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

Hesionura elongata and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse 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/379]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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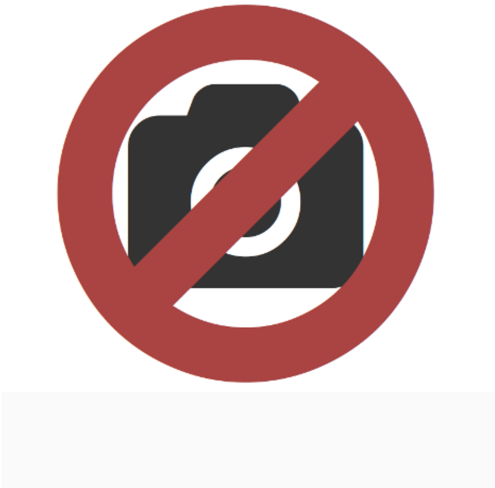

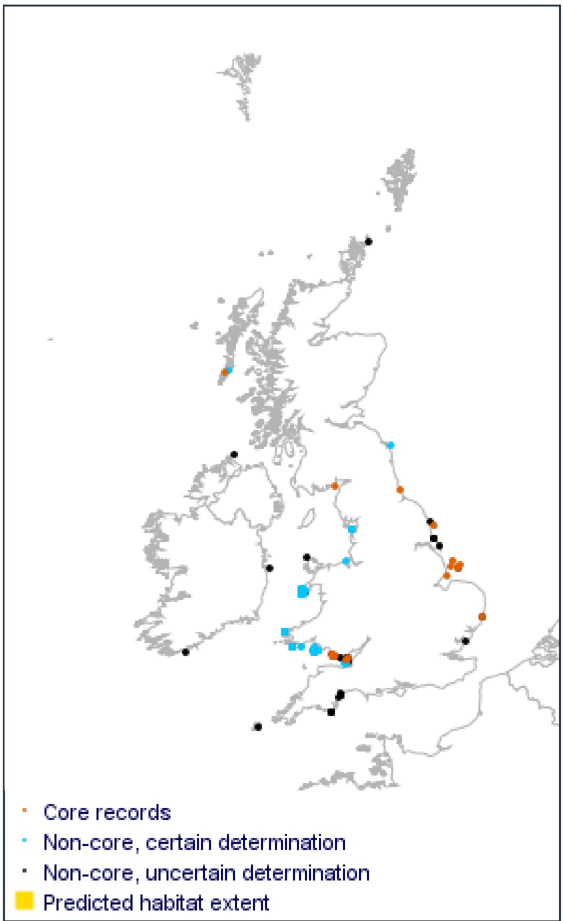

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Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by Matthew Ashley & Charlotte Marshall **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A5.134	*Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand
JNCC 2015	SS.SCS.ICS.HeloMsim	*Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand
JNCC 2004	SS.SCS.ICS.HeloMsim	*Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand
1997 Biotope		

Description

On infralittoral sandbanks and sandwaves and other areas of mobile medium-coarse sand, populations of interstitial polychaetes may be found. These habitats consist of loosely packed grains of sand forming waves up to several metres high often with gravel, or occasionally silt, in the troughs of the waves. This biotope is commonly found both inshore along the east coast of the UK e.g. around the Race Bank, Docking Shoal and Inner Dowsing banks (IECS, 1995; IECS, 1999), and in the Southern Bight of the North Sea and off the Belgian coast (Degraer *et al.* 1999; Vanosmael *et al.* 1982). These habitats support interstitial communities living in the spaces between the grains of sand, in particular hesionurid polychaetes such as *Hesionura elongata* and *Microphthalmus similis*, along with protodrilid polychaetes such as *Protodrilus spp.* and *Protodriloides spp.* Other important species may include *Turbellaria spp.* and larger deposit feeding polychaetes such as *Travisia forbesii*. An important feature of this biotope which is not reflected in much of the available data is the importance of the meiofaunal population which may exceed the macrofaunal population both in terms of abundance and biomass (Willems et al. 1982). (JNCC 2015)

Depth range

5-10 m, 10-20 m

Additional information

-

Listed By

- none -

Further information sources

Search on:

G G G JNCC

Habitat review

Ecology

Ecological and functional relationships

- High energy sand areas such as those associated with SS.SCS.ICS.HeloMsim are characterized by a low diversity, lack of sedentary forms (especially bivalve molluscs) and the numerical dominance of agile swimmers that are able to withstand continual sediment disturbance (Elliot *et al*., 1998). *Nephtys cirrosa*, for example, has been found to be strongly associated with unstable sediments (Allen & Moore, 1987, cited in Elliott *et al*., 1998) and *Hesionura*, *Microphthalmus* and *Nephtys* are all rapid burrowers able to withstand extreme physical disturbance (Vanosmael *et al*., 1982). The communities that result are shaped by physical as opposed to biological influences.
- The fauna associated with SS.SCS.ICS.HeloMsim are most likely animals which feed on diatoms and bacteria that are attached to the sand grains. Areas characterized by mobile sand are not able to support large populations of deposit feeders due to the fact that the sand will be relatively clean of silt and organic matter. Nor are the areas suitable for large populations of suspension feeders given that the large load of suspended material may clog their feeding apparatus. Nevertheless the density of individuals and species richness is often high in the coarse sand due to the large numbers of interstitial polychaetes (Vanosmael, 1982). The interstitial polychaete *Hesionura elongata* was found in densities of up to 960 / 0.2 m^2 in the Outer Bristol Channel (Mackie *et al*., 2006). Interstitial organisms occur in sediments with a median grain size above 200µ and polychaetes tend to be abundant in sands with a particle size above 300µ (Willems *et al*., 1982).
- Despite the often high species richness and density, the mean macrobenthic diversity and species richness of clean mobile sandbanks is generally lower than the surrounding sea bed (reflecting the greater stresses inherent in these environments), although the fauna is essentially comparable with that of the open sea.
- Intertidal and subtidal sandy biotopes comprise an unusual ecosystem in that the customary food chain of plants-herbivores-carnivores is not clearly discernible (Eltringham, 1971), the physical environment being too harsh for vegetation to become established. The absence of macroalgae means that herbivorous macrofauna either feed on the microscopic algae on the sediment surface, on organic material deposited on/in the sediment or on phytoplankton from the overlying seawater.
- The meiofauna are likely to be important consumers of the microphytobenthic productivity.
- Polychaete worms are dominant infaunal predators, they are opportunistic and actively pursue prey, so that their numbers may be closely related to that of their prey which includes other polychaetes and small crustaceans (Meire *et al*., 1994). Bamber (1993) found a significant linear correlation between declining densities of *Scoloplos armiger* and increasing densities of *Nephtys cirrosa* in a psammophilous (sand loving) polychaete community from the Solent Coast, Hampshire. *Nephtys* species are also scavengers.
- Due to the low organic content and productivity, high energy areas have a low carbon to nitrogen ratio (Elliott *et al*., 1998). In addition, microbial activity is low as a result of the limited availability of detritus available and the low surface area to volume ratio for microbes (Elliott *et al*., 1998).

Seasonal and longer term change

-

Habitat structure and complexity

Superficially, the habitat associated with SS.SCS.ICS.HeloMsim may appear homogenous and lacking in structural complexity. However, within the sand a variety of niches are probably available for colonization. For instance, sandbanks may show a gradient from finer sediments to coarser sediments resulting from the prevailing current pattern. The upper sand layers may be characterized by sand waves and ripples occurring on a variety scales, which are continually destroyed and rebuilt by currents. In other instances the distribution of different grades of sandy sediment may be very patchy and at the bottom of depressions finer sediments, more stable deposits, enriched with some mud might be found (Vanosmael *et al*., 1982).

Productivity

-

Recruitment processes

-

Time for community to reach maturity

-

Additional information

-

Preferences & Distribution

Habitat preferences

Depth Range	5-10 m, 10-20 m
Water clarity preferences	
Limiting Nutrients	
Salinity preferences	Full (30-40 psu)
Physiographic preferences	
Biological zone preferences	
Substratum/habitat preferences	
Tidal strength preferences	
Wave exposure preferences	Exposed, Moderately exposed, Sheltered
Other preferences	Medium to very coarse sand.

Additional Information

Found in wave sheltered to wave exposed habitats with weak to strong tidal streams.

Species composition

Species found especially in this biotope

Rare or scarce species associated with this biotope

-

Additional information

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

Hesionura elongata and *Microphthalmus similis* are considered important characterizing species. *Turbellaria spp*. occurs in high abundance and the species has the highest contribution to similarity between samples from the biotope and is reviewed where evidence is available. Protodrilid polychaetes such as *Protodrilus spp*. and *Protodriloides spp* and the deposit feeder *Travisia forbesii* are considered where pressures may impact populations of these species as they are often supported within the mobile medium-coarse sand characterizing the biotope. Loss of the medium-coarse sand, in particular changes to fine sand, silt or increases in gravel content are likely to change the species present and so the biotope.

Resilience and recovery rates of habitat

Coarse sediments drain fast, do not retain organic matter, and provide inhospitable conditions for infauna (Gray 1981; Gray *et al.* 1990; Gray & Elliott, 2009). Mobile infralittoral sandbanks and sandwaves occur in dynamic infralittoral environments where sediment is likely to move in tidal cycles and sediment characteristics may change. The characterizing species exhibit traits that aid colonization of these inhospitable conditons. The species that colonize mobile medium-coarse sand in this biotope, such as *Hesionura elongata*, *Microphthalmus similis*, *Turbellaria spp*. Protodrilid polychaetes such as *Protodrilus spp*. and *Protodriloides spp* are small (under 1cm), reach maturity under 1 year, have lifespans of 1 year or less and have medium to high fecundity. Resilience is likely to be rapid (1-2 years), depending upon larvae transport pathways and sediment characteristics remaining unchanged.

Hesionura elongata, *Microphthalmus similis*, *Turbellaria spp*. Protodrilid polychaetes such as *Protodrilus spp*. and *Protodriloides spp* are interstitial and require medium to coarse grain sizes and are unlikely to occur in finer sand sediments. The major factor driving the presence of interstitial fauna is likely to be sediment type (Nybakken, 2001). Sediment type and faunal abundance and diversity are intrinsically linked (Basford *et al*., 1990; Seiderer & Newell, 1999; Cooper *et al*., 2011), and this is most relevant to interstitial fauna, which require sediments of a certain grain size that is large enough to enable fauna to inhabit the voids between grains (Nybakken 2001, cited in Alexander *et al.* 2014).

Food sources are limited for interstitial fauna characterizing this biotope and availability of food is likely to be an important factor influencing recovery. The characterizing species include active predators and deposit feeding detritivores. Predators, such as *Hesionura elongata*, are known to feed on other interstitial fauna and various infaunal invertebrate species (MES , 2008). *Microphthalmus similis and Protodrilus spp*. are detritivores, feeding on deposits of organic matter, in addition to diatoms and microbes within the sediments (Gray, 1967; Fauchald & Jumars, 1979). Each of these food sources are likely to be affected by key drivers of their own, for example the conditions necessary for primary production, physical drivers and water column chemistry and temperature (Alexander *et al*., 2014).

Recovery from pressures such as extraction or abrasion of the substratum may be impeded as interstitial fauna are thought to have limited larval dispersal, as some species keep their eggs and larvae within the sediments (Nybakken 2001). Interstitial fauna are not typically as fecund as infaunal taxa (Nybakken, 2001). Small body size and limited mobility of the characterizing species also makes them more susceptible to impacts from removal of sediment, smothering or damage from abrasion. The recovery of interstitial fauna was reported to take years after sediment was removed, or the sediment characteristics altered by deposition. For instance, Boyd *et al.* (2003) suggested that recovery from dredging may take over 4 years, despite other literature that suggested recovery in European coastal gravelly areas was relatively rapid (2-3 years). Cooper *et al.* (2007) studied an aggregate extraction site for 8 years following cessation of dredging and found that the recovery of the benthos from low level dredging took seven years and more than this for high-level dredging. Resilience of this biotope can, therefore, be expected to depend on the extent of pressures impacting the sediment characteristics (Gray & Elliott, 2009).

Travisia forbesii is a larger species (2-7cm) with a longer lifespan (1-2 years) but reaches maturity quickly (<1 year) and displays high fecundity that suggests populations may recover quickly as long as adult mortality is not too high. As an egg laying species with limited mobility the species may also not be resistant and have limited resilience to pressures that cause direct abrasion or extraction of sediment.

Resilience is assessed as 'High' unless the pressure results in significant mortality (Low to None resistance) of the species community as a whole, or high levels of mortality to adult populations of *Travisia forbesii*, in which case full recovery would be likely to take 2-10 years. Changes of sediment grain size to finer sand or silt as well as changes to coarser gravel will also affect species communities. In this case prolonged recovery is possible and resilience is 'Low'.

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: Low C: Low

Limited evidence was found on the effect of changes in temperature and resistance is inferred from the species range. As with other marine species, changes in temperature may influence timing of reproduction and, therefore, long-term recruitment.

Hesionura elongata occurs in the Canary Islands and Caribbean, which suggests a resistance of higher water temperatures than around UK and Irish seas (Brito *et al.*, 2005; Miloslavich *et al.*, 2010). Similarly, *Microphthalmus similis* occurs in warmer waters along the west coast of Portugal (Carvalho *et al.*, 2005). *Protodrilus spp.* such as *Protodrilus corderoi*, *Protodrilus ovarium* and *Protodrilus pythonius* also occur in warmer waters and are reported from beaches in southern and south eastern Brazil (Di Domenico *et al.*, 2013).

Turbellaria spp. occur in high abundance with records of up to 115 000 per m² recorded (Murina, 1981). Although *Turbellaria spp.* occur globally there is limited evidence available on the range of species that occur in UK and Irish seas. There is limited evidence on the temperature range occupied by these species. This limits interpretation of resistance to increases in temperature. *Turbellaria spp.* display life history strategies of larger meiofauna, with planktonic development, dispersal in larval stages and continuous growth. Generation times are of no more than one year and the species feed indiscriminately on particles, these traits suggest faster recolonization and adaptability to conditions, aiding resilience and recovery times (Warwick, 1984, Martens & Schockaert, 1986).

Sensitivity assessment. This assessment relies on limited evidence and utilises global species distribution records and so confidence is low. As all characterizing species occur in water temperatures greater than they are likely to experience in the UK. Resistance and Resilience are assessed as '**High**' and Sensitivity as '**Not Sensitive'**. There is low confidence associated with this assessment as limited evidence was available.

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

Limited evidence was returned on the effect of changes in temperature and resistance is inferred from the species range. *Hesionura elongata* has been identified in samples from water ranging from 7.3-24°C (OBIS, 2016).

Microphthalmus similis is recorded in locations with water temperatures ranging from 6.05 to 11.62°C (OBIS, 2016). *Protodrilus spp.* also show a similar lower temperature preference of 7.34 °C from distribution maps of species records (OBIS, 2016).

Turbellaria spp. occur throughout colder regions than UK and Irish seas, including circumpolar seas, which suggests the species is likely to be resistant to lower temperatures (Ax & Armonies, 1990; Ax, 1993).

Sensitivity assessment. Limited evidence was available and this assessment is based on non-peer reviewed literature on species range. A 5°C decrease in temperature for one month period is likely to impact the characterizing species in winter months and therefore Resistance is '**Medium'**, Resilience is '**High'** and Sensitivity is '**Low**'.

Salinity increase (local)	None Q: Low A: NR C: NR	Medium Q: High A: Low C: Medium	Medium Q: Low A: Low C: Low

The biotope occurs in 'full' salinity conditions. An increase in one MNCR salinity category to hypersaline conditions is likely to cause mortality of characterizing species. Resistance is **'None**', Resilience is '**Medium**' and Sensitivity is '**Medium**'. There is limited evidence associated with this assessment and confidence is therefore low.

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

A decrease from full/variable to reduced (18-30‰) is considered in this assessment.

Degraer *et al*. (2006) report that *Hesionura elongate* was found in greatest abundance outside the near coastal zone (in samples from across the Belgium part of the North Sea). This suggests that the species is likely to occur in greater abundance in habitats with full salinity compared to variable salinity or reduced. Moulaert *et al*. (2008) also found that species communities in which *Hesionura elongate* was an indicator species were only present >16 km from the coast and displayed a positive correlation with increasing salinity.

Microphthalmus similis were a dominant species in the Weser estuary, suggesting resistance to the benchmark pressure although the species was most abundant in polyhaline conditions (18-30‰) but not in lower salinities (Witt, 2004). Limited evidence was found on *Protodrilus spp.*

Procerodes littoralis, a common triclad turbellarian that occurs along the Atlantic coast of Europe, has been shown to be exceptionally tolerant of short-term salinity changes ranging from completely freshwater to undiluted seawater (McAllen *et al.* 2002).

Travisia forbesii is restricted to a narrow range of clean medium sands (d50: 250 - 500 µm) under fully marine conditions. In reduced salinity waters (5-19‰), the species was found also in clean fine sands with a lower limit of about 100 µm. No occurrence was reported from coarse sediments in low salinity waters (Zettler *et al.*, 2013).

Sensitivity assessment. Resistance is assessed as **'Medium**' as *Hesionura elongate* may decrease in abundance, although confidence is limited in this assessment and all other species would have higher resistance. Resilience is assessed as '**High**' and sensitivity is assessed as **'Low**'.

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

The biotope occurs most often in weak or strong tidal streams (JNCC comparative tables) suggesting the species characterizing the biotope can adapt to a range of tidal currents, aided by each species traits, burrowing or living interstitially.

The hydrographic regime is an important structuring factor in sedimentary habitats. The most damaging effect of a change in flow rate could be the erosion of the substratum (an increase in flow rate), or deposition of fine grain sized sediment (decrease in flow rate) as this could eventually lead to loss of the habitat. Increased peak flow may cause an increase in sediment movement and this is to be prohibitive to substantial interstitial fauna colonisation due to sediment movement and the potential for the gaps in the sediment to be disturbed (Nybakken, 2001; Alexander, 2013).

The species community appears to have low resistance to changes to finer sediment grain sizes. The characterizing species *Hesionura elongata* and *Microphthalmus similis* are found in greater abundance in sediments with larger grain sizes, and decreasing abundance in fine sediments. Moulaert & Hostens (2007) found that higher gravel content and sediment grain size was a dictating environmental factor for communities in which *Hesionura elongate* was an indicator species for. Resilience is likely to be high for *Hesionura elongate* as the species showed the highest increase following cessation of sediment extraction in the Belgium part of the North Sea (Moulaert & Hostens, 2007). *Microphthalmus similis* was the principal characterizing species in medium and coarse grain sediments on Belgium coastal sandbanks, but was not present in other regional species communities that inhabited sediments with very low % coarse grain size (<10%) (Degraer *et al.*, 1999).

The deposition of fine sediment re-suspended by scour processes may alter this biotope and should be considered. Longer term deposition of fine material (e.g. continuous deposition) would be expected to lead to a decrease in abundance of the characterizing species and higher densities of other macrobenthic organisms. For example, in the North Sea (Belgium) deposition of fine particle sediment, disturbed by scour around the base of a wind farm tower led to higher macrobenthic densities and created a shift in macrobenthic communities around the wind farm tower (influenced by the direction fine material had settled) (Coates *et al.*, 2014).

Sensitivity assessment. The biotope occurs most often in weak or moderately strong tidal currents suggesting the characterizing species are resistant to changes in spring bed flow velocity. The effects on sediment transport characteristics at a site or case specific level are important. A decrease in flow velocity may increase deposition of fine material which may lead to a decrease in occurrence of characterizing species. As the biotope occurs across weak to strong categories Resistance is assessed as '**High'** as species abundance may decrease but if gravel content is still high characterizing species will still occur. Resilience is assessed as '**High**' and Sensitivity is assessed as **'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

This biotope does not occur in the intertidal, and consequently an increase in emergence is considered not relevant to this biotope.

Wave exposure changes (local)	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

The biotope occurs on sandbanks permanently covered by seawater (5-10 m depth and 10-20 m depth) and species communities are unlikely to be affected by wave action directly. However, increased wave action results in increased water flow in the shallow subtidal. Wave mediated water flow tends to be oscillatory, i.e. move back and forth (Hiscock, 1983), and may result in suspension of fine sediments and deposition in the direction of dominant water currents. In areas where fine sediment is deposited impacts will be similar to those under the section below on 'smothering and siltation changes' (light deposition).

The species community appears to have low resistance to changes to finer sediment grain sizes. The characterizing species *Hesionura elongata* and *Microphthalmus similis* are found in greater abundance in sediments with larger grain sizes, and decreasing abundance in fine sediments. Moulaert & Hostens (2007) found that higher gravel content and sediment grain size was a dictating environmental factor for communities in which *Hesionura elongate* was an indicator species for. Resilience is likely to be high for *Hesionura elongate* as the species showed the highest increase following cessation of sediment extraction in the Belgium part of the North Sea (Moulaert & Hostens, 2007). *Microphthalmus similis* was the principal characterizing species in medium and coarse grain sediments on Belgium coastal sandbanks, but was not present in other regional species communities that inhabited sediments with very low % coarse grain size (<10%) (Degraer *et al*., 1999).

Protodrilus spp. have been reported to thrive in the swash zone of reflective beaches, where turbulence is far greater than would be experienced under the pressure at baseline levels (Di Domenico *et al.* 2009; McLachlan 1985, 1990). The presence of adhesive glands as well as special epidermal glandular or skeletal structures provides these species with adaptations to such extremely turbulent environments (Bush, 1968; Delamare & Deboutteville, 1960; Boaden, 1995; Giere, 2009; Jouin, 1970).

Sensitivity assessment. The abundance of characterizing species is likely to be unaffected or increase in areas where fine sediment is removed and coarse sediment is present. However, abundance is likely to decrease in areas where fine sediment is deposited. Under pressure benchmark levels which consider <5% change, Resistance is '**High**' and Resilience '**High**'. Sensitivity is assessed 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. Although contamination at levels greater than the pressure benchmark may adversely affect the biotope.

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. The following review discusses impacts at higher concentrations than the pressure benchmark.

Suchanek (1993) reviewed the effects of oil spills on marine invertebrates and concluded that, in general, on soft sediment habitats, infaunal polychaetes, bivalves and amphipods were particularly affected. The 1969 West Falmouth Spill of Grade 2 diesel fuel, documented by Sanders (1978), illustrates the effects of hydrocarbons in a sheltered habitat with a soft mud/sand substrata (Suchanek, 1993). The entire benthic fauna was eradicated immediately following the spill and remobilization of oil that continued for a period >1 year after the spill contributed to much greater impact upon the habitat than that caused by the initial spill. Effects are likely to be prolonged as hydrocarbons incorporated within the sediment by bioturbation will remain for a long time, owing to slow degradation under anoxic conditions. Oil covering the surface and within the sediment would prevent oxygen transport to the infauna and promote anoxia as the infauna utilise oxygen during respiration. Although this study investigates impacts on an estuarine biotope the impact on benthic infauna communities is likely to be similar in shallow sandbank biotopes.

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 following review discusses impacts at higher concentrations than the pressure benchmark.

Limited evidence was available on the response of characterizing species to synthetic compound contamination. For instance, the Turbellaria species *Giardia tigrina* displayed 100% mortality when exposed to 50 ppm concentrations of diazepam and ivermectin, 60% mortality at concentrations of 25 ppm, and 20% mortality after 24 hours exposure to 1 ppm (Alves & De Melo, 2013).

Radionuclide contamination	No evidence (NEv) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

Limited evidence is available on other infauna species. Beasley & Fowler (1976) and Germain *et al.*, (1984) examined the accumulation and transfers of radionuclides in *Hediste diversicolor* from sediments contaminated with americium and plutonium derived from nuclear weapons testing and the release of liquid effluent from a nuclear processing plant. Both concluded that the uptake of radionuclides by *Hediste diversicolor* was small. Beasley & Fowler (1976) found that *Hediste diversicolor* accumulated only 0.05% of the concentration of radionuclides found in the sediment. Both also considered that the predominant contamination pathway for *Hediste diversicolor* was from the interstitial water.

Sensitivity assessment: There is insufficient information available on the biological effects of radionuclides to comment further upon the intolerance of characterizing species to radionuclide contamination. Assessment is given as 'No Evidence'.

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.**

Some, all be it limited evidence was retuned by searches on activated carbon (AC). AC is utilised in some instances to effectively remove organic substances from aquatic and sediment matrices. Lillicrap *et al.* (2015) demonstrate that AC may have physical effects on benthic dwelling organisms at environmentally relevant concentrations at remediated sites.

De-oxygenation	Medium Q: Low A: NR C: NR	High Q: High A: Low C: Medium	Low Q: Low A: Low C: Low

Limited evidence was returned on effects of decreased dissolved oxygen concentrations on the characterizing species.

All meiofauna have some sensitivity to extended hypoxia, although more mobile nematode species are able to emigrate into the water column in high numbers where they survive (Wetzel *et al.*, 2013). Emigration is likely to increase predation risk. Although evidence on characterizing species is lacking, densities of meiofauna populations are likely to be lower under prolonged anoxia (Moodley *et al.*, 1997).

A turbellarian, *Macrostomum lignano* was found to be a species that is tolerant of a wide range of oxygen concentrations (being able to maintain aerobic metabolism from extremely low P-O2 up to hyperoxic conditions), and is thought to be resistant to the drastic environmental oxygen variations that occur within intertidal sediments (Rivera-Ingraham *et al.*, 2013).

As the biotope occurs in high energy areas strong water flow occurs and deoxygenation is likely to be short lived.

Sensitivity assessment. Due to the limited evidence confidence in this assessment is low. A reduction in meiofauna populations is likely if deoxygentaion persisted for long periods, but this is unlikely due to high water flow. As some species are likely to emigrate or maintain aerobic metabolism under low dissolved oxygen conditions, Resistance is assessed as '**Medium**', Resilience is '**High**' and 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

Meiofauna respond to nutrient enrichment. The distribution of different meiofauna assemblages has been identified as a good tool for detecting short-term responses of the benthic domain to nutrient enrichment from sources such as river discharge (Semprucci *et al.*, 2015). In the Bay of Cadiz, Spain, abundance of meiofauna was seven times higher in the presence of macroalgae

(Bohorquez *et al*., 2013).

Limited evidence is available on response of characterizing species of this biotope, although Semprucci et al. (2015) identified that platyhelminthes (*Turbellaria spp*.) responded positively to nutrient enrichment.

Sensitivity assessment. As the benchmark levels comply with WFD criteria for good status, Resistance is '**High**', Resilience is '**High**' and the biotope is '**Not sensitive**' at the benchmark level, which assumes compliance with environmental standards. Confidence is limited as evidence was only available for higher taxonomic levels and study sites within warmer, coastal European locations than UK and Irish seas.

	Resistance	Resilience	Sensitivity
Organic enrichment	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

Limited evidence was returned on individual characterizing species. *Microphthalmus similis* occurred in the area of a coastal lagoon characterized by sandy sediment and low organic content (Carvalho *et al*., 2005). However, case studies for other individual species were lacking. At higher taxonomic levels meiofauna have been utilised in studies investigating their role as indicators of organic enrichment. Bianchelli *et al*. (2016) identified that meiofauna diversity increased when sediment organic contents increased.

Bianchelli *et al.* (2016) identified that meiofauna can be used as a descriptor of environmental quality, indicating conditions from sufficient to moderately impacted, in relation to organic enrichment. In the investigated sediments, characterized by oligo- and mesotrophic conditions, increasing richness of meiofaunal taxa was linked to the increase in sediment organic contents and the protein to carbohydrate content ratio (Bianchelli *et al*., 2016). Further evidence on other conditions such as mesotrophic to eutrophic was not available.

Sensitivity assessment. Evidence was limited on individual species responses and confidence in the assessment is low. Although studies identified that meiofauna diversity increased at hogher taxonomic levels this may not include characterizing species . Resistance is assessed as '**High**', Resilience as '**High**' and Sensitivity as '**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.

	Resistance	Resilience	Sensitivity
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

This biotope is only found in infralittoral sandbanks and sandwaves and other areas of mobile medium-coarse sand, and characterizing species burrow or live interstitially within the sediment and would not be able to survive if the substratum type was changed to either a soft rock or hard artificial type. Consequently, the biotope would be lost altogether if such a change occurred.

Sensitivity assessment. The Resistance to this change is '**None**', and the Resilience is assessed as '**Very low**', due to the long-term nature of a change in substratum. The biotope is assessed to have a '**High**' Sensitivity to this pressure at the benchmark.

Physical change (to another sediment type)	Low Q: High A: Medium C: Medium	Very Low Q: High A: High C: High	High Q: High A: Medium C: Medium

The biotope contains; medium coarse sand, loosely packed, forming waves up to several metres high often with gravel, or occasionally silt, in the troughs of the waves. The most relevant folk class is 'medium fine coarse sand'.

Increase in gravel content within the Folk classes is unlikely to negatively impact the characterizing species. Increase in finer sand or silt is likely to reduce abundance of the characterizing species as *Hesionura elongata* and *Microphthalmus similis* are found in greater abundance in sediments with larger grain sizes, and decreasing abundance in fine sediments. Moulaert & Hostens (2007) found that higher gravel content and sediment grain size was a dictating environmental factor for communities which *Hesionura elongate* was an indicator species for. Resilience is likely to be high for *Hesionura elongate* as the species showed the highest increase following cessation of sediment extraction in the Belgium part of the North Sea (Moulaert & Hostens, 2007). *Microphthalmus similis* was the principal characterizing species in medium and coarse grain sediments on Belgium coastal sandbanks, but was not present in other regional species communities that inhabited sediments with very low % coarse grain size (<10%) (Degraer *et al.*, 1999).

Sensitivity assessment. A decrease in gravel content and change to 'sand' or 'muddy sand' is considered in this assessment as the biotope and characterizing species are unlikely to be impacted by an increase in coarse sediment. As silt is occasionally encountered in the troughs of the sand waves and coarser sediment is most likely to be found on the ridges of sand waves, the biotope contains a range of sediment classes. However, characterizing species show preference for coarse sediment and are likely to reduce in abundance in finer sediment. Resistance is assessed as '**Low**', Resilience is assessed as '**Very low** '(the pressure is a permanent change) 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

The substratum of this biotope consists of infralittoral sandbanks and sandwaves and other areas of mobile medium-coarse sand (Conner *et al.*, 2004). The characterizing species burrow into the sediment, tunnel to depths not exceeding 30 cm or live in the interstices between the grains of sediment. The process of extraction is considered to remove all biological components of the biotope group. If extraction occurred across the entire biotope, loss of the biotope would occur. Recovery would require substratum to return to mobile medium-coarse sand.

Sensitivity assessment. Resistance to the pressure is considered **'None'**, and resilience '**Medium**'. Sensitivity has been assessed as '**Medium**'. Although no specific evidence is described, confidence in this assessment is high, due to the incontrovertible nature of this pressure.

Abrasion/disturbance of the surface of the substratum or seabed	Medium Q: High A: Medium C: Medium	High Q: High A: Medium C: Medium	Low Q: High A: Medium C: Medium

The spatial scale and duration are important to consider in utilizing this assessment. For instance, spatially the whole biotope or just a smaller area may be affected. Also different sediment types and associated species communities will occur in the surface layers, at the site of aggregate extraction or scouring (where coarser sediment grain sizes prevail) and areas where finer sediment is deposited within the prevailing currents. The species characterizing this biotope are likely to colonize areas where extraction or scour has occurred and not the areas of deposition. For instance, Vanaverbeke *et al.* (2007) found *Hesionura elongata*, *Polygordius appendiculatus* and *Microphthalmus spp.* represented a more important proportion of the density in very intensively extracted dredging sites in the Belgium North Sea. Resilience is likely to be high for *Hesionura elongate* as the species showed the highest increase following cessation of sediment extraction in the Belgium part of the North Sea (Moulaert & Hostens, 2007).

Collie *et al.* (2000) suggest that bottom towed fishing gears are likely to cause a shift from communities dominated by relatively high biomass species towards dominance by high abundances of small-sized organisms, such as the characterizing species in this biotope; *Hesionura elongata* and *Microphthalmus similis*. This suggests that, even though initial resistance to physical damage from contact with fishing gears is likely to be 'Low', resilience is 'High' given the physical traits of the species and species life history.

Boat moorings were demonstrated to impact species communities close to the mooring buoy in a case study in the Fal and Helford estuaries (south west UK). Coarser sediment was exposed close to mooring buoys, caused by suspension of fine sediments by movement of the chain (Latham *et al.*, 2012). Abrasion from anchors and anchor chains may have similar impacts on this biotope. However, the highly mobile nature of sediments in the biotope are likely to result in the sediment providing high resistance to such abrasion over small spatial scales and the biotope will only be impacted if a high density of vessels are at anchor.

Turbellarian abundance is likely to be decreased by deposition of fine material as the species live relatively shallowly in the sediment. Being mobile, individuals may be able to relocate to preferred depths. In the long-term, however, populations are likely to show a preference for sites with lower deposition of material. In the Fladen Ground area. Faubel *et al.* (1983) only found turbellarians below 4 cm occasionally. Huys *et al.* (1984) found 5 – 10 ind/10cm^2 in 19 stations of a shallow subtidal dumping site but on average Turbellarians accounted for only 3.6% of the total meiofauna in the samples.

Sensitivity assessment. Different sediment types and associated species communities will occur in association with aggregate extraction, scouring around renewable energy device bases and anchoring sites. Where coarser sediment is exposed abundance of characterizing species will display limited impact. Where deposition of fine sediment occurs, typically further away from an obstruction such as a wind farm tower, or from deposition of aggregate or drilling waste will be likely to lead to reduction in abundance of characterizing species. Resistance to damage to seabed surface features is assessed as '**Medium**'. The species community displays high recoverability and

Resilience is '**High**' and Sensitivity is assessed as '**Low.**'

Penetration or disturbance of the substratum subsurface	Low Q: High A: High C: High	Medium Q: High A: High C: High	Medium Q: High A: High C: High

Penetration and or disturbance of the substratum would result in similar effects as 'abrasion' or 'extraction' of this biotope (see evidence in those sections). As the characterizing species are burrowing species the impact from damage to the sub-surface sea bed would be greater than damage to the sea bed surface. Resistance has been assessed as '**Low'** and resilience as **Medium**, sensitivity is **Medium.**

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

This biotope is probably exposed to water flow rates that will re-suspend sediements when it occurs in areas with moderately strong tidal streams. Therefore, the resident species are probably adapted to high suspended sediment levels.

The characterizing species live infaunally. *Microphthalmus similis* and *Travisia forbesii* along with protodrilid polychaetes such as *Protodrilus spp*. and *Protodriloides spp*. are deposit feeders, 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 characterizing species. 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. This would be likely to impair growth and reproduction.

Sensitivity assessment. Changes in light penetration or attenuation associated with this pressure are not relevant to the characterizing species. As the species live in the sediment they are also likely to be adapted to increased suspended sediment (and turbidity). However, alterations in the availability of food or the energetic costs in obtaining food or changes in scour could either increase or decrease habitat suitability for these characterizing species.

The following sensitivity assessment relies on expert judgement, utilizing evidence of species traits and distribution and therefore confidence has been assessed as low. Resistance is '**High**' as no significant negative effects are identified and potential benefits from increased food resources may occur. Resilience is also '**High**' as no recovery is required under the likely impacts. Sensitivity of the biotope is therefore assessed as '**Not Sensitive'.**

Smothering and siltation rate changes (light)	Medium Q: Low A: NR C: NR	High Q: High A: Low C: Medium	Low Q: Low A: Low C: Low

Evidence is assessed for deposits of fine material from sources such as dredge waste spoil, re-suspended sediment from scouring around wind farm tower bases and recovery from aggregate dredging.

The biotope consists of mobile medium-coarse sand and the characterizing species typically occur in coarser grain size sediments, and are not found in finer grain size habitats. Moulaert & Hostens (2007) found that higher gravel content and sediment grain size was a dictating environmental factor for communities in which *Hesionura elongate* was an indicator species for. Resilience is likely to be high for *Hesionura elongate* as the species showed the highest increase following cessation of sediment extraction in the Belgium part of the North Sea (Moulaert & Hostens, 2007).

Turbellarian abundance is likely to be decreased by heavy deposition of fine material as the species live relatively shallowly in the sediment. Being mobile, individuals may be able to relocate to preferred depths. In the long-term, however, populations are likely to show a preference for sites with lower deposition of material. In the Fladen Ground area Faubel *et al.* (1983) only occasionally found turbellarians below 4 cm. Heap 1990 and Huys *et al.* (1984) found 5 – 10 ind/10cm in 19 stations of a shallow subtidal dumping site but on the average turbellarians accounted for only 3.6% of the total meiofauna in the samples.

Species of Protodrilus occur in a greater range of sediment sizes but are restricted to the interstitial environment of marine sediments, spanning from sand to gravel (Von Nordheim 1989), suggesting the finest sediment grain sizes are likely to provide unsuitable habitats.

The species community appears to have low resistance to changes to finer sediment grain sizes. The deposition of fine sediment re-suspended by scour processes as a result of presence of wind farm towers and other renewable energy device bases may alter this biotope and should be considered. Longer term deposition of fine material (e.g. continuous deposition) would be expected to lead to decrease in abundance of the characterizing species and higher densities of other macrobenthic organisms. For example, in the North Sea (Belgium) deposition of fine particle sediment, disturbed by scour around the base of a wind farm tower led to higher macrobenthic densities and created a shift in macrobenthic communities around the wind farm tower (influenced by the direction fine material had settled) (Coates *et al.*, 2014).

The species characterizing this biotope are likely to colonize areas where extraction or scour has occurred and not the areas of deposition. For instance, Vanaverbeke *et al.* (2007) found *Hesionura elongata*, *Polygordius appendiculatus* and *Microphthalmus spp.* represented a more important proportion of the density in very intensively extracted dredging sites in the Belgium North Sea.

Sensitivity assessment. Where deposition of fine sediment occurs, typically further away from an obstruction such as a wind farm tower, or from deposition of aggregate or drilling waste will be likely to lead to reduction in abundance of characterizing species. Resistance to deposition of fine sediment is assessed as **'Medium**'. The species community displays high recoverability due to inhabiting mobile sediments and resilience is **'High**'. Sensitivity is assessed as '**Low**.'

Smothering and siltation rate changes (heavy)	Low Q: Low A: NR C: NR	Medium Q: High A: Low C: Medium	Medium Q: Low A: Low C: Low

Limited evidence was found on responses of characterizing species to a deposition of up to 30cm of fine material. Evidence is assessed for deposits of fine material from sources such as dredge waste spoil and recovery from aggregate dredging.

The biotope consists of mobile medium-coarse sand and the characterizing species typically occur in coarser grain size sediments, and are not found in finer grain size habitats. Moulaert & Hostens (2007) found that higher gravel content and sediment grain size was a dictating environmental factor for communities in which *Hesionura elongate* was an indicator species for. Resilience is likely to be high for *Hesionura elongate* as the species showed the highest increase following cessation of sediment extraction in the Belgium part of the North Sea (Moulaert & Hostens, 2007).

Turbellarian abundance is likely to be decreased by heavy deposition of fine material as the species live relatively shallowly in the sediment. Being mobile, individuals may be able to relocate to preferred depths. In the long-term, however, populations are likely to show a preference for sites with lower deposition of material. In the Fladen Ground area, Faubel *et al.* (1983) only occasionally found turbellarians below 4 cm. Heap (1990) and Huys *et al.* (1984) found 5 – 10 ind/10cm in 19 stations of a shallow subtidal dumping site but on the average turbellarians accounted for only 3.6% of the total meiofauna in the samples.

Species of *Protodrilus* occur in a greater range of sediment sizes but are restricted to the interstitial environment of marine sediments, spanning from sand to gravel (Von Nordheim, 1989), suggesting the finest sediment grain sizes are likely to provide unsuitable habitats.

The species community appears to have low resistance to changes to finer sediment grain sizes. The deposition of fine sediment re-suspended by scour processes as a result of presence of wind farm towers and other renewable energy device bases may alter this biotope and should be considered. Longer term deposition of fine material (e.g. continuous deposition) would be expected to lead to decrease in abundance of the characterizing species and higher densities of other macrobenthic organisms. For example, in the North Sea (Belgium) deposition of fine particle sediment, disturbed by scour around the base of a wind farm tower led to higher macrobenthic densities and created a shift in macrobenthic communities around the wind farm tower (influenced by the direction fine material had settled) (Coates *et al*., 2014).

Sensitivity assessment. Deposition of fine sediment, typically occurring further away from an obstruction such as a wind farm tower, or deposition of aggregate or drilling waste will be likely to lead to a change in the species community. The species community will return to that charcaterizing mobile medium-coarse sand if physical processes such as sediment transport provide a return to that habitat. Resistance is assessed as '**Low**', Resilience to a single discrete event (given conditions are likely to return to coarser material over time) is '**Medium**' and Sensitivity is '**Medium**.'

The spatial scale and duration are important to consider in utilizing this assessment. For instance, spatially the whole biotope or just a smaller area may be affected. Also different sediment types and associated species communities will occur at the site of aggregate extraction or scouring (where coarser sediment grain sizes prevail) and areas where finer sediment is deposited within the prevailing currents. The species characterizing this biotope are likely to colonize areas where extraction or scour has occurred and not the areas of deposition. For instance, Vanaverbeke *et al.* (2007) found *Hesionura elongata*, *Polygordius appendiculatus* and *Microphthalmus spp.* represented a more important proportion of the density in very intensively extracted dredging sites in the Belgium North Sea.

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

No evidence was returned on the impact of litter on characterizing species for this biotope, although studies show impacts from ingestion of micro plastics by sub surface deposit feeding worms (*Arenicola marina*) and toxicants present in cigarette butts have been shown to impact the burrowing times and cause DNA damage in ragworms *Hediste diversicolor*.

Litter, in the form of cigarette butts has been shown to have an impact on Ragworms. *Hediste diversicolor* showed increased burrowing times, 30% weight loss and a >2 fold increase in DNA damage when exposed to water with toxicants (present in cigarette butts) in quantities 60 fold lower than reported from urban run-off (Wright *et al.*, 2015). Studies are limited on impacts of litter on infauna and this UK study suggests health of infauna populations are negatively impacted by this pressure.

Studies of sediment dwelling, sub surface deposit feeding worms, a trait shared by species abundant in this biotope, showed negative impacts from ingestion of micro plastics. For instance, *Arenicola marina* ingests micro plastics that are present within the sediment it feeds within. Wright *et al.* (2013) carried out a lab study that displayed presence of micro plastics (5% UPVC) significantly reduced feeding activity when compared to concentrations of 1% UPVC and controls. As a result, *Arenicola marina* showed significantly decreased energy reserves (by 50%), took longer to digest food, and decreased bioturbation levels. These effects would be likely to impact colonisation of sediment by other species, reducing diversity in the biotopes the species occurs within. Wright *et al.* (2013) also present a case study based on their results, that in the intertidal regions of the Wadden Sea, where *Arenicola marina* is an important ecosystem engineer, *Arenicola marina* could ingest 33m□; of micro plastics a year.

Sensitivity assessment. '**Not assessed**' as there is no defined benchmark for this pressure, however, both microplastics and the toxicants present in cigarette butts are likely to have negative impacts on the characterizing species.

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 was found on effects of electric and magnetic fields on the characterizing species.

Electric and magnetic fields generated by sources such as marine renewable energy device/array cables may alter behaviour of predators and affect infauna populations. Evidence is limited and occurs for electric and magnetic fields below the benchmark levels, confidence in evidence of these effects is very low.

Field measurements of electric fields at North Hoyle wind farm, North Wales recorded 110µ V/m (Gill *et al.*, 2009). Modelled results of magnetic fields from typical subsea electrical cables, such as those used in the renewable energy industry produced magnetic fields of between 7.85 and 20 µT (Gill *et al.*, 2009; Normandeau *et al.*, 2012). Electric and magnetic fields smaller than those recorded by in field measurements or modelled results were shown to create increased movement in thornback ray *Raja clavata* and attraction to the source in catshark *Scyliorhinus canicular* (Gill *et al*., 2009).

Flatfish species which are predators of many polychaete species including dab *Limanda limanda* and sole *Solea solea* have been shown to decrease in abundance in a wind farm array or remain at distance from wind farm towers (Vandendriessche *et al.*, 2015; Winter *et al*., 2010). However, larger plaice increased in abundance (Vandendriessche *et al.*, 2015). There have been no direct causal links identified to explain these results.

Sensitivity assessment. '**No evidence'** was available to complete a sensitivity assessment, however, responses by flatfish and elasmobranchs suggest changes in predator behaviour are possible. There is currently no evidence but effects may occur on predator prey dynamics as further marine renewable energy devices are deployed, these are likely to be over small spatial scales and not impact the biotope.

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

Species within the biotope can probably detect vibrations caused by noise and in response may retreat in to the sediment for protection. However, at the benchmark level the community is unlikely to be sensitive to noise and this pressure is '**Not relevant'.**

Introduction of light or shading	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

All characterizing species live in the sediment and do not rely on light levels directly to feed or find prey so limited direct impact is expected. Most species will respond to the shading caused by the approach of a predator, however, their visual acuity is probably very low. Even then, additional disturbance, such as an electronic flash, caused the retraction of palps and cirri and cessation of all activity for some minutes. Visual disturbance, in the form of direct illumination during the species' active period at night, may therefore result in loss of feeding opportunities, which may compromise growth and reproduction.

As this biotope is not characterized by the presence of primary producers it is not considered that shading would alter the character of the habitat directly. More general changes to the productivity of the biotope may, however, occur. Beneath shading structures there may be changes in microphytobenthos abundance, which would affect food resources (Tait & Dipper, 1998).

Shading will prevent photosynthesis leading to death or migration of sediment microalgae altering sediment cohesion and food supply to higher trophic levels. The impact of these indirect effects is difficult to quantify.

Sensitivity assessment. Based on the direct impact, biotope Resistance is assessed as '**High**' and Resilience is assessed as '**High'** (by default). The biotope Sensitivity is considered to be '**Not sensitive**'.

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

Barriers that reduce the degree of tidal excursion may alter larval supply to suitable habitats from source populations. Barriers may also act as stepping stones for larval supply over greater distances (Adams *et al*., 2014). Conversely, the presence of barriers at brackish waters may enhance local population supply by preventing the loss of larvae from enclosed habitats to environments, which are unfavourable, reducing settlement outside of the population. If a barrier (such as a tidal barrier) incorporated renewable energy devices such as tidal energy turbines, these devices may affect hydrodynamics and therefore migration pathways for larvae into and out of the biotope (Adams *et al*., 2014). Evidence on this pressure is limited.

Sensitivity assessment. Resistance to this pressure is assessed as '**High**' and resilience as '**High**' by default. This biotope is therefore considered to be '**Not sensitive'**.

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 interaction with bottom towed fishing gears and moorings are 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

Characterizing species may have some, limited, visual perception. As they live in the sediment the species will most probably not be impacted at the pressure benchmark and this pressure is **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

Not relevant. Key, characterizing species are not cultiviated or translocated.

Introduction or spread of invasive non-indigenous species	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

There is limited evidence of the impact of the introduction of one or more invasive non-indigenous species on this biotope or the characterizing species. There are limited studies on meiofauna at a higher taxonomic level which suggests total meiofauna numbers have increased in the presence of the invasive polychaete, *Marenzelleria spp.*, as the burrowing of the polychaete extended the vertical distribution of meiofauna in a lagoon in the southern Baltic Sea (Urban-Malinga *et al.*, 2013). In addition, *Marenzelleria spp*. had a positive impact on the survival of turbellarians (Urban-Malinga *et al.*, 2013).

Globally, examples from tropical ecosystems show similar effects of an invasive species on meiofauna abundance, with meiofauna abundance being significantly greater in an area colonized by invasive seaweed *Spartina alterniflora* in comparison with neighbouring vegetation and non-vegetated sand flats (Lin *et al.*, 2015).

Sensitivity assessment. Overall there is a lack of evidence to provide an assessment with any confidence and **'No evidence'** is recorded.

Introduction of microbial pathogens	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

Limited evidence was returned on individual characterizing or abundant species and the effect of introduction of pathogens or disease vectors.

At higher taxonomic levels meiofauna and in particular bacteria feeding nematodes, present in a Mediterranean case study were found to possibly limit the abundance of pathogenic Vibrio species. In this case study top down control through nematode grazing was suggested (Vezzulli *et al.*, 2009).

Sensitivity assessment. Due to insufficient evidence the assessment is '**No evidence'.**

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

No characterizing species are targeted directly by fishing activities at a commercial or recreational scale, this pressure is therefore 'Not relevant'. The biotope is more likely to be impacted by disturbance to substratum as discussed in sections above on 'removal' or 'abrasion' of sediment. As small polychaete species, living infaunally and capable of burrowing rapidly, *Hesionura elongata* and *Microphthalmus similis* are likely to withstand physical disturbance caused by bottom towed fishing gears (such as otter or beam trawls) (Vanosmael *et al.*, 1982; Bolam *et al.*, 2014 cited in Walmsley *et al.*, 2015). As discussed in sections on 'abrasion' and sediment deposition, the characterizing species occur in mobile sediments and exposed regions where sediment redistribution occurs and are likely to be resistant to some disturbance of the habitat (Elliot *et al.*, 1998).

Sensitivity assessment. As characterizing species are not targeted by commercial or recreational fisheries the assessment is **'Not Relevant'.**

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

Due to their small size, the characterizing species are unlikely to be removed through by-catch. But removal of features, such as the characterizing mobile medium-coarse sand sediment may occur. Bottom towed fishing gears such as trawls and dredges as well as suction dredging for shellfish will disturb or remove the sediment up to 10 cm depth. Due to the mobile nature of the substratum and existing exposure of this biotope recovery of substratum characteristics is likely to be rapid. Disturbance to substratum, relative to bottom towed fishing activity, is discussed in sections above on 'extraction' or 'abrasion' of sediment. As small polychaete species, living infaunally, *Hesionura elongata* and *Microphthalmus similis* are likely to withstand physical disturbance caused by bottom towed fishing gears (such as otter or beam trawls) (Vanosmael *et al.* 1982; Bolam *et al.* 2014 cited in Walmsley *et al.* 2015). The possibility for some physical damage to a small number of the population and the habitat alteration caused by settlement of re-suspended fine grain size sediment are likely to have an impact on the populations of characterizing species. In a global analysis of the effect of fishing activities on benthic communities in sand habitats, initial impacts occurred in relation to beam trawling but recovery was considered rapid. Otter trawling had limited initial impact but there was some evidence of a small delayed effect (Kaiser *et al.* 2006).

Sensitivity assessment. The initial impact of bottom towed fishing activity, in particular beam trawl and dredges may cause some mortality through direct damage to characterizing species. The action of the dredge or trawl may also move buried organisms to the surface or suspend them in the water column, potentially increasing predation risk. The physical effects of physicla disturbance ar addressed under 'abrasion' and 'penetration' above. However, the incidental removal of a proportion of the population may change the character of the biotope temperaility. Therefore, resistance is assessed as '**Medium'.** As resilience is probably '**High**' sensitivity is assessed as **'Low**'.

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