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

Hiatella-bored vertical sublittoral limestone rock

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

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The Marine Life Information Network, Marine Biological Association of the United Kingdom.

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/362]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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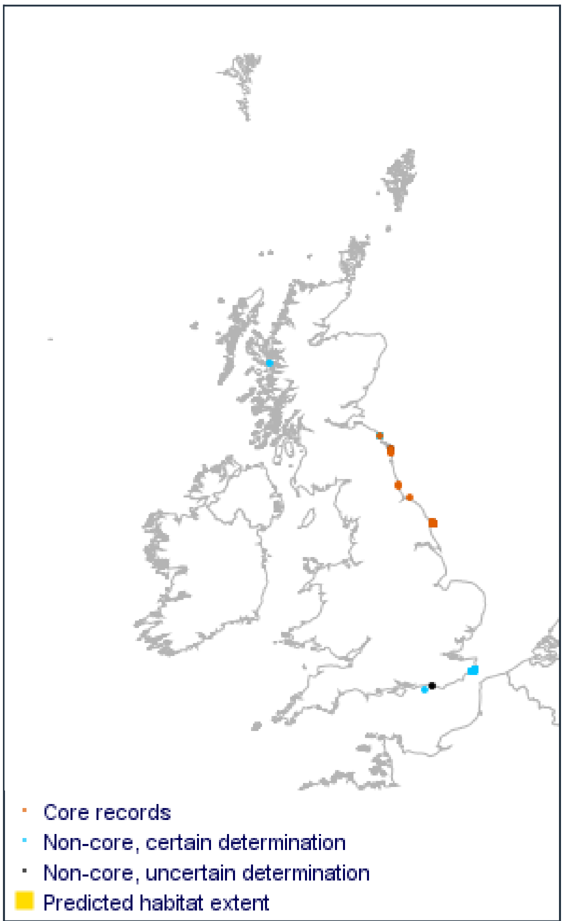
***Hiatella arctica*, bryozoans and ascidians on vertical infralittoral soft rock (IR.AlcByH.Hia).**
Photographer: Keith Hiscock



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

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

Summary

UK and Ireland classification

EUNIS 2008	A4.233	*Hiatella*-bored vertical sublittoral limestone rock
JNCC 2015	CR.MCR.SfR.Hia	*Hiatella*-bored vertical sublittoral limestone rock
JNCC 2004	CR.MCR.SfR.Hia	*Hiatella*-bored vertical sublittoral limestone rock
1997 Biotope	IR._.FaSwV.AlcByH.Hia	*Hiatella arctica*, bryozoans and ascidians on vertical infralittoral soft rock

Description

Moderately exposed vertical and overhanging soft rock (typically chalk), subject to moderately strong to weak tidal streams, bored by the rock-boring mollusc *Hiatella arctica*. As with other biotopes in the soft rock complex, it is found in areas of high turbidity, where there is poor light penetration. There may be isolated clumps of the hydroid *Nemertesia antennina* and a sparse bryozoan turf formed by various crisiids, *Crisularia plumosa* and *Bugula flabellate* (often being grazed on by the nudibranch *Janolus cristatus*), *Alcyonidium diaphanum*, *Flustra foliacea* and *Cellapora pumicosa*. A patchy 'carpet' of the brittlestar *Ophiothrix fragilis* is often recorded along with other echinoderms such as *Asterias rubens* and *Henricia sanguinolenta*. Other species present include the colonial ascidians *Polyclinum aurantium*,*Botrylloides leachi*, *Clavelina lepadiformis*, *Aplidium punctatum* and *Botryllus schlosseri*, dead mans fingers *Alcyonium digitatum* and the crab *Cancer pagurus*. Sponges present include the boring sponge *Cliona celata*, *Halichondria panicea*,*Myxilla incrustans*, *Leucosolenia botryoides*and *Dysidea fragilis*. Occasionally, the foliose red seaweed *Delessaria sanguinea* may be recorded (JNCC, 2015).

Depth range

0-5 m, 5-10 m, 10-20 m

Additional information

-

Listed By

- none -

Further information sources

Search on:

G G G JNCC

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

The description of the biotope and characterizing species is taken from Connor *et al*. (2004). This biotope occurs on moderately exposed vertical and overhanging soft rock (typically chalk), subject to moderately strong to weak tidal streams, bored by the rock-boring mollusc *Hiatella arctica*. *Hiatella arctica* is considered to be the key characterizing species as removal of the population would alter the biotope classification. This biotope occurs in sublittoral soft rocks which have a restricted distribution around the UK. As the occurrence of bored rock biotopes are highly dependent on the presence of suitable substratum, the sensitivity assessments specifically consider the sensitivity of the substratum to pressures, where appropriate. As with other biotopes in the soft rock complex, this biotope is found in areas of high turbidity, where there is poor light penetration. A 'sparse' fauna is associated with this biotope (Connor *et al*., 2004) as the substratum is too hard for sedimentary species and too soft for epifauna and flora to attach to or to maintain attachment. All the species associated with this biotope are commonly found in many subtidal rocky habitats and are either mobile or rapid colonizers. Although these species contribute to the structure and function of the biotope they are not considered key species and are not specifically assessed. These associated species include isolated clumps of the hydroid N*emertesia antennina* and a sparse bryozoan turf. A patchy 'carpet' of the brittlestar *Ophiothrix fragilis* is often recorded along with other echinoderms such as *Asterias rubens* and *Henricia sanguinolenta*. Other species present include colonial ascidians *and* sponges. Occasionally, the foliose red seaweed *Delessaria sanguinea* may be recorded.

Resilience and recovery rates of habitat

Hiatella arctica can vary in morphology depending on the life habit which may be crevice dwelling or boring into rock substrata (Trudgill & Crabtree, 1987). Some individuals settle on artificial substrata and form part of the community of fouling organisms (Arddison & Bourget, 1997; Khalaman, 2005). *Hiatella arctica* characterizing this biotope are burrowers. The adults are able to bore into rock by mechanical abrasion using the valves of the shell. Boring may utilise both chemical and mechanical action although the process is not clear (Trudgill & Crabtree, 1997). Trudgill & Crabtree report that several workers suggest that boring species avoid occupied burrows although the significance of this statement to *Hiatella arctica* is not clear. Pinn *et al*. (2008) noted that at high densities Piddock burrows became deformed to avoid the burrows of nearby individuals. If *Hiatella arctica* are similar then new arrivals would have to colonize spaces between existing burrows unless rock fractures expose new surfaces (Trudgill & Crabtree, 1997).

In the Arctic *Hiatella arctica* may be very long-lived with the oldest individual estimated to be 126 years old (based on annual growth rings) and maximum length was estimated to be achieved at 35 years. Populations in warmer waters are likely to be faster growing (Sejr *et al*., 2002). In the White Sea, Russia, *Hiatella arctica* reached a maximum age of 6 years and achieved sexual maturity at 1 year (Matveeva & Maksimovich, 1977, abstract only). In study sites in County Clare, Ireland, Trudgill & Crabtree (1997) found the mean age to be 5 years and 6 years on exposed and sheltered shores, respectively, (estimated based on growth rings). In the Clyde larvae are found all year, (Russell-Hunter 1949) although Lebour (1938) report that maximum abundances of planktonic larvae occurred from July to November.

Some associated species such as the ascidians *Ciona intestinalis* and *Clavelina lepadiformis* are effectively annual while some hydroids and bryozoans, may show annual phases of growth and dormancy or regression. For example, *Bugula* species die back in winter to dormant holdfasts, while the uprights of *Nemertesia antennina* die back after 4-5 month and exhibit three generations per year (spring, summer and winter) (see Hughes, 1977; Hayward & Ryland, 1998; Hartnoll, 1998). Hydroids, brittle stars, starfish and sponges within the biotope can repair damage and sponges and hydroids can reproduce asexually, aiding recovery of damaged populations. Many hydroid species produce dormant, resting stages that are very resistant of environmental perturbation (Gili & Hughes ,1995). Although colonies may be removed or destroyed, the resting stages may survive attached to the substratum. Rapid growth, budding and the formation of stolons allows hydroids to colonize space rapidly. Fragmentation may also provide another route for short distance dispersal. Therefore, these species can recruit and recover rapidly and hydroids are often the first organisms to colonize available space in settlement experiments (Gili &Hughes, 1995).

The brittlestar *Ophiothrix fragilis* has an extended breeding season running roughly from April to October and recruits initially settle on the arms of adults (Smith 1940; Ball *et al*., 1995). The larvae of *Ophiothrix fragilis* can disperse over considerable distances in areas where there are strong water flow rates (Davoult *et al*., 1990). However, brittlestars demonstrate sporadic and unpredictable recruitment (Buchanan, 1964), even though they have long-lived pelagic larvae with a high dispersal potential.

Resilience assessment *Hiatella arctica* and the associated biological assemblage that define this biotope are widespread, common species with planktonic larvae and hence recolonization is predicted to be rapid. A number of associated species can also repair damage or are colonial organisms able to increase in abundance and biomass via asexual reproduction. Following disturbances that remove or damage significant numbers of individuals a return to species richness and the abundance and biomass of the previous population may require a few years to return to a typical age and biomass structured population, particularly where recruitment is episodic or mortalities of juveniles are high. Resilience of the biotope is therefore assessed as 'High' (within 2 years) when resistance is either 'High' or 'Medium' and is based on recolonization of '*Hiatella arctica*' to replenish population of adults and repair and recovery of associated species and the typical biotope species richness, abundance and biomass, although some effects may persist. However, where resistance is assessed as 'Low' or 'None' recovery is considered to be 'Medium' (2-10 years) as the population of *Hiatella arctica* may have been completely removed or severely impacted and will require longer than 2 years for recovery of a similar dense population with the size and age structure typical of an unimpacted biotope. Recolonization and recovery of the associated species would also be complete within this timescale with some components such as ascidians, hydroids and bryozoans recovering within 2 years but other epifauna such as brittlestars requiring a longer time for recovery.

Hydrological Pressures

	Resistance	Resilience	Sensitivity
Temperature increase (local)	High Q: High A: Low C: High	High Q: High A: High C: High	Not sensitive Q: High A: Low C: High

Gordillo & Aitken (2000) in a review of environmental factors relevant to re-interpreting Late Quaternary environments from fossil collections suggest that *Hiatella arctica* is eurythermal, based on Aitken (1990) and Peacock (1993). The current distribution of *Hiatella arctica* is predominantly arctic and boreal (Sejr *et al*., 2004; Gordillo, 2001) and palaeecological reviews describe the genus as 'consistently linked to cool temperate and polar regions' (Gordillo, 2001). However, populations of *Hiatella arctica* occur in the Mediterrannean and have clearly acclimated to the warmer temperatures (Oberlechner, 2008). Laboratory experiments on filtration rates of *Hiatella arctica* found that activity was strongly linked to temperature (Ali, 1970). Activity rates rose steadily between 0 °C to a maximum between 15 °C and 17 °C and fell sharply to almost no activity at 25 °C (Ali, 1970). Although activity may be reduced *Hiatella arctica* have very low metabolic rates and may be able to sustain a period of reduced activity. Regression models developed by Bourget *et al*. (2003) found that temperature and water transparency (measured in metres and indicating the level of inorganic suspended solids) explained only 40% of the variation in biomass of *Hiatella arctica* fouling navigation buoys in the Gulf of St Lawrence system (Canada). These findings suggest that other variables play a more significant role in determining settlement, survival and growth over a year in this system. However the models did indicate that biomass is higher where temperatures were greater (around 14 °C) although a causal link was not identified (Bourget *et al*., (2003).

Asterias rubens is abundant throughout the north-east Atlantic, from Arctic Norway, along Atlantic coasts to Senegal, and only found occasionally in the Mediterranean (Mortensen, 1927). The geographic range of *Asterias rubens* illustrates that the species is tolerant of a range of temperatures and probably becomes locally adapted. *Asterias rubens* was reported to be unaffected by the severe winter of 1962-1963 in Britain when anomalously low temperatures persisted for two months (Crisp, 1964). *Ophiothrix fragilis* also has a geographically wide distribution, ranging from northern Norway, south to the Cape of Good Hope. Consequently, this species is exposed to temperatures both above and below those found in the UK. Temperature is also a critical factor stimulating or inhibiting reproduction in hydroids, most of which have an optimum temperature range for reproduction (Gili & Hughes, 1995). Most of the hydroid and bryozoan species within the biotope are recorded to the north or south of the UK and are unlikely to be adversely affected by long-term increases in temperature at the benchmark level.

Sensitivity assessment. No direct evidence was found to assess sensitivity to this pressure however, the experiments by (Ali, 1970) suggest that *Hiatella arctica* would be able to tolerate an acute or chronic increase in temperature at the pressure benchmark although an acute or chronic increase may result in sub-lethal effects on feeding and hence a reduction in growth and potentially reproduction. Based on the geographic range of *Hiatella arctica* and other associated species, the biotope would be able to tolerate either an acute or chronic change in temperature at the pressure benchmark. Resistance is therefore assessed as 'High' and resilience as 'High' by default, so that the biotope is considered to be '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

Gordillo & Aitken (2000) in a review of environmental factors relevant to re-interpreting Late Quaternary environments from fossil collections suggest that *Hiatella arctica* is eurythermal, based on Aitken (1990) and Peacock (1993). The current distribution of *Hiatella arctica* is predominantly arctic and boreal (Sejr, *et al*., 2004; Gordillo, 2001) and palaeecological reviews describe the genus as 'consistently linked to cool temperate and polar regions' (Gordillo, 2001) suggesting that within temperate regions this species would not be sensitive to a decrease in temperature at the pressure benchmark. Regression models developed by Bourget *et al*. (2003) found that temperature and water transparency (measured in metres and indicating the level of inorganic suspended solids) explained only 40% of the variation in biomass of *Hiatella arctica* fouling navigation buoys in the Gulf of St Lawrence system (Canada). These findings suggest that other variables play a more significant role in determining settlement, survival and growth over a year in this system. However the models did indicate that biomass is higher where temperatures were greater (around 14 °C) although a causal link was not identified (Bourget *et al*., (2003).

Asterias rubens is abundant throughout the north-east Atlantic, from Arctic Norway, along Atlantic coasts to Senegal, and only found occasionally in the Mediterranean (Mortensen, 1927). The geographic range of *Asterias rubens* illustrates that the species is tolerant of a range of temperatures and probably becomes locally adapted. *Asterias rubens* was reported to be unaffected by the severe winter of 1962-1963 in Britain when anomalously low temperatures persisted for two months (Crisp, 1964). Brittlestar populations have experienced mass mortalities when exposed to very low water temperatures in winter. Populations of *Ophiothrix fragilis* inhabiting shallow subtidal habitats (5-7m depth) in the Dutch Oosterschelde Estuary were greatly reduced (to less than 10% spatial coverage) following cold winters in 1978-79, 1984-85 and 1985-86 (Leewis *et al*., 1994). However, these decreases in temperature exceed the pressure benchmark. Temperature is also a critical factor stimulating or inhibiting reproduction in hydroids, most of which have an optimum temperature range for reproduction (Gili & Hughes, 1995). Most of the hydroid and bryozoan species within the biotope are recorded to the north or south of the UK and are unlikely to be adversely affected by acute or short-term decreases in temperature at the benchmark level.

Sensitivity assessment. Based on distribution of the key characterizing species *Hiatella arctica* and other associated species, the biotope is considered to have 'High' resistance to an acute or chronic decrease in temperature at the pressure benchmark and 'High' resilience (by default). The biotope is therefore considered to be 'Not sensitive'.

Salinity increase (local)	High Q: High A: Low C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

Filipov *et al*., (2003, abstract only) tested the salinity tolerances of *Hiatella arctica* obtained from the White Sea. The salinity tolerance of individuals kept at 25 ppt was 17-36 ppt. Acclimation of *Hiatella arctica* allowed them to adapt to higher or lower salinities with the potential tolerance range of acclimated individuals assessed as 13-42 ppt.

Sensitivity assessment. Caution should be used when extrapolating results from short-term, laboratory experiments on individuals collected from other geographic ranges. However, the results from Filippov *et al*., (2003) suggest that *Hiatella arctica* is relatively euryhaline and may acclimate to increases in salinity > 40 ppt. Resistance is therefore assessed as 'High' and resilience as 'High' (by default). The biotope is therefore classed as 'Not sensitive'. Some reduction in species richness may occur as less tolerant associated species either move away or perish but this is not considered to significantly impact the character of the biotope.

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

This biotope is reported to occur in full salinity (30-35 ppt) Connor *et al*., (2004). A change in salinity at the pressure benchmark therefore refers to a change to reduced (18-30 ppt) or variable salinity (18-35 ppt). Filipovv *et al*., (2003, abstract only) tested the salinity tolerances of *Hiatella arctica* obtained from the White Sea. The salinity tolerance of individuals kept at 25 ppt was 17-36 ppt. Acclimation of *Hiatella arctica* allowed them to adapt to higher or lower salinities with the potential tolerance range of acclimated individuals assessed as 13-42 ppt. Gordillo & Aitken (2000) in a review of environmental factors relevant to re-interpreting Late Quaternary environments from fossil collections suggest that the normal minimum salinity tolerance of *Hiatella arctica* is 20 ppt, based on Aitken (1990) and Peacock (1993).

Echinoderms are stenohaline owing to the lack of an excretory organ and a poor ability to osmo- and ion-regulate (Stickle and Diehl, 1987, Russell 2013). This means that they are unable to tolerate wide fluctuations in salinity and are considered sensitive to a decrease in salinity at the pressure benchmark. However, there are examples where brittlestars have been recorded to persist in low salinity habitats. For example, dense *Ophiothrix* aggregations have been recorded in areas where normal salinity is only 16.5 ppt (Wolff, 1968, cited from Hughes, 1998), with the species was found to persist down to 10 ppt; *Asterias rubens* has been reported from areas of reduced salinity, e.g. Loch Etive, Scotland (16 ‰) and the Baltic Sea (8 ‰), and (reported as *Asteria vulgaris*) the east coast of N. America (18 ‰), the Netherlands (18 ‰) and Maine (27.4 ‰) (Russell , 2013). Binyon (1961) demonstrated all specimens exposed to 18‰ for one week died, while those exposed to 25‰ for the same period all survived. Binyon (1961) determined that their LD50 was between 22-24‰. He also noted that the Baltic specimens tolerated 8‰ and were probably a 'physiological' race; that is, adapted to low salinity. Russell (2013) reviewed additional experimental studies in which *Asterias rubens* was reported to experience mortality at 26‰, 22‰ or 12‰, and tolerate 27.4‰ and 14‰. The results suggest local or regional variation in tolerance. Echinoderm larvae have a narrow range of salinity tolerance and will develop abnormally and die if exposed to reduced or increased salinity. Similarly Ryland (1970) stated that, with a few exceptions, bryozoans the Gymnolaemata were fairly stenohaline and restricted to full salinity (ca 35 psu) and noted that reduced salinities result in an impoverished bryozoan fauna.

Sensitivity assessment. Caution should be used when extrapolating results from short-term, laboratory experiments on individuals collected from other geographic ranges. However, the results from Filippov *et al*., (2003) suggest that *Hiatella arctica* is relatively euryhaline and may acclimate to decreases in salinity from full to reduced (18-30ppt) or variable (18-35 ppt) . The impact will be mediated by the length of exposure to lower salinities, with the evidence suggesting that long-term exposure to salinities < 20 ppt harmful. Reductions in salinity at the lower end of the pressure benchmark are likely to result in a reduction in species abundance and richness as less tolerant species either move away or perish. Resistance is assessed as 'Medium' based on the resistance of *Hiatella arctica* and resilience as 'High'. The biotope is therefore classed as having 'Low' sensitivity.

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

The key characterizing species, *Hiatella arctica* are protected from water flows within burrows, although they and other associated species may be indirectly affected by changes in water movement where these impact the supply of food or larvae or other processes. Connor *et al*. (2004) report that this biotope is found in a range of water flows from moderately strong (1-3 knots- 0/5-1.5 m/s) to areas where the flow is negligible Connor *et al*., (2004).

Most species are likely to be tolerant of changes in waterflow at the pressure benchmark. The hydroid *Nemertesia antennina*, which occurs in clumps in this biotope, is found in areas where water flows range from very weak to strong (negligible -3m/s); Dense brittlestar beds are found in a range of water flows from sea lochs with restricted water flows to higher-energy environments on open coastlines. In the Dover Strait, *Ophiothrix* beds experience current speeds of up to 1.5m/s during average spring tides (Davoult & Gounin, 1995). Similarly strong tidal streams (1.0 -1.2m/s) were also recorded over beds in the Isle of Man (Brun, 1969). Davoult & Gounin (1995) found that current speeds below 0.2m/s were optimal for suspension feeding by *Ophiothrix fragilis*; if velocity exceeded 0.3 m/s the animals cease feeding, flatten themselves against the substratum and link arms, so increasing their collective stability in the current.

Sensitivity assessment. The range of flow rates experienced by the biotope is considered to indicate, by proxy, that the biotope would have 'High' resistance and by default 'High' resilience to a change in water flow at the pressure benchmark. The biotope is therefore classed as 'Not sensitive'. This assessment is supported by evidence for the range of flow speeds in which associated species are found.

Emergence regime changes	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Changes in emergence are not relevant to this biotope (group) which is restricted to fully subtidal habitats. It should be noted that *Hiatella arctica* occur within the intertidal and subtidally and that the presence of suitable substratum rather than emergence regime is a more significant factor determining the distribution

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

As this biotope occurs in circalittoral habitats it is not directly exposed to the action of breaking waves. The key characterizing species, *Hiatella arctica* are protected within burrows from the oscillatory water flows at the seabed, although they and other associated species may be indirectly affected by changes in water movement where these impact the supply of food or larvae or other processes. No specific evidence was found to assess this pressure. However, Connor *et al.* (2004) report that this biotope is found in habitats that are moderately exposed to wave action although another *Hiatella arctica* biotope (IR.MIR.KR.HiaSw) occurs across a range of wave exposure . Similarly, Trudgill & Crabtree (1987) studied *Hiatella arctica* at both sheltered and wave exposed sites, suggesting that substratum, rather than wave action is a more significant factor determining distribution.

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

Chemical Pressures

	Resistance	Resilience	Sensitivity
Transition elements & organo-metal contamination	Not Assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR

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

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.

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.

Radionuclide contamination	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

No evidence.

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	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.

Nutrient enrichment	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

This pressure relates to increased levels of nitrogen, phosphorus and silicon in the marine environment compared to background concentrations. The benchmark is set at compliance with WFD criteria for good status, based on nitrogen concentration (UKTAG, 2014). No evidence was found to assess the sensitivity of piddocks to this pressure. Nutrient enrichment that enhances productivity of phytoplankton may indirectly benefit the suspension feeding piddocks by increasing food supply. No direct evidence was found to assess this pressure. *Hiatella arctica* is a fouling species present at fish farms suggesting that it is tolerant of the increased nutrient levels associated with fish aquaculture. Moderate increases in nutrient levels may benefit suspension feeding members of the associated species assemblage by increasing macroalgal and phytoplankton productivity, increasing the proportion of particulate and dissolved organic matter and hence increasing the food supply.

Sensitivity assessment. The benchmark is relatively protective and the presence of the key characterizing species *Hiatella arctica* within fish farms suggests that biotope resistance to this pressure is 'High', resilience is 'High' (by default) and the biotope is considered to be 'Not sensitive'.

Organic enrichment	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

No evidence was found for the key characterizing species *Hiatella arctica*.This biotope is found on vertical rock surface that may limit the deposition of organic matter on the surface. In addition the biotope is often found in areas with high levels of water flow that support assemblages of suspension feeders. Currents will remove organic matter limiting exposure to the pressure and over the course of the year low levels of input may be consumed by the brittle star *Ophiothrix fragilis*, sponges and ascidians and other suspension feeders within the biotope. Borja *et al*., (2000) and Gittenberger & van Loon (2011) in the development of the AZTI Marine Biotic Index (AMBI), a biotic index to assess disturbance (including organic enrichment), both assigned *Asterias rubens* to their ecological group III of species that are 'tolerant to excess organic matter enrichment'. Hall-Spencer *et al*., (2006) observed a much higher abundance (10-100 times higher abundance) of Asterias rubens beneath salmon farms where organic enrichment had led to a visible build-up of wastes compared to reference areas.

Sensitivity assessment. This biotope occurs in areas where vertical rock is present, often with strong water flows, both these factors would reduce deposition of organic matter within the biotope. As suspension feeders within the biotope could capture and cycle organic matter, resistance to this pressure at the benchmark is assessed as 'High', resilience is assessed as 'High' (by default) and the biotope is assessed 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.

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 characterized by the soft rock substratum which supports populations of burrowing *Hiatella arctica*. A change to a sedimentary, hard rock or artificial substratum result in the loss of burrowing *Hiatella arctica* significantly altering the character of the biotope. The biotope is therefore considered to have 'No' resistance to this pressure, recovery of the biological assemblage (following habitat restoration) is considered to be 'Medium' (2-10 years) but see caveats in the recovery notes. The biotope is dependent on the presence of soft rock, as the change at the pressure benchmark is considered to be permanent recovery is categorised as 'Very low'. Sensitivity is therefore 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

The removal of substratum to 30 cm depth will remove the attached epiflora and epifauna and burrowing *Hiatella arctica* in the impact footprint. Resistance is therefore assessed as 'None', recovery of the biological assemblage (following habitat restoration) is considered to be 'Medium' (2-10 years) but see caveats in the recovery notes. The biotope is dependent on the presence of soft rock to support populations of the characterizing *Hiatella arctica*, when lost restoration would not be feasible and recovery is therefore categorised as 'Very low'. Sensitivity is therefore assessed as 'High', based on the lack of recovery of the substratum. 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	Low Q: High A: High C: High	Medium Q: High A: Low C: Medium	Medium Q: High A: Low C: Medium

Hiatella arctica burrow depths were approximately 2 cm (mean length of *Hiatella arctica* individuals was 1-1.2 cm) with a maximum depth of 4 cm on limestone shores off the coast of Ireland (Trudgill & Crabtree,1987). The burrowing life habit provides some protection from abrasion at the surface but the presence of burrows will weaken the mechanical strength of the rock. The surface epifauna and flora are more susceptible to damage and removal by surface abrasion.

The available evidence indicates that attached epifauna, such as members of this ecological group, can be entangled and removed by abrasion. Drop down video surveys of Scottish reefs exposed to trawling showed that visual evidence of damage to bryozoans and hydroids on rock surfaces was generally limited and restricted to scrape scars on boulders (Boulcott & Howell, 2011). The study showed that damage is incremental with damage increasing with frequency of trawls rather than a blanket effect occurring on the pass of the first trawls. The level of impact may be mediated by the rugosity of the attachment, surfaces with greater damage occurring over smooth terrains where the fishing gear can move unimpeded across a flat surface. Veale *et al*. (2000) reported that the abundance, biomass and production of epifaunal assemblages decreased with increasing fishing effort. Re-sampling of grounds that were historically studied (from the 1930s) indicates that some upright species have increased in areas subject to scallop fishing (Bradshaw *et al*. 2002). This study also found increases in the tough stemmed hydroids including *Nemertesia* spp., whose morphology may prevent excessive damage. Bradshaw *et al*. (2002) suggested that as well as having high resistance to abrasion pressures, *Nemertesia* spp. have benthic larvae that could rapidly colonise disturbed areas with newly exposed substrata close to the adult.

Re-sampling of grounds that were historically studied (from the 1930s) indicates that *Ophiothrix fragilis* has declined in areas subject to scallop fishing (Bradshaw *et al*., 2002). Examination of historical and recent samples suggest that the spatial presence of *Ophiothrix fragilis* and *Amphiura* spp. in the North Sea has more than halved in comparison with the number of ICES rectangles in which they were sampled at the beginning of the century, apparently in response to fishing effort (Callaway *et al*., 2007).

Sensitivity assessment. Erect epifauna are directly exposed to abrasion and sub-surface penetration which would displace, damage and remove individuals (de Groot 1984; Veale *et al*., 2000; Boulcott & Howell, 2011). Abrasion may also damage the substratum resulting in loss of habitat and exposure of *Hiatella arctica*. Resilience of some associated species will be 'High' with recovery occurring through repair, asexual reproduction and larval settlement. However, resilience of the biotope is assessed as 'Medium 'as some slower growing species may require longer to re-establish. Sensitivity is therefore assessed as 'Medium'.

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

Penetration and disturbance below the surface of the substratum may damage and remove the surface dwelling fauna and could damage and expose the *Hiatella arctica* depnding on depth of penetration and burrow depth. Burrow depths were approximately 2 cm (mean length of *Hiatella arctica* individuals was 1-1.2 cm) with a maximum depth of 4 cm on limestone shores off the coast of Ireland (Trudgill & Crabtree (1997). Suggesting that even shallow damage would impact individuals. *Hiatella arctica* in damaged burrows or those that are removed from the substratum are unlikely to be able to rebury and will be predated by fish and other mobile species.

The evidence presented in the abrasion pressure is also relevant to sub-surface damage and penetration which will include a level of abrasion. Activities resulting in penetration and disturbance can directly affect epifauna by crushing or removal, Sub-surface disturbance may also remove the habitat by breaking up and removing the substratum. Natural erosion processes are, however, likely to be on-going within this habitat type. Where abundant the boring activities of *Hiatella arctica* contribute significantly to bioerosion, which can make the substratum habitat more unstable and can result in increased rates of erosion (Trudgill & Crabtree, 1987).

Sensitivity assessment. Sub-surface penetration and disturbance could result in damage and removal of the surface epifauna and result in the damage, exposure and loss of *Hiatella arctica* and damage to the habitat. Resistance is therefore assessed as 'Low'. The associated surface dwelling fauna are predicted to recover relatively rapidly via regrowth, larval recolonisation and migration of adults in mobile species. Recovery of the key characterizing species, *Hiatella arctica* is predicted to require 2-10 years so that resilience is considered to be 'Medium' and sensitivity is 'Medium'. As the substratum cannot recover, resilience is assessed as 'Very Low' and sensitivity of the overall biotope, based on the sedimentary habitat, is considered to be 'High'.

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

No direct evidence was found to assess this pressure. Increased suspended particles will decrease light penetration, may enhance food supply (where these are organic in origin), or decrease feeding efficiency (where the particles are inorganic and require greater filtration efforts). Very high levels of silt may clog respiratory and feeding organs of some suspension feeders. Erosion of soft rock mean that this biotope, in common with other chalk biotopes, is associated with high turbidity and low light penetration (Connor *et al*., 2004). *Hiatella arctica* is a filter feeding bivalve, many other species of this type have efficient mechanisms to remove inorganic particles via pseudofaeces. For example, *Petricola pholadiformis* is able to cope in water laden with much suspended material by binding the material in mucus and using the palps to reject it (Purchon, 1955). *Hiatella arctica* is protected from scour within burrows and increased organic particles may provide a food subsidy. Increased suspended sediments may impose sub-lethal energetic costs on bivalves by reducing feeding efficiency and requiring the production of pseudofaeces with impacts on growth and reproduction.

Local increases in turbidity in waters previously within the photic zone, may alter local abundances of phytoplankton and surface diatoms and the zooplankton and other small invertebrates that feed on them. An increase in suspended solids may therefore indirectly reduce feeding efficiency. However, where the pressure results from an increase in suspended organic matter this would be beneficial to some suspension feeders by providing increased food material (and perhaps local stimulation of phytoplankton abundance where nutrients are recycled back to the water column).

Regression models developed by Bourget *et al.* (2003) found that temperature and water transparency (measured in metres and indicating the level of inorganic suspended solids) explained only 40% of the variation in biomass of *Hiatella arctica* fouling navigation buoys in the Gulf of St Lawrence system (Canada). These findings suggest that other variables play a more significant role in determining settlement, survival and growth over a year in this system. However the models did indicate that biomass is higher where water transparency was greater (around 15 m) and declined at higher levels of suspended solids (transparency 5 m) although a causal link was not identified (Bourget *et al.*, (2003).

A significant decrease in suspended organic particles may reduce food input to the biotope resulting in reduced growth and fecundity of suspension feeding animals. However, local primary productivity may be enhanced where suspended sediments decrease, increasing food supply.

Sensitivity assessment. No direct evidence was found to assess sensitivity to this pressure. A decrease in turbidity increasing light penetration may allow some algae to colonize and could lead to the development of an assemblage resembling that of the infralittoral limestone biotope IR.MIR.KR.HiaSw. However, a year is not considered long enough to lead to the development of this community, particularly as space is occupied by attached epifauna. Resistance is therefore assessed as 'High', resilience as 'High' (by default) and the biotope is considered to be 'Not sensitive'. As the biotope occurs in turbid waters a further increase in turbidity may exceed the tolerances of *Hiatella arctica* and other associated species. Resistance is therefore assessed as 'Medium' and resilience as 'High' so that sensitivity is assessed as 'Low'. No direct evidence was found to support this assessment and confidence is 'Low'.

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

Exposure to siltation pressures will be mediated by site-specific topography and hydrodynamics as silts may not accumulate on vertical surfaces, especially where these are smooth, although some deposits may be trapped by epifauna and epiflora (where these occur). Water currents or wave action may also be sufficient to rapidly remove fine particles although this will depend partially on the scale of the impact. As *Hiatella arctica* are essentially sedentary with relatively short siphons, siltation from fine sediments rather than sands, even at low levels for short periods could be lethal. Siltation by fine sediments would also prevent larval settlement for species which require hard substratum (Berghahn & Offermann, 1999). In general it appears that hydroids are sensitive to silting (Boero, 1984; Gili & Hughes, 1995) and decline in beds in the Wadden Sea has been linked to environmental changes including siltation. Round *et al.* (1961) reported that the hydroid *Sertularia* (now *Amphisbetia*) *operculata* died when covered with a layer of silt after being transplanted to sheltered conditions.

Sensitivity assessment. As this biotope occurs on vertical surfaces siltation may be limited. However, in general, resistance to this pressure is assessed as 'Low' as siltation may smother *Hiatella arctica* and other associated species. Resilience is assessed as 'Medium' and sensitivity is therefore assessed as 'Medium'.

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

Sensitivity to this pressure will be mediated by site-specific hydrodynamic conditions and the footprint of the impact. Where a large area is covered sediments may be shifted by wave and tides rather than removed. As *Hiatella arctica* are essentially sedentary with relatively short siphons, siltation from fine sediments rather than sands, even at low levels for short periods could be lethal. In general it appears that hydroids are sensitive to silting (Boero, 1984; Gili & Hughes, 1995) and decline in beds in the Wadden Sea has been linked to environmental changes including siltation. Round *et al*., (1961) reported that the hydroid *Sertularia* (now *Amphisbetia*) *operculata* died when covered with a layer of silt after being transplanted to sheltered conditions.

Sensitivity assessment. As this biotope occurs on vertical surfaces siltation may be limited. However, in general resistance to siltation is assessed as 'Low' as siltation may smother *Hiatella arctica* and other associated species. Resilience is assessed as 'Medium' (2-10 years) and sensitivity is therefore assessed as 'Medium'. Survival will be higher in winter months when temperatures are lower and physiological demands are decreased. However, mortality will depend on the duration of smothering. Mortality is likely to be more significant in wave sheltered areas where the smothering sediment remains for prolonged periods and reduced where the smothering sediment is rapidly removed by wave action or currents.

Litter	Not Assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR

Not assessed.

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

No evidence.

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

Not relevant.

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

This biotope occurs on vertical surfaces where shading will prevent direct light. Where levels of turbidity are high light penetration will be further reduced. *Hiatella arctica* and other species present in this biotope occur in the intertidal and shallow subtidal where light levels are high, as well as deeper water wher light penetration is limited. Increases in light may allow a more diverse and abundant algal community to develop, however the soft rock surfaces and turbidity that characterize this biotope are generally unsuitable for large attached macroalgae and a shift to an algal dominated biotope is considered unlikely. Additionally, in areas of high water flow, macroalgae with insecure attachments will be removed by drag forces.

Sensitivity assessment. This biotope is considered to have 'High' resistance to changes in light levels and 'high' resilience (by default), so that the biotope 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. Conversely the presence of barriers may enhance local population supply by preventing the loss of larvae from enclosed habitats. *Hiatella arctica* and species associated with the biotope are widely distributed and produce large numbers of larvae capable of long distance transport and survival, resistance to this pressure is assessed as 'High' and resilience as 'High' by default. This biotope is therefore considered to be 'Not sensitive'.

Death or injury by collision	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Not relevant' to seabed habitats. NB. Collision by grounding vessels is addressed under 'surface abrasion.

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

Not relevant.

Biological Pressures

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

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

Introduction or spread of invasive non-indigenous species	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

The friable nature of the substratum which is subject to on-going erosion means this biotope supports only a sparse epifauna and flora. This biotope is therefore unlikely to be invaded by sessile invasive non-indigenous species that require hard substratum. As the biotope occurs subtidally and turbidity levels are often high limiting light penetration this biotope is unlikely to provide suitable habitats for many species of invasive non-indigenous algae.

The American piddock, *Petricolaria pholadiformis* is a non-native, boring piddock that was unintentionally introduced from America with the American oyster, *Crassostrea virginica*, not later than 1890 (Naylor, 1957). Rosenthal (1980) suggested that from the British Isles, the species has colonized several northern European countries by means of its pelagic larva and may also spread via driftwood, although it usually bores into clay, peat or soft rock intertidal habitats. This species is unlikely to displace *Hiatella arctica* in this biotope which occurs subtidally and on harder substrata.

Although not currently established in UK waters, the whelk *Rapana venosa*, may spread to habitats. This species has been observed predating on *Pholas dactylus* in the Romanian Black Sea by Micu (2007) and may pose a threat to other burrowing bivalves including *Hiatella arctica*.

Sensitivity assessment. Based on the lack of records of invasive non-indigenous species in this biotope, and the unsuitability of the habitat for algae and other attached epifauna this biotope is considered to have 'High' resistance to this pressure and, by default 'High' resilience, this biotope is therefore considered to be 'Not sensitive'. This assessment may need revising in light of future invasions, e.g. the introduction of the whelk *Rapana venosa*.

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

No evidence was found for the impact of microbial pathogens on characterizing species, based on the lack of evidence for outbreaks of disease or significant mortality this biotope was considered to have 'High' resistance to this pressure and 'High' resilience (by default), and is therefore assessed 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

No species within the biotope description (Connor *et al*., 2004) are targeted commercially. This pressure is therefore considered to be 'Not relevant' to this biotope. The effects of removal of non-target species (by-catch) are assessed separately.

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

The epifauna present in this biotope may be removed or damaged by activities targeting other species. These direct, physical impacts are assessed through the abrasion and penetration of the seabed pressures. Removal of the epifauana as by-catch would alter the character of the biotope and result in the loss of the ecosystem functions and habitat structure created by these species. In general the attached species present are found in low densities due to the nature of the substratum which is too soft for epifauna and flora to attach to or to maintain attachment (Connor *et al*., 2004). It is unlikely that targeted harvesting of other species would remove all of the species present or unintentionally remove the key characterizing *Hiatella arctica* species which are protected within burrows. Resistance of the biotope to this pressure is assessed as 'Medium' as the effects are through removal of the associated assemblage rather than the key characterizing *Hiatella arctica* species and resilience is assessed as 'High' so that sensitivity is assessed as 'Low'. This biotope is found on vertical surfaces which may limit exposure to activities that result in this pressure.

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