2015). SS.SCS.ICS.Glap is an infralittoral biotope occurring on mixed slightly gravelly sands on exposed open coasts (JNCC, 2015). The impoverished communities that characterize the biotope are dominated by the polychaete *Glycera lapidum* (agg.), which rarely is considered a characteristic species (Connor *et al.*, 2004). This is likely to be the case in this biotope, where exclusion of other species occurs as a result of continued or periodic sediment disturbance from wave action, preventing the establishment of a more stable community. Other taxa include spionid polychaetes such as *Spio martinensis* and *Spiophanes bombyx*, *Nephtys* spp. and in some areas the bivalve *Spisula elliptica*. These species, together with *Glycera lapidum* are considered as important characterizing species and are therefore the focus of this sensitivity assesment.

Resilience and recovery rates of habitat

Glycera spp. are long-lived. *Glycera* are monotelic having a single breeding period towards the end of their life but may recover through migration and may persist in disturbed sediments due to 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 suggest 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). *Glycera* spp. had not recovered within two years (Sardá *et al.*, 2000).

A number of studies have tracked recovery of sand and coarse sand communities following disturbance from fisheries (Gilkinson *et al.*, 2005) and aggregate extraction (Boyd *et al.*, 2005). The 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 and amphipods are therefore likely to recover more rapidly than the characterizing bivalves and the biotope classification may revert, during recovery, to a polychaete dominated biotope.

Sardá *et al.* (1999) tracked annual cycles within a *Spisula* community in Bay of Blanes (north-west Mediterranean Sea, Spain) for 4 years. Macroinfaunal abundance peaked in spring, decreased sharply throughout the summer, with low density in autumn and winter. The observed trends were related to a number of species, including species that characterize this biotope such as *Glycera* spp.. The *Spisula subtruncata* populations were dominated by juveniles, with high abundances in spring followed by declines in summer, with very few survivors 3 months after recruitment.

Nephtys cirrosa is a relatively long-lived polychaete with a lifespan of six to possibly as much as nine years. It matures at one year and the females release over 10,000 (and up to 80,000 depending on species) eggs of 0.11-0.12mm from April through to March. These are fertilized externally & develop into an early lecithotrophic larva and a later planktotrophic larva which spends as much as 12 months in the water column before settling from July-September. The genus has a relatively high reproductive capacity and widespread dispersion during the lengthy larval phase. It is likely to have a high recoverability following disturbance (MES, 2010).

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. 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. The opportunistic species are likely to recolonize disturbed areas first, although the actual pattern will depend on recovery of the habitat, season of occurrence and other factors. The recovery of bivalves that recruit episodically and the establishment of a representative age-structured population for larger, longer-lived organisms may require longer than two years. In an area that had been subjected to intensive aggregate extraction for 30 years, abundances of juvenile and adults *Nephtys cirrosa* had greatly increased three years after extraction had stopped (Mouleaert & Hostens, 2007). An area of sand and gravel subject to chronic working for 25 years had not recovered after 6 years when compared to nearby reference sites unimpacted by operations (Boyd *et al*., 2005). Where resistance is 'None' 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)	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: NR C: NR

No direct evidence was found to support assessment of this pressure. Very few laboratory studies have been carried out and the sensitivity assessment is based on studies monitoring 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. A long-term increase in temperature might cause a shift in species composition. 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 may also influence the timing of gametogenesis and spawning in several species present in the biotope. Many polychaete species recruit in spring/early summer (Sardá *et al*., 1999).

Infaunal species are likely to be protected to some extent from direct effects of acute increases in temperature by sediment buffering, although increased temperatures may affect infauna indirectly by stimulating increased bacterial activity and increased oxygen consumption. Emery & Stevensen (1957) reported that *Nephtys spp.* could withstand summer temperatures of 30-35 °C so is likely to withstand the benchmark acute temperature increase. An acute increase in temperature at the benchmark level may result in physiological stress endured by the infaunal species but is unlikely to lead to mortality. *Nephtys cirrosa* is an active worm which can swim short distances with an undulatory movement and therefore seek preferred conditions. Furthermore, other polychaetes species associated with the biotope may have wide global distributions. *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 sands that contain many of the characterizing species may experience temperatures that are higher than experienced in the UK. It is considered likely, therefore, that chronic and acute changes 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. Biotope resistance and resilience are therefore assessed as 'High'. Biotope sensitivity is therefore assessed as 'Not Sensitive'.

Temperature decrease (local)	Medium Q: Low A: NR C: NR	High Q: High A: Low C: Medium	Low Q: Low A: NR C: NR

Polychaetes and other species associated with the biotope may have wide global distributions. *Glycera lapidum* is found in the north-eastern Atlantic, Mediterranean, North Sea, Skagerrak and Kattegat (Marine Species Identification Portal). *Nephtys cirrosa* reaches its northern limit in Scotland, and German Bight of the North Sea. A decrease in temperature is likely to result in loss of the species from the biotope in these areas.

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

No directly relevant evidence was found to assess this pressure. The biotope occurs in full salinity but is also found in the outer reaches of estuaries where some salinity fluctuations may be experienced so that the characterizing species may tolerate some changes in salinity. A study from the Canary Islands indicates that exposure to high salinity effluents (47- 50 psu) from desalination plants altered the structure of biological assemblages, reducing species richness and abundance (Riera *et al*., 2012). Bivalves and amphipods appeared 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 *Spio filicornis* and *Glycera* spp. were present at the discharge point (Riera *et al*., 2012).

Nephtys cirrosa was most abundant in salinities >30 psu in the German Bight (south eastern North Sea) (Meißner *et al*., 2008), suggesting the species might be adversely affected by changes in salinity.

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

This biotope occurs in full salinity so it is unlikely that the species present experience salinity fluctuations so that the characterizing species may tolerate some changes in salinity. *Nephtys* species are tolerant of brackish waters and penetrate into the mouths of estuaries and estuarine lagoons where salinity may fall below 20 psu (Barnes, 1994), so are unlikely to be especially affected by a reduction in salinity.

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. 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: High A: Medium C: High	High Q: High A: High C: High	Not sensitive Q: High A: Medium C: High

This biotope is recorded in areas where tidal flow varies between strong (1.5-3.0 m/s) and moderately strong (0.5-1.5 m/s) (JNCC, 2015). Sands and gravel 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. *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. This biotope occurs in areas subject to moderately strong water flows and these are a key factor maintaining the the physical structure of the 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: High A: Low C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

Polychaete species that burrow are protected within the sediment from wave action disturbance. Species in the biotope may be indirectly affected by changes in water movement where these impact the supply of food or larvae or other processes. The biotope occurs in the shallow infralittoral, in habitats that are very exposed, exposed and moderately exposed to wave action (JNCC, 2015). In the description of the biotope, Connor *et al.* (2004) suggest that continual or periodic sediment disturbance from wave action prevent the establishment of a more stable community. Wave action is therefore likely to be the main factor determining the physical character and species composition in the biotope. Consequently, a decrease in wave exposure is likely to allow for the development of a more stable community, leading to loss and/or reclassification of the biotope. An increase in wave exposure is unlikely to be relevant.

Sensitivity assessment. SS.SCS.ICS.Glap is defined by an energetic hydrographic regime. A decrease in wave exposure could potentially allow for the develpment of a more stable community leading to reclassification of the biotope to SS.SCS.ICS.MoeVen, for example, which is thought to be a more diverse version of SS.SCS.ICS.Glap (Connor *et al*., 2004). However, the biotope occurs in a range of wave exposures, and a change at the pressure benchmark level (3-5% in significant wave height) is considered to fall within the natural range experienced by the biotope, so that resistance and resilience are assessed as 'High', and 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). It is therefore likely that characterizing species *Spisula elliptica* may also bioaccumulate heavy metals.

Polychaetes are regarded as relatively tolerant of heavy metals (Bryan, 1984). Bryan & Gibbs (1983) suggested that in populations of polychaetes exposed to heavy metal contamination for a long period, metal resistance could be acquired. For example, *Nephtys hombergii* from Restronguet Creek seemed able to regulate copper. The head end of the worm became blackened and x-ray microanalysis by Bryan & Gibbs (1983) indicated that this was caused by the deposition of copper sulphide in the body wall. In the same study, Bryan & Gibbs (1983) presented evidence that *Nephtys hombergii* from Restronguet Creek possessed increased tolerance to copper contamination. Specimens from the Tamar Estuary had a 96 h LC50 of 250 µg/l, whilst those from Restronguet Creek had a 96 h LC50 of 700 µg/l (35 psu; 13°C).

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. 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. *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. 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. *Nephtys* species were amongst the fauna that was eradicated from sediments following the 1969 West Falmouth spill of Grade 2 diesel fuel documented by Sanders (1978).

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 (Black *et al*., 1997; Collier & Pinn, 1998; Grant & Briggs, 1998, cited in Wilding & 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. Boon *et al*. (1985) reported that *Nephtys* species in the North Sea accumulated organochlorines but, based on total sediment analyses, organochlorine concentrations in *Nephtys* species were not correlated with the concentrations in the (type of) sediment which they inhabited.

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	Medium Q: High A: Low C: Medium	Medium 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. *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 for 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 <1 mg O_2/l in some areas. Species richness decreased by 30-50% and overall biomass fell. *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.

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 'Medium'.

Nutrient enrichment	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: High	Not sensitive Q: NR A: NR C: NR

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).

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 bivalves and polychaetes 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)	None 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 medium to coarse sand with some gravel (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. The 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). *Nepthys cirrosa* occurs in fine to coarser sands, with greatest abundance in the Belgium part of the North Sea recorded in medium grain sizes (Degraer *et al.*, 2006). Abundance of *Nephtys* may therefore increase if sediments were to become finer.

Cooper *et al.* (2011) found that characterizing species from sand dominated sediments were equally likely to be found in gravel dominated sediments. A reduction in sediment coarseness may not result in loss of characterizing species and reclassification of the biotope.

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. *Nephtys cirrosa* dominated the fine sand community.

Sensitivity assessment. A change to finer, muddy and mixed sediments is likely to reduce the abundance of the characterizing species and allow colonization by other species. Changes in the sediment type may lead to biotope reclassification. 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'.

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.*, 2010 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 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. Burrowing species such as *Glycera lapidum* may be unaffected by surface abrasion.

Mean response of infauna and epifauna communities to fishing activities is shown to be much more negative in mud and sand communities than other habitats (Collie *et al*., 2000). *Nephtys cirrosa* was found to be sensitive to experimental trawling disturbance over 18 months (Tuck *et al*., 1998). *Nephtys cirrosa* is also likely to be vulnerable to dredging but can probably accommodate limited sediment deposition from the dredging process (MES, 2010). However, the polychaete *Nephtys cirrosa* is adapted to life in unstable sediments and survives through rapid burrowing (McDermott, 1983, cited from Elliott *et al*., 1998). This characteristic is likely to protect this species from surface abrasion.

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

Pressure	Resistance	Resilience	Sensitivity
Penetration or disturbance of the substratum subsurface	Medium 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 brittlestars.

Capasso *et al.* (2010) compared benthic survey datasets from 1895 and 2007 for an area in the English Channel. Small, mobile species such as amphipods and small errant and predatory polychaetes (*Nephtys*, *Glycera*) 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).

Bergman & Hup (1992) carried out a pre and post-experimental investigation using a 12 m beam trawl. The area was trawled three times over 2 days and samples taken up to 2 weeks after trawling. Some benthic species showed a 10-65% reduction in density after trawling the area three times. There was a significant lowering of densities (40-60%) of polychaete worms, including *Spiophanes bombyx*.

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.

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'. Biotope sensitivity is therefore assessed as 'Low'.

Changes in suspended solids (water clarity)	High Q: High A: Medium C: Low	High Q: High A: High C: High	Not sensitive Q: High A: Medium 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. Where *Spisula elliptica*, the abundance of this species may be affected.

Changes in turbidity and seston are not predicted to directly affect *Glycera* and *Nephtys* spp. 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. However, the key characterizing and denominated species *Glycera* is a scavanger/predator and is unlikely to be adversely affected by changes in suspended solids. Biotope resistance and resilience are therefore assessed as 'High' and and the biotope considered '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, but it is likely to occur rapidily in this wave disturbed biotope, 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 reclassification 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. Similarly, the author indicated that the maximal overburden through which *Nephtys* could migrate was 60 cm through mud and 90 cm through sand. No further information was available on the rates of survivorship or the time taken to reach the surface. Furthermore, 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*.

The characterizing polychaetes *Spio filicornis* and *Spiophanes bombyx* were 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). *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. This biotope is exposed to tidal streams which may remove some sediments, but 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)	Low 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. Similarly, the author indicated that the maximal overburden through which *Nephtys* could migrate was 60 cm through mud and 90 cm through sand. No further information was available on the rates of survivorship or the time taken to reach the surface. Furthermore, 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*.

Sensitivity assessment. Beyond re-establishing burrow openings or moving up through the sediment, there is evidence of synergistic effects on burrowing activity of marine benthos and mortality with changes in time of burial, sediment depth, sediment type and temperature (Maurer *et al.*, 1986). Bivalve and polychaete species have been reported to migrate through depositions of sediment greater that the benchmark (30 cm of fine material added to the seabed in a single discrete event) (Bijkerk, 1988; Powilleit *et al*., 2009; Maurer *et al*., 1982). However, the character of the overburden is an important factor determining the degree of vertical migration of buried bivalves and polychaetes, and it is not clear whether the characterizing species are likely to be able to migrate through a maximum thickness of fine sediment because muds tend to be more cohesive and compacted than sand. Some mortality of the characterizing species is likely to occur. 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

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

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 pressures is therefore assessed as 'Not relevant'.

Barrier to species movement	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

The key characterizing bivalve species produce pelagic larvae as do many of the polychaete species. Barriers that reduce the degree of tidal excursion may alter larval supply to suitable habitats from source populations. Conversely, the presence of barriers may enhance local population supply by preventing the loss of larvae from enclosed habitats. As the bivalve species characterizing the biotope are widely distributed and produce large numbers of larvae capable of long distance transport and survival, resistance to this pressure is assessed as 'High' and resilience as 'High' by default. This biotope is therefore considered to be 'Not sensitive'. Some species such as *Spio filicornis* that occur within the biotope have benthic dispersal strategies (via egg masses laid on the surface) and water transport is not a key method of dispersal over wide distances.

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 substrata and hard surfaces such as bivalve shells and can sometimes form dense carpets which can smother 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) in south west Wales, UK, subtidally, 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 bivalve species.

Sensitivity assessment. The sediments characterizing this biotope are likely to be too disturbed or otherwise unsuitable for most of the recorded invasive non-indigenous species currently recorded in the UK. However, the slipper limpet may colonize this habitat resulting in habitat change and potentially reclassification of the biotope. *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	Medium Q: High A: High C: Medium	High Q: High A: High C: High	Low 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. Porosporidae of the genus Nematopsis, present with 4 species, showed a prevalence of 100%. The results suggested that severe infections of protozoans of the genus *Nematopsis* could cause a not negligible respiratory sufferance, with a possible role in the decline of the natural banks of *Chamelea gallina* (Berilli *et al.*, 2000).

Bacterial diseases are frequently found in molluscs during their larval stages, but seem to be relatively insignificant in populations of adult animals (L�pez-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 (Sindermann, 1990; L�pez-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 recognizable biotope is likely to be present after two years. Biotope sensitivity is therefore assessed as 'Low'.

Removal of target species	Low Q: Low A: NR C: NR	Medium Q: High A: High C: High	Medium Q: Low A: NR C: NR

Nephtys cirrosa is targeted by bait digging. There is limited information on effect of digging directly on *Nephtys cirrosa* populations, however there is evidence on effects on another *Nephtys* species: *Nephtys hombergii*. *Nephtys hombergii* is directly removed through commercial bait digging and by recreational anglers and abundance significantly decreased in areas of the Solent, UK, where bait digging (primarily for *Nereis virens*) had occurred (Watson *et al.*, 2007).

Recovery of *Nephtys hombergii* has been assessed to be very high as repopulation would occur initially relatively rapidly via adult migration and later by larval recruitment. Dittman *et al.* (1999) observed that *Nephtys hombergii* was amongst the macrofauna that colonized experimentally disturbed tidal flats within two weeks of the disturbance that caused defaunation of the sediment. However, if sediment is damaged recovery is likely to be slower, for instance *Nephtys hombergii* abundance was reduced by 50% in areas where tractor towed cockle harvesting was undertaken on experimental plots in Burry inlet, south Wales, and had not recovered after 86 days (Ferns *et al*., 2000).

Sensitivity assessment. Confidence in this assessment in relation to the removal of *Nephtys cirrosa* is low as it is based on evidence of removal of *Nephtys hombergii*. Resistance is 'Low' due to direct removal of a characterizing species, that on commercial scales can remove a large proportion of the population (for instance, Neves de Carvalho *et al.* (2013) calculated that bait digging activities in the Douro Estuary, Portugal may remove up to 9.9 tonnes of *Hediste diversicolor*). Resilience is assessed as 'Medium' as regions that are not regularly harvested may recover rapidly but continued harvesting will impact the population. Sensitivity is assessed as 'Medium'. It is important to consider that the spatial extent and duration of harvesting is important to consider when assessing this pressure as smaller scale extraction may not impact the entire extent of the biotope but greater scale extraction over a long period would cause longer term impacts.

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. The biotope sensitivity is therefore considered 'Low'.

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