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Large solitary ascidians and erect sponges on wave-sheltered circalittoral rock

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

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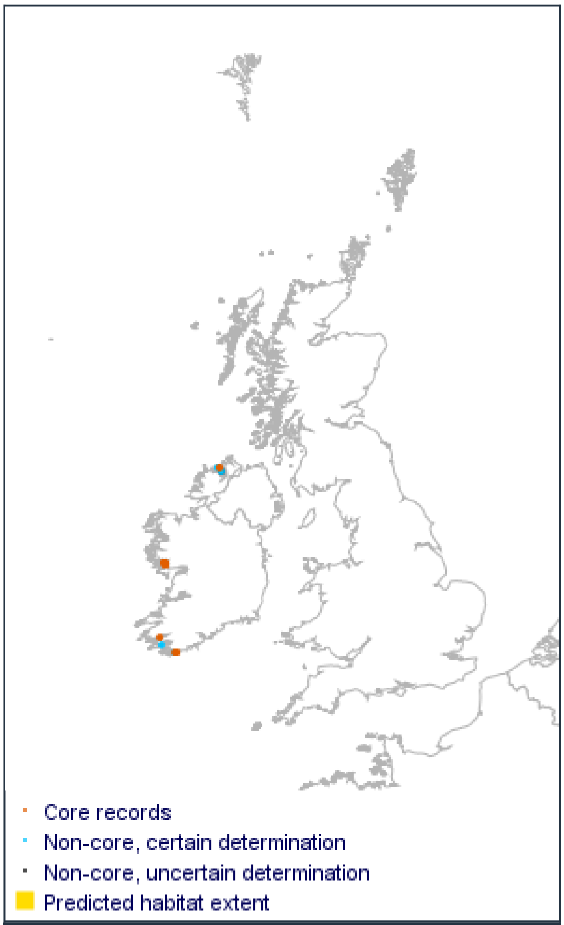

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by John Readman **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A4.312	Large solitary ascidians and erect sponges on wave-sheltered circalittoral rock
JNCC 2015	CR.LCR.BrAs.LgAsSp	Large solitary ascidians and erect sponges on wave-sheltered circalittoral rock
JNCC 2004	CR.LCR.BrAs.LgAsSp	Large solitary ascidians and erect sponges on wave-sheltered circalittoral rock
1997 Biotope		

Description

This biotope is typically found on silty circalittoral bedrock and boulders in wave-sheltered channels subject to varying amounts of tidal flow. These fully marine inlets and channels have steep, often vertical sides with small terraces or ledges. This biotope, characterized by erect sponges and large solitary ascidians, appears to be biologically diverse. A diverse ascidian fauna is generally present, including *Ascidia mentula*, *Aplidium punctum*, *Corella parallelogramma*, *Ascidia virginea*, *Botryllus schlosseri*, *Clavelina lepadiformis* and *Ciona intestinalis*. An equally diverse sponge fauna, with massive erect sponges particularly noticeable, compliments these species. Dominant species include *Esperiopsis fucorum*, *Dysidea fragilis*, *Tethya aurantium*, *Polymastia boletiformis*, *Raspailia ramosa*, *Stelligera stuposa*, *Polymastia mamilliaris* and *Pachymatisma johnstonia*. Other sponges present are *Suberites carnosus*, *Haliclona fistulosa*, *Stelligera rigida*, *Mycale rotalis*, *Haliclona simulans*, *Iophon hyndmani* and *Hemimycale columella*. Various sponge crusts may also be present but in most cases in lower abundances. Other significant components of the community include the cup coral*Caryophyllia smithii* and various echinoderms, including the sea urchin *Echinus esculentus* and the starfish *Henricia oculata* and *Marthasterias glacialis*. Small isolated clumps of *Nemertesia antennina* and individual *Alcyonium digitatum*may be seen, whilst the top shell *Calliostoma zizyphinum* may also be present. At present, there are relatively few records in this biotope, as it is only reported from around the south-western coast of Ireland, where sponge diversity is very high.

Depth range

-

Additional information

-

Listed By

- none -

Further information sources

Search on:

G G G JNCC

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

CR.LCR.BrAS.LgAsSp is a circalittoral biotope found on silty bedrock and boulders in wave sheltered channels subject to varying amounts of tidal flow (Connor *et al.*, 2004). The biotope is biologically diverse and characterized by a variety of erect sponges, including *Amphilectus fucorum*, *Dysidea fragilis*, *Tethya aurantium*, *Polymastia boletiformis*, *Raspailia ramosa*, *Stelligera stuposa*, *Polymastia mammilliaris*, *Pachymatisma johnstonia* and large solitary ascidians including *Ciona intestinalis* and *Acidia mentula*. In negligible tidal streams with similar wave sheltered conditions, CarSwi.Aglo or AmenCio.Ant tend to replace this biotope. Loss of the sponge component would result in a reclassification to the more faunally impoverished biotopes associated with the AmenCio biotope complex. Therefore, the sensitivity of the biotope is dependent on the sponge community and the ascidians. Due to the range of sponge species present, most assessments for this group are quite general. Whilst presence of the urchin *Echinus esculentus* is considered important in maintaining the grazed characteristic of related biotopes (notably AmenCio), the richer fauna present in CR.LCR.BrAs.LgAsSp suggests that echinoderm presence is not of characterizing importance.

Resilience and recovery rates of habitat

Little information on sponge longevity and resilience exists. Reproduction can be asexual (e.g. budding) or sexual (Naylor, 2011) and individual sponges are usually hermaphroditic (Hayward & Ryland, 1994). Short-lived ciliated larvae are released via the aquiferous system of the sponges and metamorphosis follows settlement. Growth and reproduction are generally seasonal (Hayward & Ryland, 1994). Rejuvenation from fragments is also an important form of reproduction (Fish & Fish, 1996).

Marine sponges often harbour dense and diverse microbial communities, which can include bacteria, archaea and single-celled eukaryotes (fungi and microalgae), comprising up to 40% of sponge volume which may have a profound impact on host biology (Webster & Taylor, 2012). Many sponges recruit annually, growth can be quite rapid, and longevity can be fromone to several years (Ackers *et al*., 1992). However, sponge longevity and growth is highly variable, depending on the species and environmental conditions (Lancaster *et al.*, 2014). It is likely that erect sponges are generally longer lived and slower growing given their more complex nature.

Fowler & Lafoley (1993) monitored marine nature reserves in Lundy and the Isles of Scilly and found that a number of more common sponges showed great variation in size and cover during the study period. Large colonies appeared and vanished at some locations. Some large encrusting sponges went through periods of both growth and shrinkage, with considerable changes taking place from year to year. For example, *Cliona celata* colonies generally grew extremely rapidly, doubling their size or more each year, but in some years an apparent shrinkage in size also took place. In contrast, there were no obvious changes in the cover of certain unidentified thin encrusting sponges. Axinellid sponges have been described as very slow growing and little to no recovery has been observed over long periods of monitoring (Fowler & Lafoley, 1993; Hiscock, 1994; 2003; 2011). Picton, B.E. & Morrow, C.C. (2015) described *Amphilectus fucorum* as extremely polymorphic and fast growing, changing shape in just a few weeks. It may be encrusting (as thin sheets or cushions), massive lobose, or branched. Hiscock (pers comm.) noted that *Amphilectus fucorum* has been found growing on (short lived) ascidian tests and has shown significant seasonal variation in abundance, suggesting this sponge is highly resilient.

Ackers (1983) described *Dysidea fragilis* readily colonising deep water wrecks and as thinly encrusting or cushion to massive lobose in form (Picton & Morrow, 2015).

Tethya aurantium produces stalked reproductive buds between July and September (Van Soest *et al.*, 2000). *Raspailia ramosa*, a branching sponge, spawns in September (Lévi, 1956, cited from Van Soest, 2000). *Stelligera stuposa* is a branching erect sponge commonly found in Britain's circalittoral (Picton & Morrow, 2015). *Polymastia mammilliaris* is an encrusting sponge present from the Arctic to the Mediterranean (Boury-Esnault, 1987). *Polymastia boletiformis* is a commonly found spherical sponge found across the western and eastern Atlantic and is recorded from the Arctic to the Mediterranean (Boury-Esnault, 1987). *Pachymatisma johnstonia* can be massive-lobose, hemispherical to irregularly rounded and up to 30 cm or more across (Picton & Morrow, 2015).

Schönberg, 2016 highlighted the gaps in Porifera understanding. Much of the literature groups sponges into one, represented by a few large, conspicuous species.

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 (MBA, 1957, Yamaguchi, 1975, Caputi *et al.*, 2015) 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 that 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 (Whittinghan, 1967; Svane & Havenhand, 1993).

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) were suggested as possible drivers.

Ascidia mentula is a larger (up to 18 cm long) and longer lived (up to 7 years) 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. Light, substratum inclination and texture are suggested by Havenhand & Svane (1989) as factors that influence larval settlement . 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 *etal.*, 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 (Sebens, 1986). Slower growing sponges would probably take longer to reach pre-clearance levels.

Resilience assessment.

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 2.5-3.0 cm, 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 the sponge *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 slower growing sponges would probably take longer to reach pre-clearance levels. Some of the characterizing sponges are encrusting and colonize new sites relatively quickly, but little information regarding the resilience of larger, branching sponges is available, and a more cautious resilience assessment is therefore applied.

If the community suffered mortality from a pressure (resistance of '**None**', '**Low**' or '**Medium**') resilience is assessed as '**Medium**' (recovery within 2-10 years). If resistance is assessed as '**High**' then resilience will be assessed as '**High**' (recovery within 2 years). Confidence is assessed as **'Low'**, given the lack of resilience, growth rates or fecundity for characterizing sponges.

NB: The resilience and the ability to recover from human induced pressures is a combination of the environmental conditions of the site, the frequency (repeated disturbances versus a one-off event) and the intensity of the disturbance. Recovery of impacted populations will always be mediated by stochastic events and processes acting over different scales including, but not limited to, local habitat conditions, further impacts and processes such as larval-supply and recruitment between populations. Full recovery is defined as the return to the state of the habitat that existed prior to impact. This does not necessarily mean that every component species has returned to its prior condition, abundance or extent but that the relevant functional components are present and the habitat is structurally and functionally recognizable as the initial habitat of interest. It should be noted that the recovery rates are only indicative of the recovery potential.

Hydrological Pressures

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

Tethya aurantium and Dysidea fragalis are found from the Arctic to the Mediterranean, *Amphilectus fucorum* is found from Norway to France, *Polymastia boletiformis* is found from the Arctic to the Atlantic coasts of Europe and *Raspailia ramosa is* found across the western British Isles and Northern France (Ackers *et al*., 1992). Berman *et al.* (2013) monitored sponge communities off Skomer Island, UK over three years with all characterizing sponges for this biotope assessed. seawater temperature, turbidity, photosynthetically active radiation and wind speed were all recorded during the study. It was concluded that, despite changes in species composition, (primarily driven by the non-characterizing *Hymeraphia*, *Stellifera* and *Halicnemia patera)*, no significant difference in sponge density was recorded in all sites studied. Morphological changes most strongly correlated with a mixture of water visibility and temperature.

Cebrian *et al.* (2011) conducted four-year surveys of two shallow-water sponge species, *Ircinia fasciculata* and *Sarcotragus spinosulum* in the western Mediterranean Sea. Two severe sponge die-offs (total mortality ranging from 80 to 95% of specimens) occurred in the summers of 2008 and 2009. These events primarily affected *Ircinia fasciculata*, and significant positive correlation was observed between elevated temperature and injured specimens. It was suggested, following *in vitro* studies of the associated cyanobacteria in increasing temperatures up to those experienced in 'extreme summer' of 27°C, that heat related disappearance of the cyanobacteria in *Ircinia fasciculata* (a bacteriosponge) was important when considering sponge mortality.

Research by Webster *et al.*(2008, 2011), Webster & Taylor, (2012), Preston &Burton (2015) suggests that many sponges rely on a holobiont of many synergistic microbes. Webster *et al*., 2011 describes a much higher thermal tolerance to sponge larval holobiont when compared with adult sponges. Adult *Rhopaloeides odorabile* from the Great Barrier Reef has been shown to have a strict thermal threshold of between 31-33°C (Webster *et al.* 2008) whereas the larvae could tolerate temperatures of up to 36°C with no adverse effects.

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 30°C. Other studies also indicated that *Ciona intestinalis* exhibits a decline in ammonia excretion rate and oxygen consumption rate above 18°C (Zhang & 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).

Sensitivity assessment. The characterizing sponges are all widely distributed across the British Isles, none being at their southern limit. Morphological changes have been observed in UK sponge communities, with temperature being a factor, but the characterizing sponges assessed have not been listed as the most highly contributing to this dynamism.

Resistance has been assessed as '**High**', resilience has been assessed as '**High**' and sensitivity has been assessed as '**Not Sensitive**'. The effects of increased temperature on the characterizing species are largely well researched, although gaps in the literature for *Ascidia mentula* result in a quality confidence rating of **Medium.**

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

Tethya aurantium and Dysidea fragalis are found from the Arctic to the Mediterranean, *Amphilectus fucorum* is found from Norway to France, *Polymastia boletiformis* is found from the Arctic to the Atlantic coasts of Europe and *Raspailia ramosa is* found across the western British Isles and Northern France (Ackers *et al.*, 1992).Berman *et al.* (2013) monitored sponge communities off Skoma Island, UK over three years with all characterizing sponges for this biotope assessed. seawater temperature, turbidity, photosynthetically active radiation and wind speed were all recorded during the study. It was concluded that, despite changes in species composition, (primarily driven by the non-characterizing *Hymeraphia Stellifera* and *Halicnemia patera*), no significant difference in sponge density was recorded in all sites studied. Morphological changes most strongly correlated with a mixture of visibility and temperature.Some sponges do exhibit morphological strategies to cope with winter temperatures e.g. *Halichondria bowerbanki* goes into a dormant state below 4°C, characterized by major disintegration and loss of choanocyte chambers with many sponges surviving mild winters in more protected areas from where it can recolonize (Vethaak *et al.*, 1992).

Crisp (1964) studied the effects of an unusually cold winter (1962-3) on the marine life in Britain, including Porifera in North Wales. Whilst difficulty distinguishing between mortality and delayed development was noted, Crisp (1964) found that *Pachymastia johnstonia* and *Halichondria panicea* were wholly or partly killed by frost, and several species appeared to be missing including *Amphilectus fucorum.* Others, including *Hymeniacidon perleve* were unusually rare and a few species, including *Polymstia boletiformis*, were not seriously affected. It should be noted that Crisp's general comments on all marine life state that damage decreased the deeper the habitat and that the extremely cold temperatures (sea temperatures between 4-6°C colder than the 5 year mean over a period of 2 months) is more extreme than the benchmark level for assessment. Tolerance for low temperatures varies among geographical ascidian 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).

Sensitivity assessment. Whilst all species assessed are present in northern/boreal habitats, there is evidence of sponge mortality at extreme low temperatures in the British Isles (although it should be noted that this event exceeded the benchmark level). Given this evidence, it is likely that a cooling of 5°C would affect some of the characterizing sponges, and resistance has been assessed as '**Medium**'. A resilience of '**Medium**' is therefore recorded and sensitivity is assessed as '**Medium**'.

Salinity increase (local)	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

Marin (1997) describes the presence of *Dysidea fragilis* in a hypersaline coastal lagoon (42-47 g/l) in La Mar Menor, Spain. No other evidence could be found for characterizing sponges. *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.

Sensitivity assessment.

CR.LCR.BrAs.LgAsSP is a subtidal full salinity biotope (Connor *et al.*, 2004) and whilst salinity increase to over 40 psu (the benchmark) may affect some of the community, not enough evidence to support an assessment could be found.

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

Castric-Fey & Chassé (1991) conducted a factorial analysis of the subtidal rocky ecology near Brest, France and rated the distribution of species from estuarine to offshore conditions. *Dysidea fragilis* and *Raspailia ramosa* were rated as indifferent to this range. *Cliona celata* and *Pachymatisma johnstonia* had a slight preference for more estuarine conditions while *Polymastia mamillaris* and *Tethya aurantium* had a slight preference for offshore conditions. *Stelligera rigida* and *Polymastia boletiformis* (as *Polymastia robusta*) were intolerant of the more estuarine conditions. Mean salinity difference between the two farthest zones was low (35.1 and 33.8 ‰ respectively) but with a greater range being experienced in the Inner Rade (± 0.1 compared with 2.4‰). It should be noted that the range of salinities identified in this study do not reach the lower benchmark level, and at least some of the characterizing sponges are likely to be affected at the benchmark level. Some characterizing sponges are present in lower salinity biotopes, such as CR.MCR.CFaVS (Connor *et al*., 2004) and proportion of the sponge community is likely to survive a low salinity event.

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).

Sensitivity assessment. CR.LCR.BrAs.LgAsSP is a subtidal full salinity biotope (Connor *et al*., 2004) and a change at the benchmark level would likely affect some of the sponges, resulting in a resistance assessment of **‘Medium’**, with a resilience of **‘Medium** and a sensitivity of **‘Medium’**

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

Riisgard *et al.* (1993) discussed the low energy cost of filtration for sponges and concluded that passive current-induced filtration may be insignificant for sponges.

Pumping and filtering occurs in choanocyte cells that generate water currents in sponges using flagella (de Vos *et al.*, 1991). Both ascidians and sponges are present in biotopes with stronger tidal streams, such as LR.HLR.FT.FserT (Conner *et al.*, 2004). In stagnant water, phytoplankton density became reduced in the 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 (Carver *et al.*, 2006).

Ciona intestinalis is typically found in areas of low flow, but 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.

Sensitivity assessment. All characterizing species are unlikely to experience mortality at an increase or decrease of water flow at the benchmark level of 0.1-0.2 m/s. Resistance has therefore been assessed as '**High**', resilience has been assessed as '**High**', and sensitivity has been assessed as '**Not sensitive**'. In the majority of examples of this biotope, occurring in strong – weak water flow, a change at the benchmark level is unlikely to be significant. In some cases, where the biotope exists in very weak or negligible flow, the more faunally impoverished CarSwi.Aglo or AmenCio.Ant biotope tend to replace LgAsSP (Connor *et al.*, 2004).

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

Roberts *et al.* (2006) studied deep sponge reef communities (18-20 m) in sheltered and exposed locations in Australia. They reported greater diversity and cover (>40% cover) of sponges in wave-sheltered areas compared with a sparser and more temporal cover in exposed sites (25% cover). Erect sponges dominated the sheltered sites, while encrusting sponges dominated in exposed locations (Roberts *et al.*,2006). Erect or massive sponge forms possess a relatively small basal area relative to volume and do poorly in high energy environments (Wulff, 1995; Bell & Barnes 2000),

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.

Sensitivity assessment. Whilst *Ciona intestinalis* is thought to be quite resistant to wave exposure, *Asidia mentula* and the characterizing sponges are considered to be more at risk of damage and mortality when subject to excessive wave exposure. The LgAsSp biotope occurs in circalittoral, low wave exposure conditions. However, a 3-5% change in significant wave height is unlikely to impact the biotope. 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.

Cliona spp. and other sponges have been used to monitor heavy metals by looking at the associated bacterial community (Marques *et al*., 2006; Bauvis *et al*., 2015).

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).

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.LgAsSP 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). Filter feeders are highly sensitive to oil pollution, particularly those inhabiting the tidal zones which experience high exposure and show correspondingly high mortality, as are bottom dwelling organisms in areas where oil components are deposited by sedimentation (Zahn *et al*., 1981). *Tethya lyncurium* concentrated BaP (benzo[a]pyrene)to 40 times the external concentration and no significant repair of DNA was observed in the sponges, which, in higher animal, would likely lead to cancers. As sponge cells are not organized into organs the long-term effects are uncertain (Zahn *et al*., 1981). 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).

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

his biotope is considered to be **'Not sensitive'** at the pressure benchmark, that assumes compliance with all relevant environmental protection standards.

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: Low A: NR C: NR	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. 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. No *Tethya aurantia*, *Kirchenpaueria pinnata*, *Hymeniacidon pereleve*, *Polymastia boletiformis* or *Ascidia mentula* were recorded at depths below 10 - 11 m. Demosponges maintained under laboratory conditions can tolerate hypoxic conditions for brief periods, (Gunda & Janapala, 2009) investigated the effects of variable DO levels on the survival of the marine sponge, *Haliclona pigmentifera*. Under hypoxic conditions (1.5-2.0 ppm DO), *Haliclona pigmentifera* with intact ectodermal layers and subtle oscula survived for 42 ± 3 days. Sponges with prominent oscula, foreign material, and damaged pinacoderm exhibited poor survival (of 1-9 days) under similar conditions. Complete mortality of the sponges occurred within 2 days under anoxic conditions (<0.3 ppm DO). 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). While adverse conditions could affect health, feeding, reproductive capability and could eventually lead to mortality, recovery should be rapid.

Sensitivity assessment:

The evidence suggests that the majority of the characterizing species 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

Gochfeld *et al.* (2012) studied the effect of nutrient enrichment (≤0.05 to 0.07 µM for nitrate and ≤0.5 µM for phosphate) as a potential stressor in *Aplysina caulifornis* and its bacterial symbionts and found that nutrient enrichment had no effects on sponge or symbiont physiology when compared to control conditions (et al. (2007) in which *Aplysina spp.* sponges were virtually absent from a site of anthropogenic stress in Bocas del Toro, Panama which experienced high rainfall and terrestrial runoff. The author suggested that whilst this site did include elevated nutrient concentrations, other pressures and stresses could be contributing. Rose & Risk, 1985 described increase in abundance of *Cliona delitrix* in organically polluted section of Grand Cayman fringing reef affected by the discharge of untreated fecal sewage. Ward-Paige *et al.*, 2005 described greatest size and biomass of Clionids corresponding with highest nitrogen, ammonia and δ^{15}N levels. *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).

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

Rose & Risk, 1985 described increase in abundance of the sponge *Cliona delitrix* in an organically polluted section of Grand Cayman fringing reef affected by the discharge of untreated faecal sewage. De Goeij et al. (2008) used ^{13}C to trace the fate of dissolved organic matter in the coral reef sponge *Halisarca caerulea.* Biomarkers revealed that the sponge incorporated dissolved organic matter through both bacteria mediated and direct pathways, suggesting that it feeds, directly and indirectly, on dissolved organic matter. 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).

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

All characterizing species are sessile epifauna and are therefore likely to be significantly affected by abrasion pressures.

Freese *et al.* (1999) studied the effects of trawling on seafloor habitats and associated invertebrates in the Gulf of Alaska. They found that a transect following a single trawling event showed significantly reduced abundance of 'vase' sponges (67% expressed damage) and 'morel' sponges (total damage could not be quantified as their brittle nature meant that these sponges were completely torn apart and scattered). The 'finger' sponges, the smallest and least damaged (14%) of the sponges assessed, were damaged by being knocked over. Van Dolah *et al.* (1987) studied the effects on sponges and corals of one trawl event over a low-relief hard bottom habitat off Georgia, US. The densities of individuals taller than 10 cm of three species of sponges in the trawl path and in adjacent control area were assessed by divers, and were compared before, immediately after and 12 months after trawling. Of the total number of sponges remaining in in the trawled area, 32% were damaged. Most of the affected sponges were the barrel sponges *Cliona* spp., whereas the encrusting sponges *Haliclona ocultа* and *Ircina campana* were not significantly affected. The abundance of sponges had increased to pre-trawl densities, or greater 12 months after trawling. Tilmant (1979) found that, following a shrimp trawl in Florida, US, over 50% of sponges, including *Neopetrosia*, *Speciospongia*, *Spongia* and *Hippiospongia*, were torn loose from the bottom. Highest damage incidence occurred to the finger sponge *Neopetrosia longleyi*. Size did not appear to be important in determining whether a sponge was affected by the trawl. Recovery was ongoing, but not complete 11 months after the trawl, although no specific data was provided. Freese (2001) studied deep cold-water sponges in Alaska a year after a trawl event; 46.8% of sponges exhibited damage with 32.1% having been torn loose. None of the damaged sponges displayed signs of regrowth or recovery. This was in stark contrast to early work by Freese (1999) on warm shallow sponge communities. Impacts of trawling activity in the Alaska study were more persistent due to the slower growth/regeneration rates of deep, cold-water sponges. Given the slow growth rates and long lifespans of the rich, diverse fauna, it was considered likely to take many years for deep sponge communities to recover if adversely affected by physical damage Freese (2001). 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 results indicated that epifaunal species, including the sponge *Pachymatisma johnstoni*, were highly damaged by the experimental trawl. Coleman *et al.*, 2013 described a 4 year study on the differences between a commercially potted area in Lundy with a no take zone. No significant difference in *Axinellid* populations was observed. The authors concluded that lighter abrasion pressures, such as potting, were far less damaging than heavier gears, such as trawls.

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). 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. 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.

Sensitivity assessment. Given the sessile, emerged nature of the sponges and ascidians, 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.

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

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

Despite sediment being generally considered to have a negative impact on suspension feeders (Gerrodette & Flechsig, 1979), many encrusting sponges appear to be able survive in highly sedimented conditions, and many species prefer such habitats (Bell & Barnes, 2001; Bell & Smith, 2004). Castric-Fey & Chassé (1991) conducted a factorial analysis of the subtidal rocky ecology near Brest, France and rated the distribution of species in varying turbidity (corroborated by the depth at which laminarians disappeared). *Cliona celata* and *Stelligera rigida* were classed as indifferent to turbidity, *Tethya aurantium*, *Pachymatisma johnstonia* and *Polymastia boletiformis* (as *Polymastia robusta*) had a slight preference for clearer water, while *Dysidea fragilis*, *Polymastia mamillaris*, and *Raspailia ramosa* had a strong preference for turbid water. Storr (1976) observed the sponge *Sphecispongia vesparium* 'back washing' to eject sediment and noted that other sponges (such as *Condrilla nucula*) use secretions to remove settled material. *Raspailia ramosa* and *Stelligera stuposa* have a reduced maximum size in areas of high sedimentation (Bell et al, 2002). Tjensvoll (2013) found that *Geodia barretti* physiologically shuts down when exposed to sediment concentrations of 100 mg /l. Rapid recovery to initial respiration levels directly after the exposure indicated that *Geodia barretti* can cope with a single short exposure to elevated sediment concentrations. However, it should be noted that a laboratory study on the impact of elevated sedimentation rates on deep water sponges found that sediment load of 30 mg sed/l resulted in significantly higher sponge mortality compared with sponges exposed to 5 and 10 mg sed/l, although no additional information was provided (Hoffman & Tore Rapp, pers com cited in Lancaster *et al.*, 2014). Schönberg (2015) reviewed and observed the interactions between sediments and marine sponges and described the lack of research on Porifera, with most studies grouping them together when looking at sediment effects. Her findings were that, whilst many sponges are disadvantaged by sedimentation (as would be expected, being sessile filter feeders), many examples exist of sponges adapting to sediment presence, including through sediment incorporation, sediment encrusting, soft sediment anchoring using spicules and living, at least partially, embedded within the sediment. Among the characterizing species, Schönberg (2015) found that *Polymastiida* interacted with sediment in 18.9% of observations (primarily through spicules), *Clionaida* had a highly variable interaction with sediment, with 5.7±11.4 %, *Tethyida* interacted in 13.1±21.1%. *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. 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, 1984). Despite these observations, the turbidity tolerance level for this species is not well established. Robbins (1985) 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.

Sensitivity assessment. Despite one report citing unpublished work that demonstrated increased sponge mortality at low suspended sediment concentrations (Lancaster *et al*., 2014), the majority of the literature reviewed suggested that a change at the benchmark level, assuming intermediate (10-100 mg/l) to medium suspended sediment (100 - 300 mg/l) is unlikely to cause significant mortality of the species considered in this study. Resistance has, therefore, been assessed as '**High**', Resilience as '**High**'. Sensitivity has been assessed as '**Not Sensitive**' at the benchmark

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

Despite sediment being generally considered to have a negative impact on suspension feeders (Gerrodette & Flechsig 1979), many encrusting sponges appear to be able survive in highly sedimented conditions, and in fact many species prefer such habitats (Bell & Barnes, 2001; Bell & Smith, 2004). However, Wulff (2006) described mortality in three sponge groups after four weeks of burial under sediment. 16% of *Amphimedon* biomass died compared with 40% and 47% in *Iotrochota* and *Aplysina* respectively. The complete disappearance of the sea squirt *Ascidiella aspera* biocoenosis and associated sponges in the Black Sea near the Kerch Strait was attributed to siltation (Terent'ev, 2008 cited in Tillin & Tyler-Walters, 2014).

Sensitivity assessment. Smothering by 5cm of sediment is likely to impact the characterizing sessile epifauna, especially the ascidians. Some of the characterizing sponges are likely to be buried in 5cm of sediment deposition. 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.

Resistance has been assessed as '**Medium**', resilience as '**Medium**' and sensitivity has been assessed as '**Medium**' at the benchmark level.

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

Despite sediment being generally considered to have a negative impact on suspension feeders (Gerrodette & Flechsig 1979), many encrusting sponges appear to be able survive in highly sedimented conditions, and in fact many species prefer such habitats (Bell & Barnes, 2001; Bell & Smith, 2004). However, Wulff (2006) described mortality in three sponge groups following four weeks of burial under sediment. 16% of *Amphimedon* biomass died compared with 40% and 47% in *Iotrochota* and *Aplysina* respectively. The complete disappearance of the sea squirt *Ascidiella aspera* biocoenosis and associated sponges in the Black Sea near the Kerch Strait was attributed to siltation (Terent'ev 2008 cited in Tillin & Tyler-Walters, 2014). In 30cm of deposition, the majority of sponges are likely to be buried, unless the topography of the biotope includes many vertical surfaces. 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 majority of the population.

Sensitivity assessment. Smothering by 30 cm of sediment is likely to cause mortality amongst the majority of characterizing species of this biotope, particularly the ascidians. Recovery is likely to be impacted, 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 has been assessed as '**Medium**', however, where this biotope occurs in negligible tidal flow, removal of the sediment, and hence recovery, would be limited, and so recovery likely to take longer. Sensitivity has been assessed as '**Medium**'.

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

Not assessed.

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

No evidence

Underwater noise changes	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 settled much faster in the presence of noise (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). No evidence could be found for the effects of noise on sponges but they are unlikely to be sensitive.

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

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

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). Jones *et al.* (2012) compiled a report on the monitoring of sponges around Skomer Island and found that many sponges, particularly encrusting species, preferred vertical or shaded bedrock to open, light surfaces.

Sensitivity assessment: Whilst sponges seem to favour shaded areas in which to settle, it is unlikely that changes at the benchmark pressure would result in mortality. Resistance to this pressure is assessed as '**High**' and resilience as '**High**'. This biotope is therefore considered to be **'Not sensitive**'.

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

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. No evidence for the genetic modification or translatocation of characterizing sponges was found.

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

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. However, **'No evidence'** of the biotope having been affected by invasive species was found.

Introduction of microbial pathogens	Medium Q: Low A: NR C: NR	Medium Q: Low A: NR C: NR	Medium Q: Low A: Low C: Low

Gochfeld *et al.* (2012) found that diseased sponges hosted significantly different bacterial assemblages compared to healthy sponges, with diseased sponges also exhibiting significant decline in sponge mass and protein content. Sponge disease epidemics can have serious long-term effects on sponge populations, especially in long-lived, slow-growing species (Webster, 2007). Numerous sponge populations have been brought to the brink of extinction including cases in the Caribbean with 70-95% disappearance of sponge specimens (Galstoff,1942), the Mediterranean (Vacelet,1994; Gaino *et al.*,1992). Decaying patches and white bacterial film were reported in *Haliclona oculata* and *Halichondria panicea* in North Wales, 1988-89, (Webster, 2007). Specimens of *Cliona* spp. have exhibited blackened damage since 2013 in Skomer. Preliminary results have shown that clean, fouled and blackened *Cliona* all have very different bacterial communities. The blackened *Cliona* were effectively dead and had a bacterial community similar to marine sediments. The fouled Cliona had a very distinct bacterial community that may suggest a specific pathogen caused the effect (Burton, pers comm; Preston & Burton, 2015). 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).

Sensitivity assessment: Whilst no evidence exists for the ascidians, current research on disease indicates that some characterizing sponges are susceptible to disease, although the extent and long term implications are still being researched. There is no evidence to suggest significant mortality of sponges in the British Isles, although mass mortality and even extinction have been reported further afield. Resistance has been assessed as ‘**Medium**’ with a resilience of ‘**Medium**’ and Sensitivity is therefore ‘**Medium**’.

Removal of target species	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

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. *Spongia officinalis* (a Mediterranean species) has been targeted as a commercial species for use as bath sponges, although this species does not occur in the British Isles and no record of commercial exploitation of sponges in the British Isles could be found. Should removal of target species occur, the sessile, epifaunal nature of the characterizing species would result in little resistance to this pressure.

'Not relevant' as none of the characterizing species are targetted.

Removal of non-target species	Low Q: Low A: NR C: NR	Medium Q: Low A: NR C: NR	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). Resistance is recorded as '**Low**', resilience is recorded as **'Medium'** and Sensitivity is **'Medium'**.

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