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Antedon spp., solitary ascidians and fine hydroids on sheltered circalittoral rock

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

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2016-03-23

This review can be cited as:
Readman, J.A.J. & Hill, J.M., 2016. [Antedon] spp., solitary ascidians and fine hydroids on sheltered circalittoral rock. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. DOI https://dx.doi.org/10.17031/marlinhab.313.1

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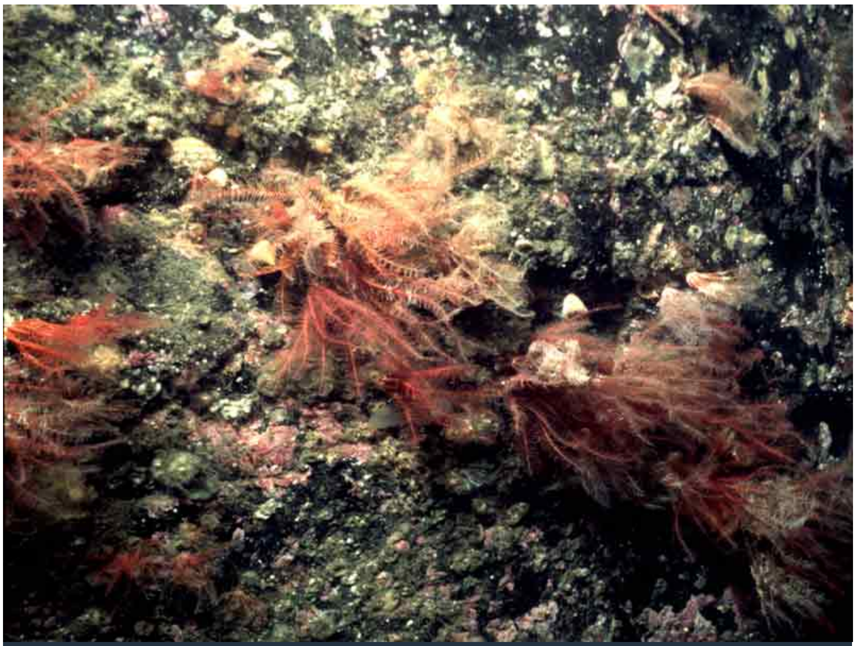

Circalittoral rock with *Antedon bifida*, hydroids and occasional solitary sea squirts.
Photographer: Keith Hiscock
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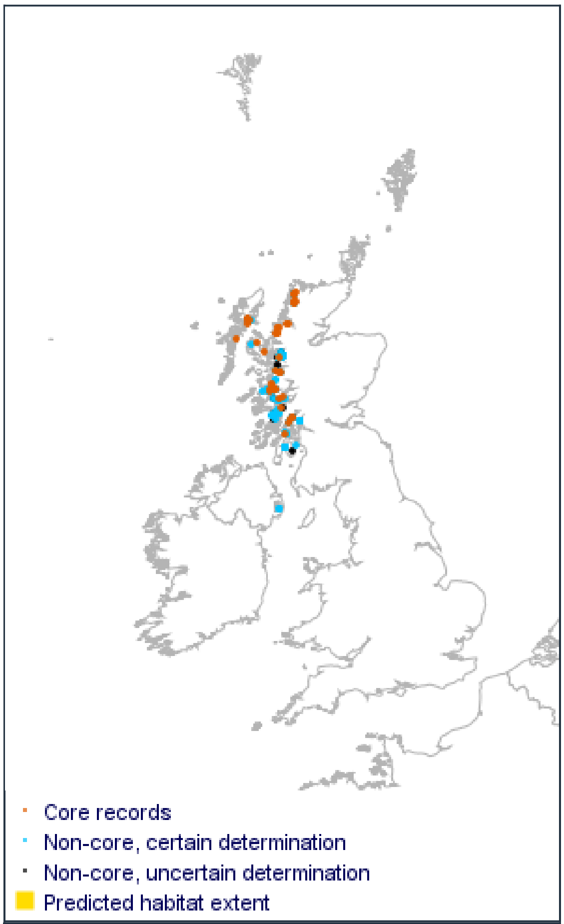

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by John Readman & Jaqueline Hill **Refereed by** This information is not refereed.

Summary

UK and Ireland classification

EUNIS 2008	A4.313	*Antedon* spp., solitary ascidians and fine hydroids on sheltered circalittoral rock
JNCC 2015	CR.LCR.BrAs.AntAsH	*Antedon* spp., solitary ascidians and fine hydroids on sheltered circalittoral rock
JNCC 2004	CR.LCR.BrAs.AntAsH	*Antedon spp.*, solitary ascidians and fine hydroids on sheltered circalittoral rock
1997 Biotope	CR.SCR.BrAs.AntAsH	*Antedon spp.*, solitary ascidians and fine hydroids on sheltered circalittoral rock

Description

This biotope is typically found on silty boulder or rock slopes, in the sheltered parts of sealochs, subject to weak or very weak tidal currents. The seabed consists of smooth, silty bedrock or boulders, often as outcrops on mixed muddy sediment. There are often small vertical faces on the sides of rock ridges, and at few sites, there may be more extensive steep or vertical bedrock. In sharp contrast to the barren, grazed appearance of AmenCio.Ant, the species composition of AntAsH is quite diverse, although no one phyla dominates. A wide range of encrusting species may be found, including the brachiopod *Novocrania anomala*, the saddle oyster *Pododesmus patelliformis*, encrusting red algae and polychaetes (*Spirobranchus triqueter* and *Protula tubularia*). Other conspicuous species include crinoids on the tops of boulders (*Antedon bifida*, commoner in shallower water and *Antedon petasus*, commoner in deeper water), scattered solitary and colonial ascidians (*Ascidia mentula*, *Ascidia virginea*, *Corella parallelogramma*, *Clavelina lepadiformis* and*Ciona intestinalis*) and tufts of fine hydroids (*Kirchenpaueria pinnata*, *Nemertesia antennina*, *Obelia dichotoma* and*Halceum halecinum*). The cup coral *Caryophyllia smithii* and the crustose bryozoan *Parasmittina trispinosa* are all typically present, as are a wide range of echinoderms, including the sea urchin *Echinus esculentus*, the starfish *Asterias rubens* and *Crossaster papposus*, and the brittlestars *Ophiothrix fragilis* and *Ophiura albida*. Other species recorded are the squat lobster *Munida rugosa*, the hermit crab *Pagurus bernhardus* and the chiton *Tonicella marmorea*.

Depth range

5-10 m, 10-20 m, 20-30 m, 30-50 m

Additional information

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Listed By

- none -

Further information sources

Search on:

G G G JNCC

Habitat review

Ecology

Ecological and functional relationships

- In this circalittoral biotope there are few algal species and limited primary production. The fauna is dominated by attached species such as hydroids, solitary ascidians and sponges. The fauna consists predominantly of suspension feeders.
- The characterizing species in this biotope occupy space in the habitat but their presence is most likely primarily determined by the occurrence of a suitable substratum and water currents rather by interspecific interactions.
- However, there are some organisms known to be associated with *Antedon bifida* such as the rare caridean crustacean *Hippolyte huntii* (Gosse) and the more common *Hippolyte varians* Leach and *Thoralus cranchi* (Leach). These species are cryptically concealed on the feather-star by their colouration. The amphipod *Apherusa bispinosa* (Bate) and a little known scale worm *Adyte pellucida* have also been found with *Antedon* spp. (Leonard & Jeal, 1984). The myzostome *Myzostoma cirriferum* Leuckart is a well known ectoparasite on the arms and disc of *Antedon* spp. Level of infestation, however, varies from location to location (Leonard & Jeal, 1984). Sponges and solitary ascidians can provide substratum for small epifaunal species such as hydroids.
- There are few predators in the biotope and predation levels are unknown. However, the various mobile echinoderms found in the biotope (e.g. *Asterias rubens*, *Crossaster papposus* and *Solaster endeca*) may have a role in modifying benthic populations through predation. *Echinus esculentus* is an omnivorous grazer that feeds on hydroids, barnacles and other encrusting invertebrates and the species may also modify faunal abundance and distribution. Hydroids are often eaten by nudibranchs. *Nemertesia ramosa*, for example, is fed on by a variety of sea slugs including *Doto fragilis*, *Doto cuspidata*, *Lomanotus genei*, and by the sea spider *Endeis spinosa*.

Seasonal and longer term change

There will be some temporal changes in the coverage and shelter provided by the species in the biotope. For example, *Ciona intestinalis* is typically an annual species, although reproduction can occur throughout the year so overall population numbers are probably quite constant over the period of a year. There is much seasonal variability in abundance of individual hydroids and experiments have shown that colony growth is highest over a defined temperature range (Gili & Hughes, 1995). However, there is much interspecific variability in temporal abundance, where different species are found at different times of the year so total hydroid coverage in the biotope may remain constant throughout the year. Seasonal cycles of hydroids are much more pronounced in shallow waters than those at greater depths, probably because of the greater seasonal differences in temperature. Other species such as the anthozoan *Alcyonium digitatum* have seasonal stages, 'shutting up shop' during the winter months. Otherwise, it is unlikely that there will be any significant seasonal or other temporal changes in the biotope.

Habitat structure and complexity

The biotope habitat is not particularly complex as fauna are sparsely distributed and there may be areas of unencrusted rock. Some microhabitats may be provided by cracks and crevices in the rock. Some of the larger species such as sponges and solitary ascidians can provide substrata for attachment, refugia and shelter of a number of animals.

Productivity

- The only photosynthetic species listed as characterizing in the biotope are algal crusts. Consequently, primary production is not a major component of productivity. High densities of encrusting or attached organisms, solitary ascidians, feather stars and tube worms can result in quite high secondary productivity through suspension feeding. However, the fauna in SCR.AntAsH are relatively sparse so secondary production in the biotope is probably not very high.
- *Antedon bifida* may lose up to half their pinnules through predation, largely, if not entirely by the corkwing wrasse (Nichols, 1994). Feather-stars can replace the loss of one fifth of the disc and the corresponding arm and can sustain the simultaneous loss of four of the five pairs of arms without death (Barnes, 1980).
- An abundance of hydroids together with high food capture rates often recorded and the fact that they are consumed by many different benthic invertebrates indicates that they may have an important, but little known, role in marine food webs by transferring energy from the plankton to the benthos. However, abundance of fauna is not very high so the biotope is not likely to represent an important food resource for a number of predatory species, such as starfish, decapod crustaceans and fish.

Recruitment processes

Most of the species in the biotope have pelagic larvae so recruitment will be largely from the water column. In sheltered sea lochs tidal flows are not very strong so there may not be a high supply of planktonic larvae so that many species may take a long time to recruit from outside if local populations are lost. However, many of the characterizing species in the biotope, particularly the hydroids and some ascidians have short lived planktonic larvae so dispersal distances are short and recruitment will largely be from local populations. For example, intense local recruitment can occur with *Ciona intestinalis* where sticky mucus strings containing eggs and larvae are trapped round nearby adults or other objects. Other species such as the anthozoan, *Alcyonium digitatum*, have long lived and potentially dispersive pelagic larvae. Where neighbouring populations are present recruitment may be rapid but recruitment from distant populations may take a long time.

Time for community to reach maturity

There is no information available on the time it takes for the biotope to reach maturity. The lifespan of *Antedon bifida* is unknown although since sexual maturity is not reached until individuals are over 1 year old. Longevity is therefore, likely to be several years. There is much interspecific variability in the lifespan of hydroids. Several species are known to live for 1 year or less (e.g. *Tubularia indivisa* and some with several generations per year (e.g. *Nemertesia antennina*). In the case of hydroid colonies it is difficult to determine the lifespan unless all the hydroids die at the same time so that a distinct change of generations is identifiable. In some cases it appears that old colonies die before the summer and new ones that grew around their bases in the spring, grow in their place in the autumn. Therefore, it appears that many hydroids live for many years. Large sponges may have considerably greater longevity and slower growth. Therefore, it may take several years for the community to reach maturity.

Additional information

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Preferences & Distribution

Habitat preferences

Depth Range	5-10 m, 10-20 m, 20-30 m, 30-50 m
Water clarity preferences	
Limiting Nutrients	Not relevant, No information found
Salinity preferences	Full (30-40 psu)
Physiographic preferences	Enclosed coast / Embayment
Biological zone preferences	Circalittoral
Substratum/habitat preferences	Bedrock, Large to very large boulders
Tidal strength preferences	Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Extremely sheltered, Sheltered, Very sheltered
Other preferences	

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.LCR.BrAs.AntAsH is a circalittoral biotope found on silty boulder or rock slopes and is typical of sheltered parts of sea lochs, subject to weak or very weak tidal currents. It is similar to CR.LCR.BrAs.AmenCio and CR.LCR.BrAs.AmenCio.Ant, but in contrast to a heavily grazed appearance, CR.LCR.BrAs.AntAsH is richer in diversity. In more shallow conditions, infralittoral silted kelp biotopes (including LhypSlat and Slat) are found and in deeper conditions, boulder slopes tend to grade into muddy slopes or plain (CMU or CMX), with a change in fauna to those species associated with soft-sediments. In this circalittoral biotope there are few algal species and limited primary production. The fauna consists predominantly of attached suspension feeders such as hydroids and solitary ascidians. Loss of the characterizing fine hydroids (including *Kirchenpaueria pinnata*, *Nemertesia ramosa*, *Obelia dichotoma* and *Halceum halecinum*) solitary ascidians (including *Ascidia mentula* and *Ciona intestinalis)* and *Antedon* spp. may result in loss or degradation of the biotope. Due to the range of hydroid species present most assessments for this group are quite general. Whilst the biotope is less heavily grazed than CR.LCR.BrAs.AmenCio, grazing by the sea urchin *Echinus esculentus* may be important in maintaining the diverse range of opportunistic species and loss of this species could affect the biotope. Other species present in these biotopes are considered transient, mobile or ubiquitous and are therefore not considered significant to assessment of the sensitivity of these biotopes. However, information on the sensitivity of other characterizing species is included where appropriate.

Resilience and recovery rates of habitat

Hydroids exhibit rapid rates of recovery from disturbance through repair, asexual reproduction and larval colonization. Sparks (1972) reviewed the regeneration abilities and rapid repair of injuries. Fragmentation of the hydroid provides a route for short distance dispersal, for example, each fragmented part of *Sertularia cupressina* can regenerate itself following damage (Berghahn & Offermann, 1999). New colonies of the same genotype may therefore arise through damage to existing colonies (Gili & Hughes, 1995). Many hydroid species also 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 and provide a mechanism for rapid recovery (Cornelius, 1995a; Kosevich & Marfenin, 1986). The lifecycle of hydroids typically alternates between an attached solitary or colonial polyp generation and a free-swimming medusa generation. Planulae larvae produced by hydroids typically metamorphose within 24 hours and crawl only a short distance away from the parent plant (Sommer, 1992). Gametes liberated from the medusae (or a vestigial sessile medusae) produce gametes which fuse to form zygotes that develop into free-swimming planula larvae (Hayward & Ryland, 1994) that are present in the water column between 2-20 days (Sommer, 1992). It has also been suggested that rafting on floating debris as dormant stages or reproductive adults (or on ships hulls or in ship ballast water), together with their potentially long lifespan, may have allowed hydroids to disperse over a wide area in the long-term and explain the near cosmopolitan distributions of many hydroid species (Cornelius, 1992; Boero & Bouillon 1993). Hydroids are therefore classed as potential fouling organisms, rapidly colonising a range of substrata placed in marine environments and are often the first organisms to colonize available space in settlement experiments (Gili & Hughes, 1995). For example, hydroids were reported to colonize an experimental artificial reef within less than 6 months, becoming abundant in the following year (Jensen *et al*., 1994). In similar studies, *Obelia* species recruited to the bases of reef slabs within three months and the slab surfaces within six months of the slabs being placed in the marine environment (Hatcher, 1998). Cornelius (1992) stated that *Obelia* spp. could form large colonies within a matter of weeks. In a study of the long-term effects of scallop dredging in the Irish Sea, Bradshaw *et al*., (2002) noted that hydroids increased in abundance, presumably because of their regeneration potential, good local recruitment and ability to colonize newly exposed substratum quickly. Cantero *et al*. (2002) and refs. therein describe fertility of *Obelia dichotoma*, *Kirchenpaureria pinnata*, *Nemertesia ramosa* in the Mediterranean as being year-round, whilst it should be noted that higher temperatures may play a factor in this year round fecundity, Bradshaw *et al*., (2002) observed that reproduction in *Nemertesia antennina* occured regularly, with three generations per year. It was also observed that presence of adults stimulate larval settlement, therefore if any adults remain, reproduction is likely to result in local recruitment. Hayward & Ryland (1994) stated that medusae release in *Obelia dichotoma* occurred in summer. *Obelia dichotoma* forms monosipphonic stems up to 50mm or polysiphonic structures that can reach up to 350 mm in height in calm habitats. It is near-cosmopolitan throughout the coasts of the British Isles and is distributed from Svalbard to the Mediterranean (Hayward & Ryland, 1994; Orjas *et al*., 2012; Cantero *et al*., 2002). *Halecium halecinum* is an erect hydroid growing up to 250 mm and is found on stones and shells in coastal areas. It is widely distributed in the Atlantic and is present from Svalbard to the Mediterranean (Hayward & Ryland, 1994; Palerud *et al*., 2004; Medel *et al*., 1998). *Kirhchenpaueria pinnata* has pinnate stems clustered on branched basal stolon which are commonly 30-100 mm. It is found on stones, algae and in pools from MLW to sublittoral and is common off all British coasts and is present from Svalbard to Mediterranean(Hayward & Ryland, 1994; Palerud *et al*., 2004). *Nemertesia ramosa* grows up to 150 mm and is found inshore to deeper water and is common throughout British Isles and is distributed from Iceland to north-west Africa (Hayward & Ryland, 1994). Sea squirts (ascidians) are simultaneously hermaphroditic, sessile filter feeding chordates. Whilst the adults do not have a backbone, their free swimming, short-lived, ascidian larvae possess a notochord which is lost during metamorphosis into its sessile form. Solitary ascidians are discrete creatures which do not fuse with others (unlike colonial ascidians), but may still form dense beds (e.g. up to 5000 individuals/m^2 for *Ciona intestinalis*) (Naylor, 2011). Both *Ascidia mentula* and *Ciona intestinalis* occur across the western, northern and southern coasts of the UK, with more scattered recordings on the eastern coast (NBN, 2015). *Ascidia mentula* is found from Norway to the Mediterranean (Picton & Morrow, 2015) and *Ciona intestinalis* occurs from Norway and Sweden (Svane, 1984) through to Cape Verde, although these latter populations are thought to be transitory (Monniot & Monniot 1994). *Ciona intestinalis* is a well-studied species owing to its status as an invasive species in many parts of the world including the USA, Chile, Western Australia, New Zealand, Canada and South Africa (Millar 1966; McDonald 2004; Blum *et al.* 2007; Ramsay *et al*., 2008; 2009; Dumont *et al*., *2011*). It is considered an indigenous species in the UK (Lambert & Lambert, 1998). *In Ciona intestinalis*, spawning has been reported as more or less year round in temperate conditions (Yamaguchi, 1975, Caputi *et al*., 2015, MBA, 1957) with seasonal spawning observed in colder climates from May to June on the Canadian coast (Carver *et al*., 2006) and in shallower habitats in Sweden (Svane & Havenhand, 1993). Oviparous solitary ascidians generally spawn both oocytes and sperm into the water column, where the resultant fertilized eggs develop into free swimming, non-feeding larvae. The eggs are negatively buoyant and slightly adhesive and are either released freely or in mucus strings which are especially adhesive. These strings have a tendency to settle close to or on the parent ascidian. *In vitro* studies conclude that fertilization proceeds normally whether in the water column or attached to the mucus string. The hatched free-swimming larvae settle nearby, are held by the mucus string until settlement or escape as plankton. Retention in the mucus string may explain the dense aggregations of adults found (Svane & Havenhand, 1993). *In vitro* studies indicate that both spawning and settlement are controlled by light, however *Ciona intestinalis in vivo* has been observed to spawn and settle at any time of the day (Whittington, 1967; Svane & Havenhand, 1993 and references therein). In the

Mediterranean, population collapses of *Ciona intestinalis* were observed, followed by recovery within 1-2 years (Caputi *et al*., 2015). The collapses are still poorly understood, although low salinity (Pérès, 1943) and temperature (Sabbadin, 1957) are suggested as possible drivers. *Ascidia mentula* is a larger (up to 18 cm long) and longer lived (up to 7 years) ascidian compared to *Ciona intestinalis* (Rowley, 2008). Recruitment has been reported to occur year round in Sweden at depths greater than 20 m, with seasonal spawning occurring at 15 m (where sea temperature variability is much greater). Svane (1984) noted that, whilst predation by sea urchins did not appear to be substantial, mortality caused by disturbance and dislocation were significant. Sea urchins were observed to leave cleared tracks as they moved across the substratum but their feeding was curtailed in the presence of more densely aggregated ascidians that had restricted urchin movement. Both active larvae settlement distribution and passive deposition of larvae (i.e. purely hydrodynamic processes) have been proposed (Havenhand & Svane, 1991 see also Meadows & Campbell, 1972; Scheltema, 1974; Butman, 1987). Long-term data from populations of the ascidian *Ascidia mentula* on subtidal vertical rock indicated that recruitment of *Ascidia mentula* larvae was positively correlated with adult population density, and then by subsequent active larval choice at smaller scales. Factors influencing larval settlement have been listed as light, substratum inclination and texture (Havenhand & Svane, 1989). The presence of hydroids may also be important in recruitment of ascidians. Schmidt (1983) described how the hydroid *Tubularia larynx* attracted a 'bloom' of the ascidians *Ciona intestinalis* and *Ascidiella aspersa* on settlement panels. However, the swimming power of an ascidian tadpole larva is relatively low (Chia, Buckland-Nicks & Young, 1984). Therefore, on a larger scale, hydrodynamics probably determine distribution (Olson, 1985; Young, 1986). Sebens (1985; 1986) described the recolonization of epifauna on vertical rock walls. Rapid colonizers such as encrusting corallines, encrusting bryozoans, amphipods and tubeworms recolonized within 1-4 months. Ascidians such as *Dendrodoa carnea*, *Molgula manhattensis* and *Aplidium* spp. achieved significant cover in less than a year, and, together with *Halichondria panicea*, reached pre-clearance levels of cover after 2 years. A few individuals of *Alcyonium digitatum* and *Metridium senile* colonized within 4 years (Sebens, 1986) and would probably take longer to reach pre-clearance levels. *Echinus esculentus* is a sea urchin found within the north-east Atlantic, recorded from Murmansk Coast, Russia to Portugal (Hansson, 1998). *Echinus esculentus* is an important algal grazer and is thought, combined with low light levels, to control red algal growth (Connor *et al*., 2004). *Echinus esculentus* is estimated to have a lifespan of 8-16 years (Nichols, 1979; Gage, 1992) and reaches sexual maturity within 1-3 years (Tyler-Walters, 2008). Maximum spawning occurs in spring although individuals may spawn over a protracted period throughout the year. Gonad weight is at its maximum in February/March in English Channel (Comely & Ansell, 1988) but decreases during spawning in spring and then increases again through summer and winter until the next spawning season. Spawning occurs just before the seasonal rise in temperature in temperate zones but is probably not triggered by rising temperature (Bishop, 1985). *Echinus esculentus* is a broadcast spawner, with a complex larval life history which includes a blastula, gastrula and a characteristic four armed echinopluteus stage, which forms an important component of the zooplankton. MacBride (1914) observed planktonic larval development could take 45-60 days in captivity. Recruitment is sporadic or variable depending on locality, e.g. Millport populations showed annual recruitment, whereas few recruits were found in Plymouth populations during Nichols' studies between 1980-1981 (Nichols, 1984). Bishop & Earll (1984) suggested that the population of *Echinus esculentus* at St Abbs had a high density and recruited regularly whereas the Skomer population was sparse, ageing and had probably not successfully recruited larvae in the previous 6 years (Bishop & Earll, 1984). Comely & Ansell (1988) noted that the largest number of *Echinus esculentus* occurred below the kelp forest. *Echinus esculentus* is a mobile species and could therefore migrate and re-populate an area quickly if removed. For example, Lewis & Nichols (1979) found that adults were able to colonize an artificial reef in small numbers within 3 months and the population steadily grew over the following year. If completely removed from a site and local populations are naturally sparse then recruitment may be dependent on larval supply which can be highly variable. As suggested by Bishop & Earll (1984) the Skomer, Wales *Echinus esculentus* population had most likely not successfully recruited for 6 years which would suggest the mature population would be highly sensitive to removal and may not return for several years. The *Prestige* oil tanker spilled 63 000t of fuel 130 nautical miles off Galicia, Spain in November 2002. High wave exposure and strong weather systems increased mixing of the oil to “some” depth within the water column, causing sensitive faunal communities to be effected. The biological community of Guéthary, France was monitored preceding and for nine years following the oil spill. Following the oil spill, taxonomic richness decreased significantly from 57 recorded species to 41, which included the loss of *Echinus esculentus* from the site. Two to three years after the oil spill taxonomic richness had increased to pre-spill levels and *Echinus esculentus* had returned (Castège *et al.*, 2014). *Antedon* is a genus of free-swimming, stem-less crinoids. Two such species are found in CR.LCR.BrAs.AmenCio.Ant; *Antedon bifida* and *Antedon petasus*, both of which are ten armed feather-stars which use claw-like cirri on their underside to move across the substratum. Mature individuals can be recognised by swollen genital papillae at the base of the arms. Eggs escape through splits which appear in the pinnule walls, and adhere in groups to the external wall of the pinnule where fertilization takes place. The embryos are held on the pinnules in a mucous net during which time the female holds its arms close together. Embryos remain attached in groups of up to 20 for four or five days (Chadwick, 1907 cited in Nichols, 1991). The embryos hatch as free-swimming larvae which, after a short pelagic phase, attach to the substratum and develop a short stalk. At this stage they are known as pentacrinoid larvae. The pentacrinoids eventually detach with prehensile cirri having developed on the underside of the disc. *Antedon bifida* spawns between May to July. However, Nichols (1991) observed that mature oocytes and active sperm were present in every month of the year although a ‘spawned out’ condition has been intermittently recorded. Despite shed embryos only having been observed between May and July, it is possible that, like the *Antedon mediterranea*, *Antedon bifida* reproduces all year (Nichols 1991). In later work Nichols (1994) suggested that the maintenance of gonads at a high level of maturity throughout the year is a life-history trait developed to tolerate the predation of expendable and easily-regenerated gonads. Little information is available on recovery of the *Antedon*. However, it should be noted that *Antedon* are mobile and judging from life-history traits, *Antedon bifida* should be able to recover within five years. The species reaches sexual maturity within the first or second year and is iteroparous, spawning for 2-3 months every year (Nichols, 1991). Eggs are brooded on the arms of the feather-star and pelagic larvae are then released into the water column. However, the pelagic phase is fairly short so dispersal distances may not be great and recruitment may rely on relatively local populations. Therefore, if populations are completely removed by a factor recovery may take longer than five years.

Resilience assessment.

The hydroids that characterize this biotope are likely to recover from damage very quickly. Based on the available evidence, resilience for the hydroid species assessed is ‘High’ (recovery within two years) for any level of perturbation (where resistance is ‘None’, ‘Low’, ‘Medium’ or ‘High’). Depending on the season of the impact and level of recovery, recovery could occur within six months. Spawning has been reported as more or less year round in temperate conditions for both *Ciona intestinalis* (Yamaguchi, 1975, Caputi *et al.*, 2015; MBA, 1957) and *Ascidia mentula* (Fish & Fish 1996). *Ciona intestinalis* reaches sexual maturity at a body height of ca 25-30mm, with one to two generations per year and longevity of ca 1.5 years. (Fish & Fish 1996). Sebens (1985, 1986) found that ascidians such as *Dendrodoa carnea, Molgula manhattensis and Aplidium spp.* achieved significant cover in less than a year, and, together with *Halichondria panicea*, reached pre-clearance levels of cover after 2 years. A few individuals of *Alcyonium digitatum* and *Metridium senile* colonized within 4 years (Sebens, 1986) and would probably take longer to reach pre-clearance levels. *Echinus esculentus* can reportedly reach sexual maturity within 1-2 years (Tyler-Walters, 2008), however as highlighted by Bishop & Earll (1984) and Castège *et al.*, (2014) recovery may take 2-6 years (possibly more if local recruitment is poor). *Antedon* spp. are mobile, reach sexual maturity within the first or second year and are iteroparous, spawning for 2-3 months every year (Nichols, 1991). Eggs are brooded on the arms of the feather-star and pelagic larvae are then released into the water column. However, the pelagic phase is fairly short so dispersal distances may not be great and recruitment may rely on relatively local populations. Therefore, if populations are completely removed, recovery will take longer.

If the community is completely removed from the habitat (resistance of '**None**' or '**Low**') resilience is assessed as '**Medium**' (recovery within 2-10 years). However if resistance is assessed as '**Medium**' or '**High**' then resilience will be assessed as '**High**' (recovery within 2 years).

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)	Medium Q: Medium A: Medium C: Medium	High Q: High A: High C: High	Low Q: Medium A: Medium C: Medium

In a review of the ecology of hydroids, Gili & Hughes, (1995) report that temperature is a critical factor stimulating or preventing reproduction and that most species have an optimal temperature for reproduction. However, limited evidence for thermal thresholds and thermal ranges were available for the characterizing species recorded in this biotope. Berrill (1949) reported that growth in *Obelia commissularis* (syn. *dichotoma*) was temperature dependant but ceased at 27°C. Hydranths did not start to develop unless the temperature was less than 20°C and any hydranths under development would complete their development and rapidly regress at ca 25°C. Berrill (1948) reported that *Obelia* species were absent from a buoy in July and August during excessively high summer temperatures in Booth Bay Harbour, Maine, USA. Berrill (1948) reported that the abundance of *Obelia* species and other hydroids fluctuated greatly, disappearing and reappearing as temperatures rose and fell markedly above and below 20°C during this period. The upwelling of cold water (8-10°C colder than surface water) allowed colonies of *Obelia* sp. to form in large numbers. Cantero *et al.* (2002) and refs. thererin describe the presence and year-round fertility of *Obelia dichotoma*, *Kirchenpaureria pinnata*, *Nemertesia ramosa* and *Halecium spp.*in the Mediterranean, indicating probable tolerance to temperature increases at the benchmark figure. *Ciona intestinalis* is considered a cold water or temperate species but has been found as far south as Cape Verde, although these tropical populations are likely transitory (Monniot & Monniot 1994).

Temperature tolerance varies among geographical populations or ecotypes. Adult *Ciona intestionalis* is reported as tolerant of temperatures up to 30°C (Dybern, 1965; Therriault & Herborg, 2008), although Petersen & Riisgard (1992) noted that filtration rates declined above 21°C which suggested thermal stress, and indicated that long-term survival was likely to require temperatures lower than the 30°C. Other studies also indicated that *Ciona intestinalis* exhibits a decline in ammonia excretion rate and oxygen consumption rate above 18°C (Zhang and Fang 1999, Zhang *et al*., 1999). The effect of higher temperatures on *Ascidia mentula* is not as well researched. It is distributed from Norway through to the Mediterranean and Black Sea, and the species appears to tolerate a broad range of temperatures. Svane (1984) found that in Sweden, whilst lower temperatures decreased recruitment, populations responded positively to the “warm period” of 1972-1976 (Glantz, 2005), with an increase in population density across all sites in the study and a gradual decrease during the ensuing “cold period”, and minor fluctuations throughout. Unusually high mean temperatures in 1975 did result in higher recruitment, with colder temperatures in January 1976 and spring 1979 coinciding with very little recruitment. Svane (1984) found that, unlike recruitment, mortality was regulated locally and independent of temperature within the range of the study (mean monthly deviation of ±3°C) (Svane, 1984). Bishop (1985) suggested that *Echinus esculentus* cannot tolerate high temperatures for prolonged periods due to increased respiration rate and resultant metabolic stress. Ursin (1960) reported *Echinus esculentus* occurred at temperatures between 0-18°C in Limfjord, Denmark. Bishop (1985) noted that gametogenesis occurred at 11-19°C, however, continued exposure to 19°C disrupted gametogenesis. Embryos and larvae developed abnormally after 24 hr exposure to 15°C but normally at 4, 7 and 11°C (Tyler & Young 1998). *Antedon bifida* is found from Scotland to Portugal (WoRMS, 2015) so is probably able to tolerate a long-term increase in temperature of 2°C. However, as a subtidal species, *Antedon bifida* is less likely to be able to tolerate a short-term increase in temperature of 5°C. *Antedon petasus* has a more northerly range and is therefore thought to be more at risk of temperature increases (Goodwin *et al*., 2008; Goodwin *et al*., 2013). Exposure of laboratory cultures of *Antedon petasus* to temperatures in excess of 14°C were detrimental or fatal (Gislén, 1924 cited in Khanna, 2005).

Sensitivity assessment. This biotope occurs in the north west of the UK where sea temperatures vary between 4 and 15°C (Beszczynska-Möller & Dye, 2013) and are typically 9 - 14°C (Huthnance, 2010). An increase in sea surface temperature of 2°C for a period of 1 year combined with high summer temperatures may approach the upper temperature threshold of *Echinus esculentus* and would likely affect *Antedon petasus*, and result in decline in abundance.

Short-term increases in temperatures (i.e. 5°C for a month) may be detrimental for recruitment, or cause mobile echinoderms to move out of the affected area but should not be detrimental to the sessile species. Any short-term reduction in grazing due to loss of *Echinus esculentus* is probably also short-term.

Therefore, resistance has been assessed as ‘**Medium**’, resilience has been assessed as ‘**High**’ and sensitivity has been assessed as ‘**Low**’. The effects of increased temperature on the characterizing species are largely well researched, although gaps in the literature for *Ascidia mentula* result is a confidence rating of **Medium.**

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

Orjas *et al*., 2012 describes studying the feeding ecology of *Obelia dichotoma* in an Arctic environment (Kongsfjorden, Svalbard) which experiences temperatures of 1-5°C (Beszczynska-Möller & Dye, 2013). Palerud et al., 2004 also describes the presence in Svalbard of *Obelia dichotoma*, *Halecium Halecinum* and *Nemertesia* sp. This suggests that these characterizing hydroids are probably tolerant of the lowest temperatures they are likely to encounter in Britain and Ireland of ca 4°C (Beszczynska-Möller & Dye, 2013). It should be noted that growth rates are reduced at low temperatures. Berrill (1949) reported that for *Obelia*, stolons grew, under optimal nutritive conditions, at less than 1 mm in 24 hrs at 10-12 °C, 10 mm in 24 hrs at 16-17 °C, and as much as 15-20 mm in 24 hrs at 20 °C. Tolerance for low temperatures varies among geographical populations. In the Mediterranean, most adult *Ciona intestinalis* die when temperatures fall below 10°C, and the population is maintained by the survival of younger individuals which are more tolerant of colder temperatures (Marin *et al.* 1987). Observation of Scandinavian populations indicated a higher mortality rate of *Ciona intestinalis* during the coldest period of the year (temperatures down to 1°C) (Dybern, 1965). In Scandinavian populations, normal egg development requires 8-22°C and larval development occurs between 6-24°C (Dybern, 1965). Larval temperature tolerances may play a part in successful recruitment in unseasonable temperature fluctuations. *Ciona savigny* larvae were found to acclimate to temperature, with embryos collected in the summer dividing normally between 14 - 27°C and embryos collected in the winter dividing normally between 10 - 20°C (Nomaguchi *et al.*, 1997). *Ascidia mentula* is distributed from Norway through to the Mediterranean and Black Sea, and the species appears to tolerate a broad range of temperatures. Svane (1984) found that in Sweden, whilst lower temperatures (of ±3°C of monthly mean) decreased recruitment, mortality did not significantly increase. Shallow populations (15m) experiencing much greater seasonal variability did exhibit seasonal spawning rather than year-round spawning that occurs in more temperate and deeper populations (Svane, 1984). Populations responded positively to the "warm period" of 1972-1976 (Glantz, 2005), with an increase in population density across all sites in the study and a gradual decrease during the ensuing "cold period", with minor fluctuations throughout. Unusually high mean temperatures in 1975 did result in higher recruitment, with colder temperatures in January 1976 and spring 1979 coinciding with very little recruitment. Svane (1984) found that, unlike recruitment, mortality was regulated locally and independent of temperature within the range of the study (mean monthly deviation of ±3°C). Bishop (1985) suggested that *Echinus esculentus* cannot tolerate high temperatures for prolonged periods due to increased respiration rate and resultant metabolic stress. Ursin (1960) reported *Echinus esculentus* occurred at temperatures between 0-18°C in Limfjord, Denmark. Bishop (1985) noted that gametogenesis occurred at 11-19°C, however, continued exposure to 19°C disrupted gametogenesis. Embryos and larvae developed abnormally after 24 hr exposure to 15°C but normally at 4, 7 and 11°C (Tyler & Young 1998). *Echinus esculentus* has been recorded from the Murmansk Coast, Russia. Due to the high latitude at which *Echinus esculentus* can occur, it is unlikely to be affected by changes in temperature at the pressure benchmark. Studies looking at low temperature tolerance of Antedon is lacking with the majority of the literature focusing on high temperature effects. As these biotopes occur in the mid-range of *Antedon bifida*'s geographical range and at the high temperature limit of *Antedon petasus* (Picton, 1993), it is unlikely that a reduction in temperature would negatively impact either *Antedon* spp. considered in this biotope.

Sensitivity assessment. All species assessed are present in northern/boreal habitats and are unlikely to be affected at the benchmark level. Resistance has been assessed as '**High**', resilience as '**High**'. Therefore, sensitivity has been assessed as '**Not sensitive**'.

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

Studies on hydroids in general have found that prey capture rates may be affected by salinity and temperature (Gili & Hughes, 1995) although no evidence was found for species that characterize this biotope. *Ciona intestinalis* has been classified as euryhaline with a high salinity tolerance range (12-40‰) although it typically occurs in full salinity conditions (>30‰) (Tillin & Tyler-Walters, 2014). *Ciona intestinalis* has been found in salinities ranging from 11 to 33 PSU in Sweden, although the same study found that parent acclimation to salinity (high or low) has an overriding and significant effect on larval metamorphic success, independent of parent origins (Renborg, 2014). No information on *Ascidia* spp. was found. Echinoderms, including *Echinus esculentus* and *Antedon spp.* are generally stenohaline, possess no osmoregulatory organ (Boolootian, 1966) and lack the ability to osmo- and ion-regulate (Stickle & Diehl, 1987). The inability of echinoderms to osmoregulate extracellularly causes body fluid volume to decrease when individuals experience higher external salinity. Over the period of a year, populations are unlikely to survive increased salinity. Echinoderm larvae have a narrow range of salinity tolerance and will develop abnormally and die if exposed to increased salinity.

Sensitivity assessment

CR.LCR.BrAs.AntAsH is a subtidal full salinity biotope (Connor *et al*., 2004) and salinity increase to over 40 psu (the benchmark) may adversely impact several members of the community and, in particular, the echinoderms. Resistance is assessed as '**None**' and recovery as '**Medium**' (following restoration of usual salinity). Sensitivity is therefore assessed as '**Medium**'. In the absence of direct evidence on the effects of hypersaline conditions on the characterizing species, confidence is therefore classed as '**Low**'.

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

This biotope is recorded in full salinity habitats (Connor et al., 2004). Little evidence for the characterizing hydroids could be found. Stebbing, 1981 found that, for the hydroid *Campanularia flexuosa*, growth was inhabited from 70% seawater(ca 25‰) and that exposure to below 30% seawater (ca 10‰) was lethal after 3 days. *Ciona intestinalis* has been classified as euryhaline with a high salinity tolerance range (12-40‰) although it typically occurs in full salinity conditions (>30‰) (Tillin & Tyler-Walters, 2014) but has been found in Scandinavian waters in salinities as low as 11 PSU (Renborg, 2014, Dybern, 1967). Adult acclimation to salinity was shown to have an overriding and significant effect on larval metamorphic success, independent of parent origins (Renborg, 2014). 'Massive die-offs' of *Ciona interstinalis* were observed following winter rains in Californian harbours with 'massive recolonizations usually following in the spring' (Lambert & Lambert, 1998). Population collapses of *Ciona intestinalis* in the Mediterranean have also been reported, and whilst the drivers for these events are not well understood, it has been postulated that low salinity could play a part (Péres, 1943; Caputi *et al*., 2015). Oxygen consumption rate has been shown to decline with decreasing salinity and ceased at 19‰ with siphons tightly closed. (Shumway, 1978). *Ascidia mentula* is found on the West coast of Norway in salinities greater than 20‰ (Dybern, 1969) and found in a brackish lake in Corsica with a salinity gradient of 6.5 to 18.5 ‰ Cl^- (Verhoeven, 1978).

Echinoderms, including urchins and antedons are generally stenohaline, possess no osmoregulatory organ (Boolootian, 1966) and lack the ability to osmo- and ion-regulate (Stickle & Diehl, 1987). The inability of echinoderms to osmoregulate extracellularly causes body fluid volume to increase when individuals experience lower external salinity. Over the period of a year, populations are unlikely to survive descreased salinity. Echinoderm larvae have a narrow range of salinity tolerance and will develop abnormally and die if exposed to decreased salinity. At low salinity urchins gain weight, and the epidermis loses its pigment as patches are destroyed; prolonged exposure is fatal (Tillin & Tyler-Walters, 2014). There is some evidence to suggest *Echinus esculentus* makes use of intracellular regulation of osmotic pressure due to increased amino acid concentrations. Furthermore *Echinus esculentus* is found within a number of variable and reduced salinity biotopes, e.g. IR.LIR.KVS.SlatPsaVS (Connor *et al.*, 2004).

Sensitivity assessment. CR.LCR.BrAs.AntAsH is a subtidal full salinity biotope (Connor *et al.*, 2004) and salinity decrease at the benchmark figure is thought to have some limited impacts on the species of this biotope, most notably the echinoderms.

Resistance is therefore assessed as ‘**Medium**’ and recovery as ‘**Medium**’ (following restoration of usual salinity). Therefore, sensitivity is therefore assessed as ‘**Medium**’.

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

The key characterizing hydroids are typically found in places of low to moderate water movement although Hayward & Ryland (1995) note that the abundant communities occur in narrow straits and headlands which may experience high levels of water flow. Hydroids can bend passively with water flow to reduce drag forces to prevent detatchment and enhance feeding (Gili & Hughes, 1995). Hydroid growth form also varies to adapt to prevailing conditions, allowing species to occur in a variety of habitats (Gili & Hughes, 1995). Hiscock, (1979) assessed feeding behaviour of the hydroid *Tubularia indivisa* in response to different flow rates. At flow rates <0.05 m/s, polyps actively moved tentacles. Increasing the flow rate to 0.2 m/s increased capture rates but at higher flow rates from 0.5-0.9 m/s the tentacles were extended downcurrent and pushed together and feeding efficiency was reduced. In general, flow rates are an important factor for feeding in hydroids and prey capture appears to be higher in more turbulent conditions that prevent self-shading by the colony (Gili & Hughes, 1995). The capture rate of zooplankton by hydroids is correlated with prey abundance (Gili & Hughes, 1995), thus prey availability can compensate for sub-optimal flow rates. Water movements are also important to hydroids to prevent siltation which can cause death (Round, 1961). Tillin & Tyler-Walters (2014) suggest that the range of flow speeds experienced by biotopes in which hydroids are found indicate that a change (increase or decrease) in the maximum water flow experienced by mid-range populations for the short periods of peak spring tide flow would not have negative effects on this ecological group.

As sessile filter feeders, ascidians generally require a reasonable water flow rate in order to ensure sufficient food availability. It was shown that in stagnant water, phytoplankton density became reduced in a 20-30 cm layer immediately above a dense colony of *Ciona intestinalis* (Riisgård *et al.*, 1996). However, *Ciona intestinalis* has been recognised as tolerant of low water flow environments which it uses as a competitive advantage in areas with minimal water exchange and renewal such as harbours, marinas and docks, outcompeting other species (Carver *et al.*, 2006). Whilst *Ciona intestinalis* is typically found in areas of low flow, it can reportedly withstand flow rates up to 3 knots (Jackson 2008). If dislodged, juveniles and adults have a limited capability to re-attach, given calm conditions and prolonged contact with the new substrata (Carver *et al.*, 2006; Jackson, 2008; Millar 1971). Hiscock (1983) found that, for the solitary ascidian *Ascidia mentula*, siphons closed when current velocity rose above about 0.15 m/s. *Echinus esculentus* occurred in kelp beds on the west coast of Scotland in currents of about 0.5 m/sec. Outside the beds specimens were occasionally seen being rolled by the current (Comely & Ansell, 1988), which may have been up to 1.4 m/sec. *Echinus esculentus* are also displaced by storm action. After disturbance *Echinus esculentus* migrates up the shore, an adaptation to being washed to deeper water by wave action (Lewis & Nichols, 1979). Therefore, increased water flow may remove the population from the affected area, probably to deeper water; however individuals would probably not be killed in the process and could recolonize the area quickly. *Antedon* spp. occur in areas where there is fast current flow suitable for passive suspension feeding. In a series of unpublished experiments by Hannan (cited in Hiscock, 1983) *Antedon bifida* was able to maintain its grip on a concrete substratum in currents up to 90 cm/s in a flume. The claw-like cirri enable the species to survive in moderately strong currents and dense populations are found in areas where water flow is likely to be between 1 and 3 knots (ca 0.5 - 1.5 m/s) during maximal tidal flow. La Touche (1978) observed that *Antedon bifida* was unable to maintain its arms in a vertical feeding position in all but the weakest of currents.

Sensitivity assessment. The CR.LCR.BrAs.AntAsH biotope is typical of low energy environments, and occurs on rocky substrata with little tidal flow, and weak to very weak tidal flow (Connor *et al*., 2004). Therefore, a decrease of 0.1-0.2 m/s is unlikely to be significant. Mobile *Echinus esculentus* and *Antedon* spp. occur in biotopes with higher flow (e.g. BrAs.AmenCio) and are unlikely to be killed should they become dislodged and may recolonize quickly. *Ciona intestinalis* has been shown to withstand flow rates up to the upper limit of the biotope (Jackson, 2008). An increase in flow may reduce grazing pressure and allow other suspension feeders to colonize the biotope or increase in abundance. However, it is unlikely that a change of 0.1-0.2 m/s would be significant.

Therefore, Resistance has been assessed as '**High**', resilience has been assessed as '**High**', and sensitivity has been assessed as '**Not Sensitive**'.

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

Changes in emergence are **not relevant** to this biotope as it 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: Medium A: Low C: Medium	High Q: High A: High C: High	Not sensitive Q: Medium A: Low C: Medium

Jackson (2004) reported that *Nemertesia ramosa* was intolerant of high wave exposure and was only found in sheltered areas. Faucci *et al*. (2000) recorded hydroid communities at two sites of different wave exposure and recorded the presence of *Obelia dochotoma* and *Halecium* spp. in both the exposed and sheltered sites, but only found *Kirchenpaueria* sp. in the sheltered site. High energy wave action can be detrimental to ascidian populations. This is mainly through physical damage to the sea squirts and through the abrasive action of suspended sediment (Jackson, 2008). *Ciona intestinalis* is often dominant in highly sheltered areas such as harbours (Carver *et al*., 2006). Decreases in wave exposure are unlikely to have any effect. If dislodged, juvenile and adult *Ciona intestinalis* have a limited capability to re-attach, given calm conditions and prolonged contact with the new substratum (Carver *et al*., 2006; Jackson 2008; Millar 1971) but increases in wave exposure above moderately exposed are likely to cause a proportion of the population to die, especially in the shallower examples of the biotope if the cobbles and pebbles on which the biotope occurs are mobilized by wave action. *Ascidia mentula* has rarely been recorded at depths shallower than 15 m (Svane, 1984), it is possible that damage could occur if subjected to increased wave exposure. *Echinus esculentus* occurred in kelp beds on the west coast of Scotland in currents of about 0.5 m/sec. Outside the beds, specimens were occasionally seen being rolled by the current (Comely & Ansell, 1988), which may have been up to 1.4 m/sec. Urchins are removed from the stipe of kelps by wave and current action. *Echinus esculentus* are also displaced by storm action. After disturbance, *Echinus esculentus* migrates up the shore, an adaptation to being washed to deeper water by wave action (Lewis & Nichols, 1979). Keith Hiscock (pers. comm.) reported *Echinus esculentus* occurred in significant numbers as shallow as 15 m below low water at the extremely wave exposed site of Rockall, Scotland. Therefore, localised increases in wave height may remove the population from the affected area; probably to deeper water although individuals would probably not be killed in the process and could recolonize the area quickly. *Antedon bifida* and *Antedon petasus* are not generally found in areas subject to wave exposure stronger than 'exposed' or tidal streams stronger than 'moderately strong' (1-3 kn) (Connor *et al*., 2004). Studies have noted that the upper limit of *Antedon bifida* has been limited in some cases by excessive wave action in shallower habitats (8-9 m) (La Touche, 1978). Being mobile, *Antedon* spp. should recover quite quickly following a short-term event.

Sensitivity assessment.

Whilst *Ciona intestinalis* and *Echinus esculentus* are thought to be quite resistant to wave exposure, some of the hydroids, *Asidia mentula* and *Antedon* spp. are considered to be more at risk of damage and mortality when subject to excessive wave exposure. CR.LCR.BrAs.AntAsH occurs in sheltered to extremely sheltered conditions, a 3-5% change in significant wave height is unlikely to be significant. Therefore resistance has been assessed as '**High**', resilience has been assessed as '**High**' and sensitivity has been assessed as '**Not sensitive**'.

Chemical Pressures

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

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

Although no information on the effects of heavy metals on the assessed hydroids was found, evidence suggests that hydroids may suffer at least sub-lethal effects and possibly morphological changes and reduced growth due to heavy metal contamination. Various heavy metals have been shown to have sublethal effects on growth in the few hydroids studied experimentally (Bryan, 1984). Stebbing (1981) reported that Cu, Cd, and tributyl tin fluoride affected growth regulators in *Laomedea* (as *Campanularia*) *flexuosa* resulting in increased growth. Stebbing (1976) reported that 1 µg/l Hg^{2+} was stimulatory, although the effect was transitory, exposure resulting in reduced growth towards the end of his 11 day experiments. Cadmium (Cd) was reported to cause irreversible retraction of 50% of hydranths in *Laomedea loveni* after 7 days exposure at concentrations between 3 µg/l (at 17.5 °C and 10 ppt salinity) and 80 µg/l (at 7.5 °C and 25 ppt salinity) (Theede *et al*., 1979). *Laomedea loveni* was more tolerant of Cd exposure at low temperatures and low salinities. Karbe (1972, summary only) examined the effects of heavy metals on the hydroid *Eirene viridula* (Campanulidae). He noted that Cd and Hg caused cumulative effects, and morphological changes. Mercury (Hg) caused irreversible damage at concentrations as low as 0.02 ppm. He reported threshold levels of heavy metals for acute effects in *Eirene viridula* of 1.5-3 ppm Zn, 1-3 ppm Pb, 0.1-0.3 ppm Cd, 0.03-0.06 ppm Cu and 0.001-0.003 ppm Hg. Karbe (1972, summary only) suggested that *Eirene viridula* was a sensitive test organism when compared to other organisms. Although no information on the effects of heavy metals on assessed hydroid species was found, the above evidence suggests that hydroids may suffer at least sub-lethal effects and possibly morphological changes and reduced growth due to heavy metal contamination. Trace metals (particularly mercury and copper) have been found to affect embryogenesis and larval settlement in *Ciona intestinalis* (Bellas *et al*., 2004). Whilst there are extensive studies of larval intolerance to TBT (Mansueto *et al*., 1993, Pellerito *et al*., 1996, Bellas, 2005) and zinc pyrithione (Bellas, 2005), data appears non-existent for the adult stage. Chesher (1971) found that *Ascidia niagra* was surprisingly intolerant of desalination effluent (50% mortality in 5.8% effluent solution after 96 hours), far less tolerant than the other species included in the study (echinoids, crabs and gorgonians). Whilst presence of copper was considered the most deleterious factor across the study, the increased sensitivity of the ascidians was attributed to synergistic copper and temperature effects, although presence of other contaminants (e.g. nickel) could not be ruled out (Chesher, 1971). Little is known about the effects of heavy metals on echinoderms. Bryan (1984) reported that early work had shown that echinoderm larvae were sensitive to heavy metals contamination, for example Migliaccio *et al.* (2014) reported exposure of *Paracentrotus lividis* larvae to increased levels of cadmium and manganese caused abnormal larval development and skeletal malformations. Kinne (1984) reported developmental disturbances in *Echinus esculentus* exposed to waters containing 25 µg / l of copper (Cu).

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.

CR.LCR.BrAs.AntAsH is a sub-tidal biotope (Connor *et al*., 2004). Oil pollution is mainly a surface phenomenon its impact upon circalittoral turf communities is likely to be limited. However, as in the case of the *Prestige* oil spill off the coast of France, high swell and winds can cause oil pollutants to mix with the seawater and potentially negatively affect sub-littoral habitats (Castège *et al*., 2014). *Echinus esculentus* was reported absent after the oil spill however returned after 2-5 years. Large numbers of dead *Echinus esculentus* were found between 5.5 and 14.5 m in the vicinity of Sennen cove, presumably due to a combination of wave exposure and heavy spraying of dispersants following the *Torrey canyon*'s oil spill (Smith 1968). Smith (1968) also demonstrated that 0.5 -1ppm of the detergent BP1002 resulted in developmental abnormalities in its echinopluteus larvae. *Echinus esculentus* populations in the vicinity of an oil terminal in A Coruna Bay, Spain, showed developmental abnormalities in the skeleton. The tissues contained high levels of aliphatic hydrocarbons, naphthalenes, pesticides and heavy metals (Zn, Hg, Cd, Pb, and Cu) (Gomez & Miguez-Rodriguez 1999). Ignatiades & Becacos-Kontos (1970) found that *Ciona intestinalis* can resist the toxicity of oil polluted water and ascidia are frequently found in polluted habitats such as marinas and harbours, etc. (Carver *et al*., 2006) as well as *Ascidia mentula* (Aneiros *et al*., 2015).

Although there is no information available on the effect of hydrocarbons on *Antedon bifida or Antedon petasus*, echinoderms in general appear to be highly intolerant. long-term chronic pollution is thought to be responsible for reduced abundance of *Asterias rubens* (Bokn *et al*., 1993) and *Echinocardium cordatum* (Daan & Mulder, 1996). Crude oil from the *Torrey Canyon* in 1967, and the subsequent use of detergent caused mass mortalities of echinoderms including *Asterias rubens, Echinocardium cordatum, Psammechinus miliaris, Echinus esculentus, Marthasterias glacialis and Acrocnida brachiata* (Smith, 1968).

Little information of the effects of hydrocarbons on hydroids was found although hydroid species adapted to a wide variation in environmental factors and with cosmopolitan distributions tend to be more tolerant of polluted waters (Boero, 1984; Gili & Hughes, 1995).

Synthetic compound contamination	Not Assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR

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

The species richness of hydroid communities decreases with increasing pollution but hydroid species adapted to a wide variation in environmental factors and with cosmopolitan distributions tend to be more tolerant of polluted waters (Boero, 1984; Gili & Hughes, 1995). Stebbing (1981) reported that Cu, Cd, and tributyl tin fluoride affected growth regulators in *Laomedea* (as *Campanularia*) *flexuosa* resulting in increased growth. Stebbing (1981) cited reports of growth stimulation in *Obelia geniculata* caused by methyl cholanthrene and dibenzanthrene. Bryan & Gibbs (1991) reported that virtually no hydroids were present on hard bottom communities in TBT contaminated sites and suggested that some hydroids were intolerant of TBT levels between 100 and 500 ng/l. No information concerning the intolerance of the hydroids assessed was found. However, the above evidence suggests that several species of hydroid exhibit sublethal effects due to synthetic chemical contamination and lethal effects due to TBT contamination. Prolonged exposure to low concentrations of polychlorinated biphenyls (PCB's) have been shown to result in growth and regenerative abnormalities in the feather-star *Antedon mediterranea* but there have been no reports of mortality (Carnevali *et al.*, 2001). Hoare & Hiscock (1974) reported that *Antedon bifida* appeared to be completely intolerant of conditions within the vicinity of an acidified, halogenated effluent discharge in Anglesey, Wales.

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

In general, respiration in most marine invertebrates does not appear to be significantly affected until extremely low concentrations are reached. For many benthic invertebrates this concentration is about 2 ml/l (Herreid, 1980; Rosenberg *et al.*, 1991; Diaz & Rosenberg, 1995). Cole *et al.* (1999) suggest possible adverse effects on marine species below 4 mg/l and probable adverse effects below 2 mg/l. Hydroids mainly inhabit environments in which the oxygen concentration exceeds 5 ml/l (Gili & Hughes, 1995). Although no information was found on oxygen consumption for the characterizing hydroids, Sagasti *et al.* (2000) reported that epifaunal species, including several hydroids and *Obelia bidentata (*as *bicuspidata)* in the York River, Chesapeake Bay, tolerated summer hypoxic episodes of between 0.5 and 2 mg O_2/l (0.36 and 1.4 ml/l) for 5-7 days at a time, with few changes in abundance or species composition. The ability of solitary ascidians to withstand decreasing oxygen levels has not been well documented. Mazouni *et al.* (2001) noted that whilst oysters (*Magallana gigas*) can survive short-term exposure to periods of anoxia (Thau Lagoon, France), the associated biofouling community dominated by *Ciona intestinalis* suffered heavy mortality. It should be noted, however, that this species is frequently found in areas with restricted water renewal where oxygen concentrations may drop (Carver *et al.*, 2006). Whist adverse conditions could affect health, feeding, reproductive capability and could eventually lead to mortality, recovery should be rapid.

Antedon bifida is an aerobic organism and oxygen uptake is by the tube feet and across the body wall. It is typically found in areas of fast tidal flow where water will be oxygenated. Although there is no evidence regarding the effect of low oxygen conditions. Mass mortality of species including *Echinus esculentus* was observed due to a stratified hypoxic event below 8 m caused by a phytotplankton bloom (Griffiths *et al.*, 1979). Hiscock & Hoare (1975) reported an oxycline forming in the summer months (Jun-Sep) in a quarry lake (Abereiddy, Pembrokeshire) from close to full oxygen saturation at the surface to <5% saturation below ca 10 m. During these summer events, no echinoderms or *Ascidia mentula* were recorded at depths below 10 - 11 m.

Sensitivity assessment:

CR.LCR.BrAs.AmenCio and CR.LCR.BrAs.AmenCio.Ant are typically low energy biotopes; a hypoxic event is likely to remain for some time, depending on local conditions. The evidence suggests that *Ciona intestinalis*, *Ascidia mentula* and *Echinus esculentus* would be lost in hypoxic conditions. Resistance is therefore recorded as '**Low**', with a resilience of '**Medium**' and sensitivity is classed as '**Medium**'. Due to the lack of specific data for these species, confidence is recorded as '**Low**'.

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

Witt *et al.*, 2004 found that the hydroid *Obelia* spp. was more abundant in a sewage disposal area in the Weser estuary (Germany) which experienced sedimentation of 1 cm for more than 25 days. It should be noted that another hydroid (*Sertularia cupressina)* was reduced in abundance when compared with unimpacted reference areas. As suspension feeders, an increase in organic content at the benchmark is likely to be of benefit to the characterizing hydroids. *Ascidia mentula* has been reported in Iberian bays subject to both nutrient-rich upwelling events and anthropogenic pollution (Aneiros *et al.*, 2015). There is some suggestion that there are possible benefits to ascidians from increased organic content of water; ascidian 'richness' in Algeciras Bay was found to increase in higher concentrations of suspended organic matter (Naranjo *et al.* 1996). It was suggested by Comely & Ansell (1988) that *Echinus esculentus* could absorb dissolved organic material for the purposes of nutrition. Nutrient enrichment may encourage the growth of ephemeral and epiphytic algae and therefore increase sea-urchin food availability. Lawrence (1975) reported that sea urchins had persisted over 13 years on barren grounds near sewage outfalls, presumably feeding on dissolved organic material, detritus, plankton and microalgae, although individuals died at an early age. However, this biotope is considered to be **'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: Medium C: High	Not sensitive Q: High A: Medium C: High

Witt *et al*., 2004 found that the hydroid *Obelia* spp. was more abundant in a sewage disposal area in the Weser estuary (Germany) which experienced sedimentation of 1 cm for more than 25 days. It should be noted that another hydroid (*Sertularia cupressina)* was reduced in abundance when compared with unimpacted reference areas. As suspension feeders, an increase in organic content at the benchmark is likely to be of benefit to the characterizing hydroids. There is some suggestion that there are possible benefits to the ascidians from increased organic content of water; Ascidian 'richness' in Algeciras Bay was found to increase in higher concentrations of suspended organic matter (Naranjo *et al.* 1996). Kocak & Kucuksezgin (2000) noted that *Ciona intestinalis* was one of the rapid breeding opportunistic species that tended to be dominant in Turkish harbours enriched by organic pollutants and was frequently found in polluted environments (Carver *et al*., 2006). *Ascidia mentula* has been reported in Iberian bays subject to both nutrient-rich upwelling events and anthropogenic organic pollution (Aneiros *et al*., 2015). It was suggested by Comely & Ansell (1988) that *Echinus esculentus* could absorb dissolved organic material for the purposes of nutrition. Organic enrichment may encourage the growth of ephemeral and epiphytic algae and therefore increase sea-urchin food availability. Lawrence (1975) reported that sea urchins had persisted over 13 years on barren grounds near sewage outfalls, presumably feeding on dissolved organic material, detritus, plankton and microalgae, although individuals died at an early age. *Antedon bifida* has been reported in Iberian bays subject to both nutrient-rich upwelling events and anthropogenic organic pollution (Aneiros *et al*., 2015).

Sensitivity assessment: The above evidence suggests that resistance to this pressure is s '**High**'. Therefore, resilience is assessed as '**High**' and the biotope is therefore considered to be **'Not sensitive'.**

Physical Pressures

	Resistance	Resilience	Sensitivity
Physical loss (to land or freshwater habitat)	None Q: High A: High C: High	Very Low Q: High A: High C: High	High Q: High A: High C: High

All marine habitats and benthic species are considered to have a resistance of '**None**' to this pressure and to be unable to recover from a permanent loss of habitat (resilience is '**Very low'**). Sensitivity within the direct spatial footprint of this pressure is therefore '**High**'. Although no specific evidence is described confidence in this assessment is '**High**', due to the incontrovertible nature of this pressure.

Physical change (to another seabed type)	None Q: High A: High C: High	Very Low Q: High A: High C: High	High Q: High A: High C: High

If rock were replaced with sediment, this would represent a fundamental change to the physical character of the biotope and the species would be unlikely to recover. The biotope would be lost.

Sensitivity assessment. Resistance to the pressure is considered '**None**', and resilience '**Very low**'.

Sensitivity has been assessed as '**High**'.

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)	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 species characterizing this biotope are epifauna or epiflora occurring on rock and would be sensitive to the removal of the habitat. However, extraction of rock substratum is considered unlikely and this pressure is considered to be '**Not relevant'** to hard substratum habitats.

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

The available evidence indicates that hydroids 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. Re-sampling of grounds that were historically studied (from the 1930s) indicates that some species have increased in areas subject to scallop fishing (Bradshaw et al., 2002). This study also found (unquantified) increase in abundance of tough stemmed hydroids including *Nemertesia* spp., its morphology may have prevented 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 colonize disturbed areas with newly exposed substrata close to the adult. Hydroids may also recover rapidly as the surface covering of hydrorhizae may remain largely intact, from which new uprights are likely to grow. In addition, the resultant fragments of colonies may be able to develop into new colonies. Hydroid colonies were still present in the heavily fished area, albeit at lower densities than in the closed area. This may largely be because the Isle of Man scallop fishery is closed from 1st June to 31st October (Andrews et al., 2011), so at the time the samples were taken for the study in question, the seabed had been undredged for at least 3.5 months. The summer period is also the peak growing/breeding season for many marine species (Bradshaw, 2003). Both *Ciona intestinalis* and *Ascidia mentula* are large, emergent, sessile ascidians, and physical disturbance is likely to cause damage with mortality likely. Emergent epifauna are generally very intolerant of disturbance from fishing gear (Jennings & Kaiser, 1998). However, studies have shown *Ascidia spp*. to become more abundant following disturbance events (Bradshaw *et al*., 2000). Species with fragile tests, such as *Echinus esculentus* were reported to suffer badly as a result of scallop or queen scallop dredging (Bradshaw *et al*., 2000; Hall-Spencer & Moore, 2000a). Kaiser *et al*. (2000) reported that *Echinus esculentus* were less abundant in areas subject to high trawling disturbance in the Irish Sea. Jenkins *et al*. (2001) conducted experimental scallop trawling in the North Irish sea and recorded the damage caused to several conspicuous megafauna species. The authors used simultaneous assessment of both bycatch and organisms left on the seabed to estimate capture efficiency for both target and non-target organisms. This found

16.4% of *Echinus esculentus* were crushed/dead, 29.3% would have >50% spine loss/minor cracks, 1.1% would have <50% spine loss and the remaining 53.3% would be in good condition. Sea urchins can rapidly regenerate spines, e.g. *Psammechinus miliaris* were found to re-grow all spines within a period of 2 months (Hobson, 1930). The trawling examples mentioned above were conducted on sedimentary habitats and thus the evidence is not directly relevant to rock based, however it does indicate the likely effects of abrasion on *Echinus esculentus*. *Antedon* spp. are likely to be intolerant of abrasion as individuals would probably be killed or damaged by a force equivalent to a scallop dredge dragged across them (Hill, 2008). The species can regenerate body parts even when most arms and part of the disc have been lost so most damaged individuals are likely to recover. However, Cook *et al*. (2013) noted a significant decline in abundance of *Antedon bifida* one year after a trawling event on a protected reef. Boulcott & Howell (2011) conducted experimental Newhaven scallop dredging over a circalittoral rock habitat in the sound of Jura, Scotland and recorded the damage to the resident community. The authors highlight physical damage to faunal turfs (erect bryozoans and hydroids) was difficult to quantify in the study. However, the faunal turf communities did not show large signs of damage and were only damaged by the scallop dredge teeth, which was often limited in extent (approximately. 2cm wide tracts). The authors indicated that faunal turf communities were not as vulnerable to damage through trawling as sedimentary fauna and whilst damage to circalittoral rock fauna did occur, it was of an incremental nature, with loss of faunal turf communities increasing with repeated trawls.

Sensitivity assessment.

Given the sessile, emerged nature of the hydroids, *Ciona intestinalis* and *Asidia mentula*, damage and mortality following a physical disturbance effect are likely to be significant, however some studies have brought into question the extent of damage to the faunal turf. *Echinus esculentus* and *Antedon* spp. have been found to be negatively impacted following disturbance events.

Resistance has been assessed as '**Low**', resilience has been assessed as '**Medium**'. Sensitivity has been assessed as '**Medium**'.

Please note Boulcott & Howell (2011) did not mention the abrasion caused by fully loaded collection bags on the Newhaven dredges. A fully loaded Newhaven dredge may cause higher damage to community as indicated in their study.

Penetration or disturbance of the substratum subsurface	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 species characterizing this biotope group are epifauna or epiflora occurring on rock which is resistant to subsurface penetration. The assessment for abrasion at the surface only is therefore considered to equally represent sensitivity to this pressure. This pressure is thought '**Not Relevant'** to hard rock biotopes

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

An increase in suspended sediment may have a deleterious effect on the suspension feeding community. It is likely to clog their feeding apparatus to some degree, resulting in a reduced ingestion over the benchmark period and, subsequently, a decrease in growth rate (Jackson, 2004).

As the hydroids capture small prey in suspension (Gili & Hughes, 1995), a reduction in feeding efficiency could potentially lead to a reduction in overall biomass. *Nemertesia ramosa* is a passive suspension feeder, extracting seston from the water column. Increased siltation may clog up the feeding apparatus, requiring energetic expenditure to clear. Recovery is likely to take only a few days (Jackson, 2004). A decrease in suspended sediment is likely to benefit the community associated with. The suspension feeders may be able to feed more efficiently due to a reduction in time and energy spent cleaning feeding apparatus. Over the course of the benchmark the hydroids may increase in abundance. *Ciona intestinalis* frequently occurs in habitats close to harbours and marinas with high levels of silt and suspended matter (Carver *et al*., 2006; Kocak & Kucuksezgin, 2000). Naranjo *et al*. (1996) described *Ciona intestinalis* as having a large body and siphons that have wide apertures that helps prevent blocking. Increased suspended sediment may potentially have some detrimental effects in clogging up feeding filtration mechanisms, however, there are possible benefits from increased suspended sediment as ascidian ‘richness’ in Algeciras Bay was found to increase in higher concentrations of suspended organic matter (Naranjo *et al.* 1996). In high (up to 300 mg/l of inorganic and 2.5 x10^7 cells/l) suspended particulate concentrations, the active rejection mechanism (squirting) is increased in *Ciona intestinalis* with no discrimination between organic and inorganic particulates observed in any of the ascidians observed (Robbins, 1984a). Despite these observations, the turbidity tolerance level for this species is not well established. Robbins (1985a) found that continual exposure to elevated levels of inorganic particulates (>25 mg/l) arrested the growth rate of *Ciona intestinalis* and exposure to 600 mg/l resulted in 50% mortality after 12-15 days and 100% mortality after 3 weeks. It was suggested that because this species can only “squirt” to clear the branchial sac, it may be vulnerable to clogging under heavy sediment loads. *Ascidia mentula* has been shown to decrease absolute (instantaneous) rate of pumping in high suspended particulate concentrations, whilst filtration efficiency remained unchanged (Robbins, 1984a). However, specific data on the sensitivity to suspended sediment is lacking. Moore (1977a) suggested that *Echinus esculentus* was unaffected by turbid conditions. *Echinus esculentus* is an important grazer in CR.LCR.BrAs.AmenCio and CR.LCR.BrAs.AmenCio.Ant. Whilst increased turbidity and resultant reduced light penetration may negatively affect algal growth, *Echinus esculentus* can also feed on alternative prey, detritus or dissolved organic material (Lawrence, 1975, Comely & Ansell, 1988). Studies on the impact of high suspended sediment conditions on *Antedon* spp. are lacking, however a study of *Antedon bifida* showed 17% of gut content was inorganic particles and that this was consistent throughout the year and for all locations studied (La Touche & West, 1980). *Antedon* spp. are not considered directly sensitive to the associated change in light attenuation as this does not impact upon suspension feeding. An increase in turbidity, reducing light availability, may reduce primary production by phytoplankton in the water column and thus influence food availability. However, particulate food supplies are also likely to be derived from distant sources so the long-term impact is not likely to be significant. *Antedon bifida* has also been shown to ingest a large fraction of detritus (ca 65% of stomach contents), which is considered an important source of nutrition (La Touche & West, 1980).

Sensitivity assessment

CR.LCR.BrAs.AntAsH is found in silty, circalittoral rock, wave-sheltered conditions. A change at the benchmark level is unlikely to have significant effects on the species considered in this study.

Resistance at the benchmark has been assessed as ‘**High**’, Resilience as ‘**High**’. Sensitivity has been assessed as ‘**Not Sensitive**’.

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

In general, it appears that hydroids are sensitive to silting (Boero, 1984; Gili & Hughes, 1995) and decline in beds in the Wadden Sea have 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. Boero (1984) suggested that deep water hydroid species develop upright, thin colonies that accumulate little sediment, while species in turbulent water movement were adequately cleaned of silt by water movement. Hughes (1977) found that maturing hydroids that had been smothered with detritus and silt lost most of the hydrocladia and hydranths. After one month, the hydroids were seen to have recovered but although neither the growth rate nor the reproductive potential appeared to have been affected, the viability of the planulae may have been affected. *Nemertesia ramosa* is an upright hydroid with a height of up to 15 cm. The colony structure is fairly tough and flexible. Smothering with 5 cm of sediment may cover over some individuals, others may just have the lower section of the main stem covered (Hayward & Ryland, 1994).

Whilst monosipphonic *Obelia dichotoma* stems grow to 5 cm, polysiphonic structures can reach up to 35 cm in height,

Halecium halecinumcan grow up to 25 cm and *Kirchenpaueria pinnata* can grow to ca 10 cm (Hayward & Ryland, 1994). Some of the community is therefore likely to survive smothering by 5 cm. The solitary ascidians considered in this report are permanently attached to the substratum and are active suspension feeders. Because the adults reach up to 15 cm and 18 cm in length for *Ciona intestinalis* and *Ascidia mentula* respectively (Rowley, 2008; Jackson, 2008) and frequently inhabit vertical surfaces (Jackson, 2008), smothering with 5 cm of sediment is likely to only affect a small proportion of the population. Recovery should be rapid, facilitated by the remaining adults. Comely & Ansell (1988) recorded large *Echinus esculentus* from kelp beds on the west coast of Scotland in which the substratum was seasonally covered with "high levels" of silt. This suggests that *Echinus esculentus* is unlikely to be killed by smothering, however, smaller specimens and juveniles may be less resistant. A layer of sediment may interfere with larval settlement. If retained within the host biotope for extended periods a layer of 5cm of the sediment may negatively affect successive recruitment events. *Antedon bifida* has been found to be limited to vertical surfaces in the presence of a heavy layer of sediment (Eleftheriou *et al*., 1997). Antedons are also unlikely to be able to move above the sediment as they require a hard substratum for attachment and the feeding and respiratory structures are likely to become clogged (Hill, 2008). As CR.LCR.BrAs.AmenCio.Ant is often found on vertical rocks, it is possible that most of the population would survive the event in order to repopulate.

Sensitivity assessment. Smothering by 5 cm of sediment is likely to impact hydroids, ascidian and antedon species, however it is likely that enough of the population would survive to recover quite rapidly should the thin layer of sediment be removed. Resistance has been assessed as '**Medium**', resilience as '**High**' and sensitivity has been assessed as '**Low**' at the benchmark level.

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

In general, it appears that hydroids are sensitive to silting (Boero, 1984; Gili & Hughes, 1995) and decline in beds in the Wadden Sea have 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. Boero (1984) suggested that deep water hydroid species develop upright, thin colonies that accumulate little sediment, while species in turbulent water movement were adequately cleaned of silt by water movement.

Nemertesia ramosa is an upright hydroid with a height of up to 15 cm. The colony structure is fairly tough and flexible (Hayward & Ryland, 1994). Monosipphonic *Obelia dichotoma* stems grow to 5 cm, polysiphonic structures can reach up to 35 cm in height, *Halecium halecinumcan* grow up to 25 cm and *Kirchenpaueria pinnata* can grow to ca 10 cm (Hayward & Ryland, 1994). Smothering by 30 cm of material is likely to cover almost all the hydroids. Hughes (1977) found that maturing hydroids that had been smothered with detritus and silt lost most of the hydrocladia and hydranths. After one month, the hydroids were seen to have recovered but, although neither the growth rate nor the reproductive potential appeared to have been affected, the viability of the planulae may have been affected. Therefore, if the deposition is removed fairly rapidly, impact may be limited, however given that CR.LCR.BrAs.AntAsH experiences weak water movement, the effects are likely to persist for some time.

The solitary ascidians considered in this report are permanently attached to the substratum and are active suspension feeder. Because the adults reach up to 15 cm and 18 cm in length for *Ciona intestinalis* and *Ascidia mentula* respectively (Rowley, 2008; Jackson, 2008) and frequently inhabit vertical surfaces(Jackson, 2008), smothering with 30 cm of sediment is likely to affect the vast majority of the population. Comely & Ansell (1988) recorded large *Echinus esculentus* from kelp beds on the west coast of Scotland in which the substratum was seasonally covered with "high levels" of silt. This suggests that *Echinus esculentus* is unlikely to be completely removed by smothering, however, smaller specimens and juveniles may be less resistant. A layer of sediment may interfere with larval settlement.

Smothering by 30 cm of sediment is likely to result in emigration of feather-stars as they require a hard substratum for attachment and the feeding and respiratory structures are likely to become clogged (Hill, 2008). *Antedon bifida* has been found to be limited to vertical surfaces in the presence of a heavy layer of sediment (Eleftheriou *et al.*, 1997).

Sensitivity assessment. Smothering by 30 cm of sediment is likely to cause mortality amongst the majority of characterizing and important species of these biotopes and impact recovery unless the sediment is removed, especially where the epifauna occur on cobbles and pebbles which would be completely covered by sediment. However, vertical surfaces may protect a proportion of the population, so that the effects will depend on the topography of the substratum. Resistance at the benchmark has been assessed as '**Low**'. Resilience is assessed as '**Low**' as recovery is dependent on the removal of the sediment by tidal flow and wave action, both of which are limited in this low energy biotope. Sensitivity has been assessed as '**High**'.

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

McDonald (2014) studied the effect of generator noise on fouling of four vessels by *Ciona intestinalis* and found that fouling was highest at locations closest to the generators and lowest furthest away from the generators. Subsequent *in vitro* experiments demonstrated that larvae in the presence of noise settled much faster (2h- 20h compared with 6h-26h for control), underwent metamorphosis more rapidly (between 10 and 20h compared with ca 22h) and had a markedly increased survival rate to maturity (90-100% compared with 66%). Other studies also reported that noise emissions from vessels promoted fouling by organisms including ascidians (Stanley *et al*., 2016). *Echinus esculentus* has no hearing perception but vibrations may cause an impact, however no studies exist to support an assessment. No evidence could be found for the effects of noise or vibrations on the characterizing hydroids or *Antedon* spp.

Sensitivity assessment: Resistance to this pressure is assessed as '**High**' and resilience as '**High**'. This biotope is therefore considered to be **'Not sensitive'**. Confidence has to be assessed as '**Low**' given the lack of literature for echinoderms and hydroids.

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

Gili & Hughes (1995) reviewed the effect of light on a number of hydroids and found that there is a general tendency for most hydroids to be less abundant in well-lit situations. Whilst hydroid larvae can be positively or negatively photoactic, the planulae of *Nemertesia antennina* show no response to light (Hughes, 1977). *In vitro* studies of solitary ascidians indicate that both spawning and settlement are controlled by light, however *Ciona intestinalis in vivo* has been observed to spawn and settle at any time of the day. (Svane & Havenhand, 1993 and references therein). Whilst there is some evidence that the basiepithelial nerve plexus below the entire outer skins of echinoderms is sensitive to light (Hill, 2008), the species considered in this study are not thought to be sensitive at the benchmark level.

Sensitivity assessment: Resistance to this pressure is assessed as '**High**' and resilience as '**High**'. This biotope is therefore considered to be **'Not sensitive'.** Confidence has to be assessed as '**Low**' given the lack of literature for echinoderms.

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: barriers and changes in tidal excursion are 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	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	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

Echinus esculentus was identified by Kelly & Pantazis (2001) as a species suitable for culture for the urchin Roe industry. However, at present no evidence could be found to suggest that significant *Echinus esculentus* mariculture was present in the UK. If industrially cultivated it is feasible that *Echinus esculentus* individuals could be translocated. *Ciona intestinalis* is considered a fouling species and adheres readily to the hulls of vessels, and is considered an invasive species in the USA, Chile, Western Australia, New Zealand, Canada and South Africa (Millar 1966; McDonald 2004; Blum *et al.* 2007; Ramsay *et al.* 2008, 2009; Dumont *et al.,2011*)

Whilst there have been novel proposals to farm *Ciona intestinalis* as potential feedstock for aquaculture in Sweden (Laupsa, 2015), there is no evidence to suggest such farming exists. Therefore, there is currently **'No evidence'** on which to assess this pressure.

Introduction or spread of invasive non-indigenous species	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

There is '**No evidence**' regarding known invasive species posing a threat to CR.LCR.BrAs.AmenCio or CR.LCR.BrAs.AmenCio.Ant.

Styela clava was first recorded in the UK at Plymouth in 1952 (Eno *et al.*, 1997). Where *Styela clava* and *Ciona intestinalis* co-occur they may compete for space and food (Jackson, 2008).

Didemnum vexillum is an invasive colonial sea squirt native to Asia which was first recorded in the UK in Darthaven Marina, Dartmouth in 2005. *Didemnum vexillum* can form extensive matts over the substrata it colonizes; binding boulders, cobbles and altering the host habitat (Griffith *et al.*, 2009). *Didemnum vexillum* can also grow over and smother the resident biological community. Recent surveys within Holyhead Marina, North Wales have found *Didemnum vexillum* growing on and smothering native tunicate communities, including *Ciona intestinalis* (Griffith *et al.*, 2009). Due to the rapid-re-colonization of *Didemnum vexillum* eradication attempts have to date failed.

Presently *Didemnum vexillum* is isolated to several sheltered locations in the UK (NBN, 2015), however *Didemnum vexillum* has successfully colonized the offshore location of the Georges Bank, USA (Lengyel *et al.*, 2009) which is more exposed than the locations which *Didemnum vexillum* have colonized in the UK. It is therefore possible that *Didemnum vexillum* could colonize more exposed locations within the UK and could therefore pose a threat to these biotopes.

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

Hydroids exhibit astonishing regeneration and rapid recovery from injury (Sparks, 1972) and the only inflammatory response is active phagocytosis (Tokin & Yaricheva, 1959;1961, as cited in Sparks, 1972). No record of diseases in the characterizing hydroids could be found. There appears to be little research into ascidian diseases particularly in the Atlantic. The parasite *Lankesteria ascidiae* targets the digestive tubes and can cause 'long faeces syndrome' in *Ciona intestinalis* (although it has also been recorded in other species).Mortality occurs in severely affected individuals within about a week following first symptoms. (Mita *et al*., 2012). *Echinus esculentus* is susceptible to 'Bald-sea-urchin disease', which causes lesions, loss of spines, tube feet, pedicellariae, destruction of the upper layer of skeletal tissue and death. It is thought to be caused by the bacteria *Vibrio anguillarum* and
Aeromonas salmonicida. Bald sea-urchin disease was recorded from *Echinus esculentus* on the Brittany Coast. Although associated with mass mortalities of *Strongylocentrotus franciscanus* in California and *Paracentrotus lividus* in the French Mediterranean it is not known if the disease induces mass mortality (Bower, 1996). Like most echinoderms, *Antedon spp*. are host to symbiotic organisms. The annelid myzostome *Myzostoma cirriferum* is an obligate associate of echinoderms and lives mainly with crinoids including *Antedon bifida* (Eeckhaut & Jangoux, 1997). Infestation levels seem to vary between sites (Leonard & Jeal, 1984). Although no diseases associated with these organisms have been reported echinoderms in other parts of the world have been severely affected by epidemic type diseases so there is the potential for this to occur.

Sensitivity assessment: In the absence of evidence of mortalities due to disease both resistance and resilience are assessed as '**High**'; the biotope is therefore '**Not Sensitive**' to this pressure. However, the assessment has a low confidence score as more research is needed into the effects of microbial pathogen on faunal turfs and associated communities.

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

Despite historic harvesting of the hydroid *Sertularia cupressinain* in the Wadden Sea (Wagler et al., 2009), no evidence for harvesting of the characterizing hydroids could be found and targeted extraction is highly unlikely.

Despite novel proposals to farm *Ciona intestinalis* as potential feedstock for aquaculture in Sweden (Laupsa, 2015), it is very unlikely that solitary ascidians, would be targeted for extraction. Despite historic extraction as a curio (Jangoux, 1980; Nichols, 1984), *Echinus esculentus* is not thought to be currently targeted. Extraction of *Antedon spp.* is unlikely because it has no commercial value. If *Echinus esculentus* was removed from the biotope, the loss of grazing pressure would result in increasing competition from algae and could lead to a change in biotope classification. Resistance is therefore recorded as '**Low**', resilience is recorded as **'Medium'** and Sensitivity is **'Medium'.**

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

This biotope may be removed or damaged by static or mobile gears that are targeting other species. These direct, physical impacts are assessed through the abrasion and penetration of the seabed pressures. The sensitivity assessment for this pressure considers any biological/ecological effects resulting from the removal of non-target species on this biotope.

While recovery of the characterizing species should be possible within 2-10 years following non-targeted removal (e.g. from static or mobile gears), loss of *Echinus esculentus* from the biotope and subsequent loss of grazing pressure would result in increasing competition from algae and could lead to a change in biotope classification. Resistance is recorded as '**Low**', resilience is recorded as **'Medium'** and Sensitivity is **'Medium'**.

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