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Polydora sp. tubes on moderately exposed sublittoral soft rock

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/247]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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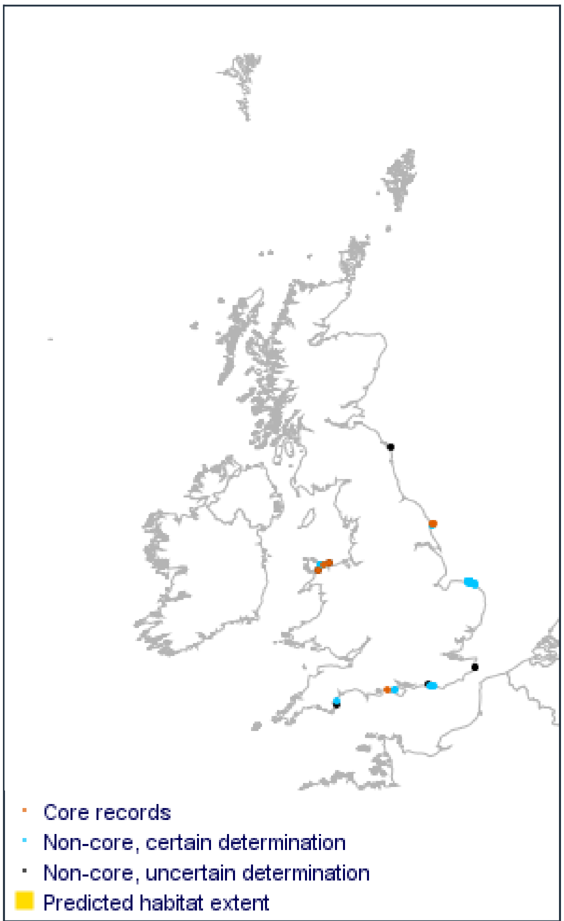
Polydora sp. tubes on upward-facing circalittoral soft rock, with the sponge *Suberites* sp. also present.
Photographer: Keith Hiscock



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

Researched by Eliane De-Bastos & Jacqueline Hill **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A4.232	*Polydora* sp. tubes on moderately exposed sublittoral soft rock
JNCC 2015	CR.MCR.SfR.Pol	*Polydora* sp. tubes on moderately exposed sublittoral soft rock
JNCC 2004	CR.MCR.SfR.Pol	*Polydora sp.* tubes on moderately exposed sublittoral soft rock
1997 Biotope	CR.MCR.SfR.Pol	*Polydora sp.* tubes on upward-facing circalittoral soft rock

Description

Large patches of chalk and soft limestone are occasionally covered entirely by *Polydora* sp. tubes to the exclusion of almost all other species. This tends to occur in highly turbid conditions and spans the infralittoral and circalittoral in limestone areas such as the Great and Little Ormes (North Wales) and Gower (South Wales). It is even present on the lower shore in the Severn estuary. The boring form of the sponge *Cliona celata* often riddles the surface layer of the stone. Other sponges present include *Halichondria panicea*, *Haliclona oculata* and *Hymeniacidon perlevis* (syn. *Hymeniacidon* *perleve*). *Polydora* sp. also frequently occurs in small patches as part of other biotopes (e.g. FluCoAs). Other species present include *Alcyonium digitatum*, *Sarcodictyon roseum*, the hydroids *Halecium halecinum*, *Abietinaria abietina* and *Tubularia indivisa*, the ascidians C*lavelina lepadiformis*, *Botryllus schlosseri* and *Morchellium argus*, the anemones *Urticina felina*, *Metridium dianthus* (syn. *Metridium senile)* and *Sagartia elegans* and the bryozoans *Flustra foliacea* and a crisiid turf. The starfish *Asterias rubens*, the crabs *Inachus phalangium* and *Carcinus maenas*, the polychaete *Spirobranchus triqueter* (syn. *Spirobranchus triqueter)*, the barnacle *Balanus crenatus* and the brittlestar *Ophiothrix fragilis* may also be seen. **Please note**: this biotope may extend into the infralittoral and littoral zone in areas where water turbidity is sufficiently high. (Information taken from Connor *et al*., 2004).

Depth range

Lower shore, 0-5 m, 5-10 m, 10-20 m

Additional information

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Listed By

- none -

Further information sources

Search on:

G G JNCC

Habitat review

Ecology

Ecological and functional relationships

- In areas of mud, the tubes built by *Polydora ciliata* can agglomerate and form layers of mud up to an average of 20 cm thick, occasionally to 50cm. These layers can eliminate the original fauna and flora, or at least can be considered as a threat to the ecological balance achieved by some biotopes (Daro & Polk, 1973).
- Daro & Polk (1973) state that the formation of layers of *Polydora ciliata* tend to eliminate original flora and fauna. The species readily overgrows other species with a flat morphology and feeds by scraping its palps about its tubes, which would inhibit the development of settling larvae of other species.
- The activities of *Polydora* plays an important part in the process of temporary sedimentation of muds in some estuaries, harbours or coastal areas (Daro & Polk, 1973).
- *Polydora ciliata* is predated upon by urchins and in Helgoland there is a close relationship between the distribution of *Polydora ciliata* and *Echinus esculentus*. *Echinus esculentus* grazes almost exclusively on the *Polydora ciliata* carpets and takes its main food not from biodetritus and animals living between the *Polydora* chimneys but by feeding on the worm itself. To reach the worm, *Echinus esculentus* has to scrape away between 0.5and 1.2 cm of solid rock and this feeding behaviour is responsible for the bioerosion of rocks in the Helgoland area by an estimated 1cm per annum (Krumbein & Van der Pers, 1974).

Seasonal and longer term change

The early reproductive period of *Polydora ciliata* often enables the species to be the first to colonize available substrata (Green, 1983). The settling of the first generation in April is followed by the accumulation and active fixing of mud continuously up to a peak during the month of May, when the hard substrata are covered with the thickest layer of mud. The following generations do not produce a heavy settlement due to interspecific competition and heavy mortality of the larvae (Daro & Polk, 1973). Later in the year, the surface layer cannot hold the lower layers of the mud mat in place, they crumble away and are then swept away by water currents. The empty tubes of *Polydora* may saturate the sea in June. Recolonization of the substratum is made possible, when larva of other species are in the plankton so recolonization by *Polydora* may not be as successful as earlier in the year.

Habitat structure and complexity

The biotope has very little structural complexity as *Polydora* tubes aggregate to form layers of muddy tubes on soft rock. *Polydora* mats tend to be single species providing little space for other fauna or flora. A *Polydora* mud is about 20cm thick, but can be up to 50cm thick.

Productivity

Productivity in MCR.Pol is mostly secondary, derived from detritus and organic material. Macroalgae are absent from the biotope. The biotope often occurs in nutrient rich areas, for example, close to sewage outfalls. Allochthonous organic material is derived from anthropogenic activity (e.g. sewerage) and natural sources (e.g. plankton, detritus). Autochthonous organic material is formed by benthic microalgae (microphytobenthos e.g. diatoms and euglenoids) and heterotrophic micro-organism production. Organic material is degraded by micro-organisms and the nutrients are recycled. The high surface area of fine particles that covers the *Polydora* mud provides surface for microflora.

Recruitment processes

The spawning period for *Polydora ciliata* in northern England is from February until June and three or four generations succeed one another during the spawning period (Gudmundsson, 1985). After a week, the larvae emerge and are believed to have a pelagic life from two to six weeks before settling (Fish & Fish, 1996). Larvae are substratum specific selecting rocks according to their physical properties or sediment depending on substrate particle size. Larvae of *Polydora ciliata* have been collected as far as 118km offshore (Murina, 1997). Adults of *Polydora ciliata* produce a 'mud' resulting from the perforation of soft rock substrates and the larvae of the species settle preferentially on substrates covered with mud (Lagadeuc, 1991).

Time for community to reach maturity

A *Polydora* biotope is likely to reach maturity very rapidly because *Polydora ciliata* is a short lived species that reaches maturity within a few months and has three or four spawnings during a breeding season of several months. For example, in colonization experiments in Helgoland (Harms & Anger, 1983) *Polydora ciliata* settled on panels within one month in the spring. The tubes built by *Polydora* agglomerate sometimes to form layers of mud up to an average of 20cm thick. However, it may take several years for a *Polydora ciliata* 'mat' to reach a significant size.

Additional information

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Preferences & Distribution

Habitat preferences

Depth Range	Lower shore, 0-5 m, 5-10 m, 10-20 m
Water clarity preferences	
Limiting Nutrients	Not relevant
Salinity preferences	Full (30-40 psu)
Physiographic preferences	Open coast
Biological zone preferences	Circalittoral
Substratum/habitat preferences	Bedrock
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Moderately exposed
Other preferences	Soft rock including chalk, limestone and sandstone

Additional Information

Species composition

Species found especially in this biotope

Rare or scarce species associated with this biotope

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Additional information

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

CR.MCR.SfR.Pol is a sublittoral biotope occurring in moderately exposed areas with strong, but also moderately strong and weak tidal streams (Connor *et al.*, 2004). This biotope is defined by occurring in soft rock, such as chalk and soft limestone, in areas where water turbidity is high. Large patches of chalk and soft limestone are occasionally covered entirely by Polydora sp. tubes to the exclusion of almost all other species (Daro & Polk, 1973). The species readily overgrows other species with a flat morphology and feeds by scraping its palps about its tubes, which would inhibit the development of settling larvae of other species. For this reason, the mat of Polydora spp. tubes is considered as the defining characteristic of this biotope. In the north west of Europe, Polydora ciliata has been mainly associated to limestone rock and stones (Hayward & Ryland, 1995b), so it is likely that this species is characteristic of this this biotope and is therefore the focus of this assessment as an example of tube building Polydora spp. In this biotope Polydora spp. (and their tubes) are therefore the key structuring and defining element. A range of other epifaunal species are present in patches including sponges, hydroids, barnacles, ascidians and anemones. These contribute to species richness and diversity but are not considered key characterizing, defining or structuring species and are not considered within the assessments. More information on these species can be found in other biotope assessments available on this website.

The soft rock substratum is considered a key element defining the habitat and supporting the development of this biotope. The substratum is therefore considered in sensitivity assessments where the pressure may alter or change it.

Resilience and recovery rates of habitat

Polyodra is a small, sedentary, burrowing polychaete worm up to 3 cm long. All *Polydora* spp. make a U-shaped tube from small particles (Hayward & Ryland, 1995b). *Polydora ciliata* usually burrows into substrata containing calcium carbonate such as limestone, chalk and clay, as well as shells or oysters, mussels and periwinkles (Fish & Fish, 1996). The sexes are separate and breeding has been recorded in spring in a number of locations. In northern England, spawning has been recorded to occur from February until June and three or four generations succeed one another during the spawning period (Gudmundsson, 1985). Eggs are laid in a string of capsules that are attached by two threads to the wall of the burrow (Fish & Fish, 1996). After a week the larvae emerge and are believed to have a pelagic life of from 2-6 weeks before settling. Length of life is no more than 1 year (Fish & Fish, 1996). Larvae of *Polydora ciliata* have been collected as far as 118 km offshore (Murina, 1997). Larvae settle on specific substratum types, selecting rocks according to their physical properties or sediment depending on substrate particle size. Adults of *Polydora ciliata* produce a 'mud' resulting from the perforation of soft rock substrates and the larvae of the species settle preferentially on substrates covered with mud (Lagadeuc, 1991). The tubes built by *Polydora* agglomerate sometimes to form layers of mud up to an average of 20 cm thick. However, it may take several years for a *Polydora ciliata* 'mat' to reach a significant size (Hill, 2007). However, interspecific competition and heavy mortality of the larvae have been observed on *Polydora* mats (Daro & Polk, 1973).

The early reproductive period of *Polydora ciliata* often enables the species to be the first to colonize available substrata (Green, 1983). The settling of the first generation in April is followed by the accumulation and active fixing of mud continuously up to a peak during the month of May. The following generations do not produce a heavy settlement due to interspecific competition and heavy mortality of the larvae (Daro & Polk, 1973). Later in the year, the surface layer cannot hold the lower layers of the mud mat in place, they crumble away and are then swept away by water currents. The empty tubes of *Polydora* may saturate the sea in June. Recolonization of the habitat later in the year may be inhibited by other species that colonize and compete for rock and therefore later settlements may not result in the formation of this biotope.

A *Polydora* biotope is likely to reach maturity very rapidly because *Polydora ciliata* is a short lived species that reaches maturity within a few months and has three or four spawnings during a breeding season of several months. For example, in colonization experiments in Helgoland (Harms & Anger, 1983) *Polydora ciliata* settled on panels within one month in the spring.

Resilience assessment: Removal of the characterizing species *Polydora* would likely result in the biotope being lost and re-classified. *Polydora* is short lived species, reaching maturity within a few months, and communities appear to be annual, sustained by three or even four generations succeeding one another and resulting in planktonic larvae that can be found throughout the year (Daro & Polk, 1973). In the event of a large portion of the *Polydora* community being lost, the biotope is likely to reach maturity very. For as long as the substrate nature of the biotope remains suitable for the settlement of *Polydora* recruits, the biotope is likely to recover fully within two years, hence resilience has been assessed as **High**.

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

Murina (1997) categorized *Polydora ciliata* as a eurythermal species because of its ability to spawn in temperatures ranging from 10.6-19.9°C. This is consistent with a wide distribution in north-west Europe which extends into the warmer waters of Portugal and Italy (Pardal *et al.*, 1993; Sordino *et al.*, 1989). In the western Baltic Sea, Gulliksen (1977) recorded high abundances of *Polydora ciliata* in temperatures of 7.5 to 11.5°C and in Whitstable in Kent, where sea temperatures varied between 0.5 and 17°C (Dorsett, 1961). Growth rates may increase if temperature rises. For example, at Whitstable in Kent, Dorsett (1961) found that a rapid increase in growth of *Polydora ciliata* coincided with the rising temperature of the seawater during March.

Sensitivity assessment: Typical surface water temperatures around the UK coast vary, seasonally from 4-19°C (Huthnance, 2010). No information was found on the maximum temperature tolerated by *Polydora ciliata*. However, it is likely that the species is able to resist a long-term increase in temperature of 2°C and may resist a short-term increase of 5°C. Resistance and resilience are therefore assessed as **High** and the biotope is judged as **Not Sensitive**.

Temperature decrease (local)	High Q: High A: Medium C: High	High Q: High A: High C: High	Not sensitive Q: High A: Medium C: High

Murina (1997) categorized *Polydora ciliata* as a eurythermal species because of its ability to spawn in temperatures ranging from 10.6-19.9°C. This is consistent with a wide distribution in north-west Europe. In the western Baltic Sea, Gulliksen (1977) recorded high abundances of *Polydora ciliata* in temperatures of 7.5 to 11.5°C and in Whitstable in Kent abundance was high when winter water temperatures dropped to 0.5°C (Dorsett, 1961). During the extremely cold winter of 1962/63 *Polydora ciliata* was apparently unaffected, when temperature anomalies of between 2.5-5.8°C where observed (Crisp, 1964).

Sensitivity assessment: Typical surface water temperatures around the UK coast vary, seasonally from 4-19°C (Huthnance, 2010). *Polydora ciliata* is likely to be able to resist a long-term decrease in temperature of 2°C and may resist a short-term decrease of 5°C. Temperature may act as a spawning cue and an acute or chronic decrease may result in some delay in spawning, however this is not considered to impact the adult population and may be compensated by later spawning events. Resistance and resilience are therefore assessed as **High** and the biotope judged as **Not Sensitive**.

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

Polydora ciliata is a euryhaline species inhabiting fully marine and estuarine habitats. However, there are no records of the species or the biotope occurring in hypersaline waters.

Sensitivity assessment: A long-term increase in salinity at the pressure benchmark level is likely to result in the death of many individuals. Resistance is therefore assessed as **Low** and resilience is likely to be **High** so the biotope is considered to have **Low** sensitivity to an increase in salinity at the pressure benchmark level.

Salinity decrease (local)	High Q: High A: High C: High	High Q: High A: High C: High	Not sensitive Q: High A: High C: High

Polydora ciliata is a euryhaline species inhabiting fully marine and estuarine habitats. In an area of the western Baltic Sea, where bottom salinity was between 11.1 and 15.0psu *Polydora ciliata* was the second most abundant species with over 1000 individuals per m^2 (Gulliksen, 1977).

Sensitivity assessment: Records indicate CR.MCR.SfR.Pol occurs in areas of variable (18-35 ppt) salinity (Connor *et al*., 2004). *Polydora ciliata* is therefore likely to resist a decrease in salinity at the pressure benchmark level. Resistance is therefore assessed as **High** and resilience as **High** (by default) and the biotope is considered **Not Sensitive** to a decrease in salinity at the pressure benchmark level.

Water flow (tidal current) changes (local)	High Q: High A: Low C: High	High Q: High A: High C: High	Not sensitive Q: High A: Low C: High

CR.MCR.SfR.Pol is recorded in a range of tidal streams, including strong (1.5-3 m/s), moderately strong (0.5-1.5 m/s) and weak tidal stream conditions (<0.5 m/s) (Connor *et al.*, 2004).

Polydora ciliata colonized test panels in Helgoland in three areas, two exposed to strong tidal currents and one site sheltered from currents (Harms & Anger, 1983). Very strong water flows may sweep away *Polydora* colonies, where these are present as a thick layer of mud on a hard substratum.

The most damaging effect of increased flow rate (above the pressure benchmark) could be the erosion of the soft rock substratum as this could eventually lead to loss of the habitat.

Sensitivity assessment: CR.MCR.SfR.Pol is recorded in a range of tidal streams, including strong, moderately strong and weak tidal stream conditions (Connor *et al.*, 2004). A change in water flow at the benchmark level of 0.1-0.2 m/s is therefore likely to fall within the normal range of water flows experienced by the biotope. Resistance and resilience are therefore considered to be **High** and the biotope is assessed as **Not Sensitive** to a change in water flow rate at the pressure benchmark level.

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 the biotope, which is restricted to fully subtidal/circalittoral conditions. The pressure benchmark is relevant only to littoral and shallow sublittoral fringe biotopes.

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

The biotope is found in moderately exposed sites (Connor *et al.*, 2004). Feeding of *Polydora ciliata* may be impaired in strong wave action and changes in wave exposure may also influence the supply of particulate matter for tube building activities. Decreases in wave exposure may influence the supply of particulate matter because wave action may have an important role in re-suspending the sediment that is required by the species to build its tubes. Food supplies may also be reduced affecting growth and fecundity of the species.

Potentially the most damaging effect of increased wave heights would be the erosion of the soft rock substratum as this could eventually lead to loss of the habitat.

Sensitivity assessment. Some erosion will occur naturally and storm events may be more significant in loss and damage of soft rocks than changes in wave height at the pressure benchmark. The biotope is therefore considered to have **High** resistance to changes at the pressure benchmark where these do not lead to increased erosion of the substratum. Resilience is therefore assessed as **High** and the biotope is considered to be **Not Sensitive**, at the pressure benchmark.

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.

Experimental studies with various species suggest that polychaete worms are quite resistant to heavy metals (Bryan, 1984). *Polydora ciliata* occurs in an area of the southern North Sea polluted by heavy metals but was absent from sediments with very high heavy metal levels (Diaz-Castaneda *et al*., 1989).

Hydrocarbon & PAH contamination	Not Assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR

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

In analysis of kelp holdfast fauna following the Sea Empress oil spill in Milford Haven the fauna present, including *Polydora ciliata*, showed a strong negative correlation between numbers of species and distance from the spill (SEEEC, 1998). After the extensive oil spill in West Falmouth, Massachusetts, Grassle & Grassle (1974) followed the settlement of polychaetes in the disturbed area. Species with the most opportunistic life histories, including *Polydora ligni*, were able to settle in the area. This species has some brood protection which enables larvae to settle almost immediately in the nearby area (Reish, 1979).

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.

Polydora ciliata was abundant at polluted sites close to acidified, halogenated effluent discharge from a bromide-extraction plant in Amlwch, Anglesey (Hoare & Hiscock, 1974). Spionid polychaetes were found by McLusky (1982) to be relatively resistant of distilling and petrochemical industrial waste in Scotland.

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

No evidence was found

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

Polydora ciliata is frequently found at localities with oxygen deficiency (Pearson & Rosenberg, 1978). For example, in polluted waters in Los Angeles and Long Beach harbours *Polydora ciliata* was present in the oxygen range 0.0-3.9 mg/l and the species was abundant in hypoxic fjord habitats (Rosenberg, 1977). Furthermore, in a study investigating a polychaete community in the north west Black Sea, *Polydora ciliata* was observed in all four study sites, including those severely affected by eutrophication and hypoxia as a result of discharges of wastewaters (Vorobyova *et al.*, 2008). However, *Polydora ciliata* is unlikely to be able to resist anoxic conditions. Hansen *et al.* (2002) reported near total extinction of all metazoan in the Mariager Fjord (Denmark), including *Polydora* spp. after a severe hypoxia event that resulted in complete anoxia in the water column for two weeks. Additionally, Como & Magni (2009) investigated seasonal variations in benthic communities known to be affected by episodic events of hypoxia. The authors observed that abundance of *Polydora ciliata* varied seasonally, decreasing during the summer months, and suggested it could be explained by the occurrence of hypoxic/anoxic conditions and sulphidic sediments during the summer. No details of the levels of dissolved oxygen leading to these community responses were provided.

Sensitivity assessment: *Polydora ciliata* is frequently found at localities with oxygen deficiency (Pearson & Rosenberg, 1978) and seems to only be affected by severe de-oxygenation episodes. Resistance to de-oxygenation at the pressure benchmark level is likely to be **High.** Opportunistic *Polydora* spp. have also repeatedly been reported amongst the first to recover hypoxia events (Hansen *et al.*, 2002; Van Colen *et al.*, 2010) so resilience is likely to also be **High.** The biotope is therefore considered **Not Sensitive** to exposure to dissolved oxygen concentration of less than or equal to 2 mg/l for 1 week.

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

Polydora ciliata is often found in environments subject to high levels of nutrient input. For example, the species was abundant in areas of the Firth of Forth exposed to high levels of sewage pollution (Smyth, 1968), in nutrient rich sediments in the Mondego estuary, Portugal (Pardal *et al.*, 1993) and the coastal lagoon Lago Fusaro in Naples (Sordino *et al.*, 1989). The extensive growths of *Polydora ciliata* in mat formations were recorded at West Ganton, in the Firth of Forth, prior to the introduction of the Sewage Scheme (Read *et al.*, 1983). The abundance of the species was probably associated with their ability to use the increased availability of nutrients as a food source and silt for tube building.

Sensitivity assessment: The characterizing species of this biotope is likely to be able to resist nutrient enrichment. The biotope is considered **Not Sensitive** at the pressure benchmark that assumes compliance with good status as defined by the WFD.

Organic enrichment	High Q: High A: Medium C: High	High Q: High A: High C: High	Not sensitive Q: High A: Medium C: High

In colonization experiments in an organically polluted fjord receiving effluent discharge from Oslo, *Polydora ciliata* had settled in large numbers within the first month (Green, 1983; Pardal *et al.*, 1993). However, Callier *et al.* (2007) investigated the spatial distribution of macrobenthos under a suspended mussel culture, in eastern Canada, where the sedimentation of organic matter to the bottom was approx. 1-3 gC/m^2/d. *Polydora ciliata* was recorded as absent in the sites under the suspended mussel farm after one year and as dominant in reference areas of the study. It should be noted that the organic matter input from the mussel farm exceeds the pressure benchmark.

Como & Magni (2009) investigated seasonal variations in benthic communities known to be affected by episodic events of sediment over-enrichment. The authors observed that abundance of *Polydora ciliata* varied seasonally, and suggested this could be a result of major accumulation of organic C-bounding fine sediments in the study site.

Studies by Almeda *et al.* (2009) and Pedersen *et al.* (2010) investigated larval energetic requirements for *Polydora ciliata*, and suggested maximum growth rates were reached at food concentrations ranging from 2.5 to 1.4 µg C/ml depending on larval size, energetic carbon requirements of 0.09 to 3.15 µg C l/d, respectively.

Polydora ciliata can also occur in organically poor areas (Pearson & Rosenberg, 1978).

Borja *et al.* (2000) and Gittenberger & van Loon (2011) in the development of an AMBI index to assess disturbance (including organic enrichment) both assigned *Polydora ciliata* to their Ecological Group IV 'Second-order opportunistic species present in slight to pronounced unbalanced situations'.

Sensitivity assessment: The evidence presented suggests *Polydora ciliata* may not be able to resist organic enrichment that exceeds the pressure benchmark level (Callier *et al.*, 2007) but may not be affected by at the benchmark level. Resistance and resilience are therefore assessed as **High** and the biotope is considered **Not Sensitive** to organic enrichment (deposit of 100 $gC/m^2/yr$).

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

CR.MCR.SfR.Pol is characterized by the soft rock substratum which supports populations of *Polydora* sp. tubes. A change to a sedimentary, hard rock or artificial substratum would result in the loss of *Polydora*, significantly altering the character of the biotope. The biotope would be lost and/or re-classified.

Sensitivity assessment: Resistance to the pressure is considered **None**, and resilience **Very Low** based on the loss of suitable substratum to support the community of the characterizing species of *Polydora*. Sensitivity has been assessed as **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 sediment type)	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 biotopes occurring on bedrock.

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

Removal of the substratum to 30 cm would result in the loss of *Polydora* sp. tubes. Resistance to the pressure is considered **None**, and resilience **Very Low** based on the loss of suitable substratum to support the community of the characterizing species of *Polydora*. Sensitivity has been assessed as **High**. 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	None Q: High A: High C: High	High Q: High A: Medium C: High	Medium Q: High A: Medium C: High

This biotope is characterized by epifauna occurring on hard rock substratum. The tubes of *Polydora* spp. are likely to be removed by abrasion as these project above the surface and are not physically robust. Other epifauna associated with this biotope are also likely to be damaged and/or removed by surface abrasion. Some species such as anemones and sponges may be able to rapidly repair damage while others may recolonize rapidly, e.g. barnacles.

Sensitivity assessment. The characterizing *Polydora* community in this biotope, is considered likely to be damaged and removed by abrasion. As a soft bodied species, *Polydora ciliata* is likely to be crushed and killed by an abrasive force or physical blow. Erect epifauna are directly exposed to this pressure which would displace, damage and remove individuals. Resistance to abrasion is considered **None**. However, *Polydora* is likely to be able to re-establish the lost community rapidly, so resilience of the biotope is assessed as **High** with the biotope considered to have **Medium** sensitivity to abrasion or disturbance of the surface of the seabed. The substratum is unable to recover from damage and therefore the biotope would be considered highly sensitivity to abrasion that damaged or removed the soft rock substratum.

Penetration or disturbance of the substratum subsurface	None Q: High A: High C: High	High Q: High A: High C: High	Medium Q: High A: High C: High

Activities that disturb the surface of the mat and penetrate below the surface would remove a significant proportion of the *Polydora* tubes within the direct area of impact. Biotope resistance is therefore assessed as **None** and recovery is assessed as **High** based on the assumption that the suitable substratum to support the community of the characterizing species of *Polydora* would only be damaged, not lost. Sensitivity is therefore assessed as **Medium**. The substratum is unable to recover from damage and therefore the biotope would be considered highly sensitivity to physical disturbance that damaged or removed the soft rock substratum. Although no specific evidence is described confidence in this assessment is 'High', due to the incontrovertible nature of this pressure.

Changes in suspended solids (water clarity)	Low Q: High A: High C: High	High Q: High A: Medium C: High	Low Q: High A: Medium C: High

CR.MCR.SfR.Pol tends to occur in highly turbid areas (Connor *et al.*, 2004). In the Firth of Forth, *Polydora ciliata* formed extensive mats in areas that had an average of 68 mg/l suspended solids and a maximum of approximately 680 mg/l, indicating the species is able to tolerate different levels of suspended solids (Read *et al.*, 1982; Read *et al.*, 1983). Occasionally, in certain places siltation is speeded up when *Polydora ciliata* is present because the species actually produces a 'mud' as it perforates soft rock and chalk habitats and larvae settle preferentially on substrates covered with mud (Lagadeuc, 1991).

Suspended sediment and siltation of particles is important for tube building in *Polydora ciliata* so a decrease in suspended solids may reduce tube building or the thickness of the mud surrounding the 'colonies'. Daro & Polk (1973) reported that the success of *Polydora* is directly related to the quantities of muds of any origin carried along by rivers or coastal currents.

An increase in turbidity, reducing light availability may reduce primary production by phytoplankton in the water column. A reduction in primary production in the water column may result indirectly in reduced food supply to the detritus feeding *Polydora* which in turn may affect growth rates and fecundity.

Sensitivity assessment: An increase in suspended solids at the pressure benchmark level is unlikely to affect the characterizing species of this biotope. However, a decrease in suspended matter in the biotope could result in limitation of material for tube building activity of *Polydora* and also in the substrate no longer being suitable for colonization by new recruits. Resistance of the biotope is therefore considered to be **Low** (loss of 25-75%) and resilience is **High** (following a return to normal conditions) so the biotope is considered to have **Low** sensitivity to a decrease in suspended solids at the pressure benchmark level.

Smothering and siltation rate changes (light)	High Q: High A: Medium C: High	High Q: High A: High C: High	Not sensitive Q: High A: Medium C: High

Adults of *Polydora ciliata* produce a 'mud' resulting from the perforation of soft rock substrates (Lagadeuc, 1991). A *Polydora* mud can be up to 50 cm thick, but the animals themselves occupy only the first few centimetres. They either elongate their tubes to reach the surface, or leave them to rebuild close to the surface.

Munari & Mistri (2014) investigated the spatio-temporal variation pattern of a benthic community following deposition of dredged material, at a maximum thickness of 30–40 cm. *Polydora ciliata* was amongst the first colonizers of the newly deposited sediments. The authors suggested that it was possible that the individuals migrated vertically through the deep layer of dredged sand. This was based on the results of Roberts *et al.* (1998) who suggested 15 cm as the maximum depth of overburden through which benthic infauna can successfully migrate. After one year, no adverse impact of sand disposal on the benthic fauna was detected on the study site.

Sensitivity assessment: Based on the evidence presented by Munari & Mistri (2014), *Polydora ciliata* is considered likely to resist smothering by 5 cm of sediment. Resistance and resilience are therefore assessed as **High** and the biotope is considered **Not Sensitive** to a ‘light’ deposition of up to 5 cm of fine material in a single discrete event.

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

Adults of *Polydora ciliata* produce a 'mud' resulting from the perforation of soft rock substrates (Lagadeuc, 1991). A *Polydora* mud can be up to 50 cm thick, but the animals themselves occupy only the first few centimetres. They either elongate their tubes, or leave them to rebuild close to the surface.

Munari & Mistri (2014) investigated the spatio-temporal variation pattern of a benthic community following deposition of dredged material, at a maximum thickness of 30–40 cm. *Polydora ciliata* was amongst the first colonizers of the newly deposited sediments. The authors suggested that it was possible that the individuals migrated vertically through the deep layer of dredged sand. This was based on the results of Roberts *et al*. (1998) who suggested 15 cm as the maximum depth of overburden through which benthic infauna can successfully migrate. After one year, no adverse impact of sand disposal on the benthic fauna was detected on the study site.

Sensitivity assessment: 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) (Maurer *et al*., 1982). However, it is not clear whether *Polydora ciliata* is likely to be able to migrate through a maximum thickness of fine sediment that would compare to that investigated by Munari & Magni (2014) because muds tend to be more cohesive and compacted than sand. Some mortality of the characterizing species is likely to occur. Resistance is therefore assessed as **Low** and resilience as **High** and the biotope is considered to have **Low** sensitivity to a ‘heavy’ deposition of up to 30 cm of fine material in a single discrete event.

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

No Evidence is available on which to assess this pressure.

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

Polydora ciliata may respond to vibrations from predators or bait diggers by retracting their palps into their tubes. However, the species is unlikely to be affected by noise pollution and so the biotope is assessed as **Not Sensitive**.

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

CR.MCR.SfR.Pol is a circalittoral biotope (Connor *et al*., 2004) and therefore, not directly dependent on sunlight.

Sensitivity assessment. Although *Polydora* spp. can perceive light, this pressure is not considered relevant. The biotope is considered to have **High** resistance and, by default, **High** resilience and therefore is **Not Sensitive** to the introduction of light.

Barrier to species movement	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Not Relevant to biotopes restricted to open waters.

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	High Q: Low A: Low C: Low	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

Polydora ciliata exhibits shadow responses and withdraws its palps into its burrow, which is believed to be a defence against predation. The withdrawal of the palps interrupts feeding and possibly respiration, although the species also shows habituation of the response (Kinne, 1970). *Polydora* is unlikely to be sensitive to visual disturbance caused by passing shipping but may respond to passing divers at close range. Resistance and resilience are, therefore, assessed as **'High'** and the biotope judged as **'Not Sensitive'** to visual disturbance.

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

The key characterizing species in the biotope are not cultivated or likely to be translocated. This pressure is therefore considered **Not Relevant**.

Introduction or spread of invasive non-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

There is no evidence on the presence of non-indigenous species or impacts of non-indigenous species relevant to this biotope. This pressure is therefore considered **Not Relevant**.

Introduction of microbial pathogens	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: NR C: NR

Introduced organisms (especially parasites or pathogens) are a potential threat in all coastal ecosystems. However, so far, no information was found on microbial pathogens affecting *Polydora ciliata*.

Sensitivity assessment. The biotope is judged to have **High** resistance to this pressure. By default resilience is assessed as **High** and the biotope is classed as **Not Sensitive**.

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

CR.MCR.SfR.Pol is currently not targeted by commercial fisheries and hence not directly affected by this pressure. This pressure is therefore considered **Not Relevant**.

Removal of non-target species	None Q: High A: High C: High	High Q: High A: Medium C: High	Medium Q: High A: Medium C: High

Direct, physical impacts are assessed through the abrasion and penetration of the seabed pressures, while this pressure considers the ecological or biological effects of by-catch. Species in this biotope, including the characterizing species *Polydora ciliata*, may be damaged or directly removed by static or mobile gears that are targeting other species (see abrasion and penetration pressures). Loss of *Polydora* species and the mat of tubes would alter the character of the biotope resulting in re-classification. Loss of *Polydora* spp. and the associated epifauna would alter the physical structure of the habitat and result in the loss of the ecosystem functions such as secondary production performed by these species.

Sensitivity assessment. Removal of the characterizing species would result in the biotope being lost or re-classified. Thus, the biotope is considered to have a resistance of **None** to this pressure and to have **High** resilience, resulting in the sensitivity being judged as **Medium**.

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