Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata

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

John Readman

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17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)
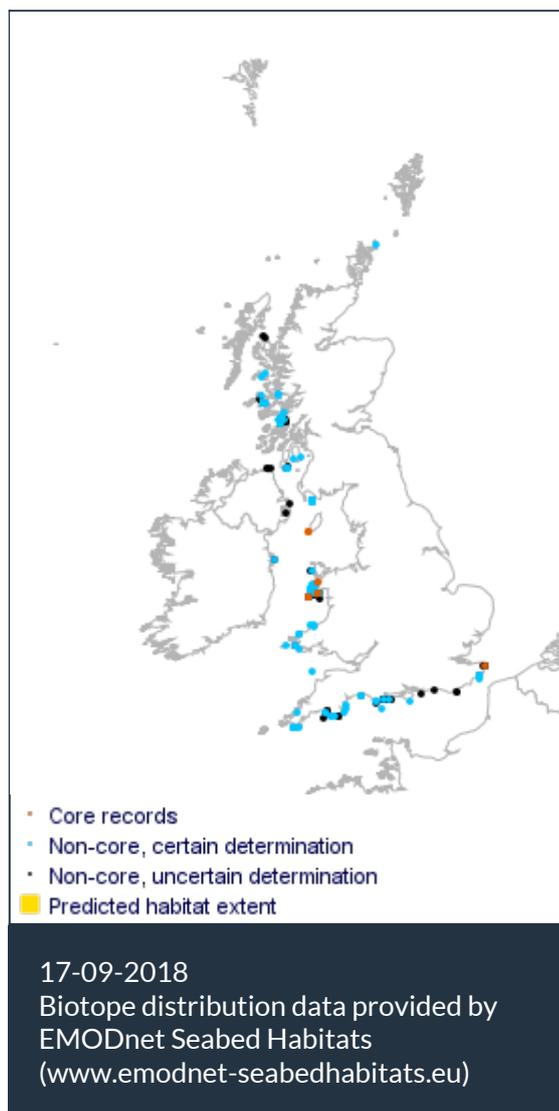
Researched by John Readman   **Refereed by** Admin

Summary

☰ UK and Ireland classification

EUNIS 2008	A4.135	Sparse sponges, *Nemertesia* spp., and *Alcyonidium diaphanum* on circalittoral mixed substrata
JNCC 2015	CR.HCR.XFa.SpNemAdia	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata
JNCC 2004	CR.HCR.XFa.SpNemAdia	Sparse sponges, *Nemertesia spp.* and *Alcyonidium diaphanum* on circalittoral mixed substrata
1997 Biotope	CR.MCR.ByH.SNemAdia	Sparse sponges, *Nemertesia spp.*, *Alcyonidium diaphanum* and *Bowerbankia spp.* on circalittoral mixed substrata

🏷 Description

This biotope is found on moderately wave-exposed sand-scoured, circalittoral boulders, cobbles and pebbles that are subject to moderately strong tidal streams (referred to as lag-cobbles locally).

It is characterized by sparse sponges and a diverse bryozoan and hydroid turf. The sparse sponge community is primarily composed of *Dysidea fragilis* and*Scypha ciliata*. The mixed faunal turf is composed of *Nemertesia antennina, Nemertesia ramosa, Halecium halecinum,Sertularia argentea, Alcyonium digitatum, Bugulina flabellata, Bugulina turbinata, Crisularia plumosa, Flustra foliacea,Cellepora pumicosa, Alcyonidium diaphanum, Cellaria fistulosa* and crisiid bryozoans. The anemones *Epizoanthus couchii, Sagartia elegans* and *Cerianthus lloydii* may also be recorded. Echinoderms such as the starfish *Asterias rubens, Crossaster papposus, Henricia oculata* and the crinoid *Antedon bifida*. Other species present include the colonial ascidian *Clavelina lepadiformis*, the barnacle *Balanus crenatus*, the top shell *Gibbula cineraria*, the polychaete*Spirobranchus triqueter*, the ascidian *Morchellium argus, Prosthecareus vittatus* and the crab *Cancer pagurus*. It is distributed off Pen Llyn and over considerable areas of the Irish Sea.

↓ Depth range

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🏛 Additional information

Please note, molecular taxonomy of the genus *Bugula* (Fehlauer-Ale *et al.*, 2015) identified several clear genera (clades), *Bugula sensu stricto* (30 species), *Bugulina* (24 species), *Crisularia* (23 species) and the monotypic *Virididentulagen*. The following review was derived from information concerning species of *Bugula* where possible. The review assumes that, while their taxonomy has changed, the biology of *Bugula sensu stricto* and *Bugulina* remains similar. Hence, references to Bugula spp. in the text refer to *Bugula sensu stricto*, *Bugulina*, and *Crisularia* species.

✔ Listed By

- none -

🔗 Further information sources

Search on:

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Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

CR.HCR.XFa.SpNemAdia is dominated by a dense hydroid and bryozoan turf with sparse sponges and is subject to sand scour. The sand scour is probably responsible for the diversity of opportunistic hydroids and bryozoans. SS.SSa.IFiSa.ScupHyd and SS.SMx.CMx.FluHyd are also dominated by a bryozoan and hydroid turf, on hard substrata (boulders, stone, etc.) subject to scour. Therefore the sensitivities are probably similar.

CR.HCR.XFa.SpNemAdia occurs on hard substrata and, in addition to the mixed faunal turf, includes a sponge component characterized by *Dysidea fragilis* and *Scypha ciliata*. This biotope is found on moderately wave-exposed sand-scoured, circalittoral boulders, cobbles and pebbles that are subject to moderately strong tidal streams. The mixed faunal turf is composed of *Nemertesia antennina, Nemertesia ramosa, Halecium halecinum,Sertularia argentea, Alcyonium digitatum, Bugula flabellata, Bugula turbinata, Bugula plumosa, Flustra foliacea,Cellepora pumicosa, Alcyonidium diaphanum, Cellaria fistulosa* and crisiid bryozoans (Connor *et al.*, 2004).

SS.SSa.IFiSa.ScupHydm occurs on shallow sands with cobbles and pebbles which are exposed to strong tidal streams. It is characterized by colonies of hydroids, particularly *Hydrallmania falcata* along with *Sertularia cupressina* and *Sertularia argentea*. These hydroids are tolerant to periodic burial and scour by sand.(Connor *et al.*, 2004).

SS.SMx.CMx.FluHyd is characterized by *Flustra foliacea* and the hydroid *Hydrallmania falcate* with other hydroids such as *Sertularia argentea, Nemertesia antennina* and *Nemertesia ramosa* occurring on suitable, stable hard substrata. It is similar, but experiences less sand scouring than SS.SSa.IFiSa.ScupHyd (Connor *et al.*, 2004).

The sensitivity assessment is based on the sensitivity of the bryozoan and hydroid turf, and the sensitivity of the other species species is addressed where relevant.

Resilience and recovery rates of habitat

These biotopes are considered to have a high recovery potential. Sebens (1985, 1986) noted that bryozoans and hydroids covered scraped areas within four months in spring, summer and autumn. 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 life cycle 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 vestigial sessile medusae) produce gametes that fuse to form zygotes that develop into free-swimming planula larvae (Hayward & Ryland, 1994). Planulae are present in the water column between 2 and 20 days (Sommer, 1992).

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) 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* occurred 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. 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). For example, *Halecium halecinum* is an erect hydroid growing up to 25 cm 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).   *Nemertesia ramosa* grows up to 15 cm and is found inshore to deeper water and is common throughout the British Isles and is distributed from Iceland to north-west Africa (Hayward & Ryland, 1994). *Hydrallmania falcata* grows to 50 cm, grows on rock and shell, particularly in sandy areas and is found from the Arctic to the Mediterranean (Hayward & Ryland, 1994).

Bryozoans are sessile fauna forming colonies through asexual budding following settlement of sexually produced larvae (Hayward & Ryland, 1995b). Larvae have a short pelagic lifetime of up to about 12 hours (Ryland, 1976). Recruitment is dependent on the supply of suitable, stable, hard substrata (Eggleston, 1972b; Ryland, 1976; Dyrynda, 1994). Even in the presence of available substratum, Ryland (1976) noted that significant recruitment in bryozoans only occurred in the proximity of breeding colonies, although Hiscock (1981) described *Flustra foliacea* colonizing the wreck of the *MV Roberts*, several hundreds of metres from any significant hard substrata, and hence a considerable distance from potentially parent colonies.

Flustra foliacea is a coarse, foliaceous bryozoan which tends to be found on stones and shells, reaches 10 cm in height. It is common to all coasts in North-West Europe (Hayward & Ryland, 1995b) and is found across all coasts in the British Isles (NBN, 2015).   Stebbing (1974) noted that *Flustra foliacea* on the Gower peninsular, South Wales had an annual growth season between March and November, with a dormant winter period, when no growth occurred, leading to a line forming across the fronds which can be used to age specimens. The species can regularly reach six years of age, although twelve year old specimens were reported off the Gower Peninsula (Stebbing, 1971a; Ryland, 1976). Fortunato *et al.* (2013) compared numerous sets of growth data with their own observations and reported that colonies grow faster during the first couple of years (about 1.05 cm/year), slowing down afterwards, which could be due to the lateral growth of the fronds. Colonies appeared to be able to regenerate areas of the frond which had been removed by grazing. Silén (1981) found that *Flustra foliacea* could repair physical damage to its fronds with

5-10 days, concluding that, as long as the holdfast remains intact, *Flustra foliacea* would survive and grow back. Once settled, new colonies of *Flustra foliacea* take at least 1 year to develop erect growth and 1-2 years to reach maturity, depending on environmental conditions (Tillin & Tyler Walters, 2014). Four years after sinking off Lundy, the M.V. Roberts was found to be colonized by erect bryozoans and hydroids, including occasional *Flustra foliacea* (Hiscock, 1981). *Flustra foliacea* colonies are perennial, and potentially highly fecund with increasing colony size as each zooid produces a single embryo (Tillin & Tyler Walters, 2014; Eggleston (1972a) with ca 10,000 larvae released from a specimen of *Flustra foliacea* within 3 hrs (Dalyell, cited in Hincks, 1880). Whilst bryozoan larvae are typically very short-lived, limiting recruitment to the immediate area surrounding breeding colonies, specimens experiencing strong water movement would improve dispersal potential, and may explain reports of *Flustra foliacea* colonizing a wreck several hundreds of metres from any significant hard substrata, and hence a considerable distance from potentially parent colonies (Hiscock, 1981). *Flustra foliacea* requires stable hard substrata (Eggleston, 1972; Ryland, 1976; Dyrynda, 1994) and the abundance of bryozoans is positively correlated with supply of stable hard substrata and hence with current strength (Eggleston, 1972b; Ryland, 1976).

Alcyonidium diaphanum forms an erect colony that can grow up to 50 cm long but more usually 15 cm. It has a small encrusting base, which attaches to hard substratum. The size, colour and colony form varies widely around the British Isles (Ager, 2007).

Bugula spp. are perennials that tend to form short-lived, large colonies in summer with significant die-back in late autumn and a dormant winter phase (Eggleston 1972a; Dyrynda & Ryland, 1982). Reproduction occurs in summer/early autumn with some species such as *Bugula flabellate* reportedly having two generations of fronds capable of reproduction each year (Dyrynda & Ryland, 1982). Eggleston (1972a) reported that newly settled specimens from the first generation in the Isle of Man grew rapidly and contributed to the second generation.

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 and metamorphosis follows settlement. Growth and reproduction are generally seasonal (Hayward & Ryland, 1994). Rejuvenation from fragments can also be considered an important form of reproduction (Fish & Fish, 1996). Some sponges are known to be highly resilience to physical damage with an ability to survive severe damage, regenerate and reorganize to function fully again, however, this recoverability varies between species (Wulff, 2006). Marine sponges often harbour dense and diverse microbial communities, which can include bacteria, archaea and single-celled eukaryotes (fungi and microalgae), and comprise up to 40% of sponge volume. The microbial community may have a profound impact on host biology (Webster & Taylor, 2012). Many sponges recruit annually, growth can be quite rapid, with a lifespan of one to several years (Ackers, 1983). However, sponge longevity and growth is highly variable depending on the species and conditions (Lancaster *et al.*, 2014). It is likely that erect sponges are generally longer lived and slower growing given their more complex nature than smaller encrusting or cushion sponges. Fowler & Laffoley (1993) monitored marine nature reserves in Lundy and the Isles Scilly and found that a number of more common sponges showed great variation in size and cover during the study period. 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. 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. *Dysidea fragilis* is an encrusting sponge without spicules (5 cm across and up to 0.75 cm in height to lobose at up to 30

cm across). *Dysidea fragilis* incorporates foreign material including hard material and sand grains (Hayward & Ryland, 1994). The skeleton is composed of spongin fibres making the consistency of *Dysidea fragilis* soft and elastic (Rowley, 2007). It is found from the Arctic to the Mediterranean (Ackers *et al.,* 1992; Mustapha *et al.,* 2004) and is a ubiquitous species, present in superficial and deep, clean and polluted, marine and brackish waters (Aiello *et al.,* 1996). Galera *et al.* (2000) note that *Dysidea avara* is relatively fast growing and opportunistic.

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 is 'High' (recovery within two years) for any level of perturbation. Depending on the season of the impact and level of recovery, recovery could occur within six months.

Bryozoans tend to be fast growing fauna that are capable of self-regeneration. Dispersal of the larvae is limited and whilst it is likely that the bryozoan turfs would regenerate rapidly, within 2 years (resilience of 'High') from most levels of damage. However, in the case of removal of 75% or more of the bryozoans/habitat (resistance of 'None'), recovery could take longer and a resilience of 'Medium' (2-10 years) should be recorded in such cases.

Sebens (1985, 1986) found that 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. If the sponge community suffers significant mortality from a pressure (resistance of 'None', 'Low') resilience is assessed as '**Medium**' (recovery within 2-10 years). If resistance is assessed as 'Medium' or 'High' then resilience is assessed as '**High**' (recovery within 2 years).

🚢 Hydrological Pressures

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

Gili & Hughes, (1995) reported 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 dependent 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) describe the presence and year-round fertility of *Obelia dichotoma*, *Kirchenpaureria pinnata*, *Nemertesia ramosa* and *Halecium spp.* in the Mediterranean.

Bugula spp. grows and reproduces in the summer months, however, day length and/or the phytoplankton bloom characteristic of temperate waters are probably more important than temperature (Ryland, 1967; 1970; Tyler-Walters, 2005c). *Bugula turbinata* is a predominantly southern species in British waters (Lewis, 1964; Hayward & Ryland, 1998) but has been recorded

as far north as Shetland (NBN, 2015). A long-term increase in temperature may increase its abundance in northern British waters and allow the species to extend its range. It occurs as far south as the Mediterranean (Rosso, 2003) and likely to tolerate increases of temperature, at the benchmark level. Cocito & Sgorbini (2014) studied spatial and temporal patterns of colonial bryozoans in the Ligurian Sea over 9 years. High temperature events were recorded, the first causing mass mortality among a number of species. *Alcyonidium diaphanum* is commonly found across the British Isles and is probably widely distributed across North-West Europe (Fish & Fish, 1996).

Dysidea fragilis is found from the Arctic to the Mediterranean (Ackers *et al.*, 1992; Mustapha et al., 2004). 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.

Sensitivity assessment. None of the characterizing species are at their southern distribution limit and no evidence for mortality linked to increase in temperature in the British Isles could be found. The biotope is therefore assessed as having resistance of '**High**', Resilience of '**High**' and is assessed as '**Not sensitive**' at the benchmark level.

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

errill (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. All important characterizing bryozoans (*Alcyonidium diaphanum*, *Flustra foliacea*, *Bugula plumosa* and *Bugula flabellata*) have been recorded across the British Isles, from the Channel Isles to the northern coast of Scotland (NBN, 2015). *Alcyonium digitatum* is recorded from Iceland in the north, to Portugal in the south and it is unlikely that this species will be adversely affected by a long-term temperature change in British waters (Budd, 2008). *Alcyonium digitatum* was also reported to be apparently unaffected by the severe winter of 1962-1963 (Crisp, 1964b).

The hydroids *Obelia dichotoma*, *Halecium Halecinum* and *Nemertesia* sp. were recorded in Svalbard (Orjas *et al.*, 2012).

Dysidea fragilis is found from the Arctic to the Mediterranean (Ackers *et al.*, 1992; Mustapha et al., 2004). Crisp (1964b) studied the effects of an unusually cold winter (1962-63) on the marine life in Britain, including *Porifera* in North Wales.   Whilst *Dysidea fragilis* was not mentioned in the study, Crisp 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 *Polymastia boletiformis*, were not seriously affected. It should be noted that Crisp's (1964b) general observations on all marine life stated 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.

Sensitivity assessment. The majority of characterizing species occur in boreal environments, with none at their northerly distribution limit. Therefore, resistance is likely to be '**High**' with resilience of **'High'** and the biotope is probably '**Not sensitive**' at the benchmark level.

Salinity increase (local)	No evidence (NEv)	No evidence (NEv)	No evidence (NEv)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

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. Marin *et al.* (1998) described 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. Soule & Soule (1979) cite Hastings (1927) who described the presence of 5 bryozoans in hypersaline conditions in the Suez Canal. **'No evidence'** for mortality or tolerance of the characterizing bryozoans or hydroids in hypersaline conditions could be found.

Salinity decrease (local)	Low	High	Low
	Q: Medium A: Low C: Medium	Q: Medium A: Medium C: 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 inhibited in 70% seawater (ca 25‰) and that exposure to below 30% seawater (ca 10‰) was lethal after 3 days.

Ryland (1970) stated that, with a few exceptions, the Gymnolaemata were fairly stenohaline and restricted to full salinity (30-35 ppt), noting that reduced salinities result in an impoverished bryozoan fauna. *Flustra foliacea* appears to be restricted to areas with high salinity (Tyler-Walters & Ballerstedt 2007; Budd 2008). Dyrynda (1994) noted that *Flustra foliacea* and *Alcyonidium diaphanum* were probably restricted to the vicinity of the Poole Harbour entrance by their intolerance to reduced salinity. Although, protected from extreme changes in salinity due to their subtidal habitat, severe hyposaline conditions could adversely affect *Flustra foliacea* colonies.

Dysidea fragilis is a ubiquitous species, found in superficial and deep, clean and polluted, marine and brackish waters (Aiello et al., 1996).

Sensitivity assessment. The characterizing bryozoans are likely to be affected by a reduction in salinity, and species diversity is likely to decrease. Resistance is assessed as '**Low**', resilience is assessed as '**High**' and sensitivity is '**Low**'.

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

Hayward & Ryland (1995b) noted that abundant communities of hydroids 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 detachment and enhance feeding (Gili & Hughes, 1995). The 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 et al., 1961). Tillin & Tyler-Walters (2014) suggested 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.

Water flow has been shown to be important for the development of bryozoan communities and the provision of suitable hard substrata for colonization (Eggleston, 1972b; Ryland, 1976). In addition, areas subject to high mass transport of water such as the Menai Strait and tidal rapids generally support large numbers of bryozoan species (Moore, 1977a). Although, active suspension feeders, their feeding currents are probably fairly localized and they are dependent on water flow to bring adequate food supplies within reach (McKinney, 1986). A substantial decrease in water flow will probably result in impaired growth due to a reduction in food availability, and an increased risk of siltation (Tyler-Walters, 2005c).

Okamura (1984) reported that an increase in water flow from slow flow (1-2 cm/s) to fast flow (10-12 cm/s) reduced feeding efficiency in small colonies but not in large colonies of *Bugula stolonifera*.

Flustra foliacea colonies are flexible, robust and reach high abundances in areas subject to strong currents and tidal streams Stebbing, 1971a; Eggleston, 1972b; Knight-Jones & Nelson-Smith, 1977; Hiscock, 1983, 1985; Holme & Wilson, 1985). Dyrynda (1994) suggested that mature fronded colonies do not occur on unstable substratum due to the drag caused by their fronds, resulting in rafting of colonies on shells or the rolling of pebbles and cobbles, resulting in destruction of the colony. Dyrynda (1994) reported that the distribution of *Flustra foliacea* in the current swept entrance to Poole Harbour was restricted to circalittoral boulders, on which it dominated as nearly mono-specific stands. While, the pumping activity of the lophophores provide the greatest proportion of the colonies food requirements (Hayward & Ryland, 1998), the current generated is probably very localized and the colonies are likely to be dependant on water currents for food supply. A significant decrease in water flow is likely to result in a decrease in the abundance of bryozoans.

Sensitivity assessment. The biotope experiences moderate tidal streams and substantial increase or decrease would probably result in decline of the biotope. However, a 0.1 – 02. m/s change (the benchmark) is unlikely to significantly impact the characterizing species. Resistance is, therefore, assessed as '**High**', resilience is assessed as '**High**' and the biotope is assessed as '**Not Sensitive**' at the benchmark level.

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

Jackson (2004) reported that *Nemertesia ramosa* was intolerant of high wave exposure and 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.

Bugula spp. produce flexible erect tufts, which are likely to move with the oscillatory flow created by wave action. *Bugula turbinata* has been recorded from very wave exposed to very wave sheltered habitats (Tyler-Walters, 2005c).

Flustra foliacea occurs from very wave exposed to sheltered waters, although probably limited to deeper waters in very wave exposed conditions (Tyler-Walters & Ballerstedt , 2007) The oscillatory water flow generated by wave action may be more damaging than constant strong currents, e.g. strong wave action may generate an oscillatory flow of 2 m/sec at 20 m (Hiscock, 1983, 1985). *Flustra foliacea* is a common member of the flotsam, having been removed from its substratum by storms. Whilst the biotope is circalittoral, a severe increase in wave exposure (e.g. storms) could affect bryozoans colonies, especially on mobile substrata such as cobbles and pebbles). Cocito *et al.* (1998) described a severe winter storm of 1993 had devastating effects on the same *Flustra foliacea* population, sweeping away most of the colonies down to 11 m.

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.

Sensitivity assessment. Significant increase in wave exposure could affect the characterizing species due to increased scour and movement of mobile substrata. A significant decrease may also affect the biotope. However, a change at the benchmark level would be unlikely to affect the characterizing species. Resistance is, therefore, assessed as '**High**', resilience is assessed as '**High**' and the biotope is assessed as '**Not sensitive**' at the benchmark level.

⚗ Chemical Pressures

	Resistance	Resilience	Sensitivity
Transition elements & organo-metal contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	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 (1981a) 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.

Bryozoans are common members of fouling communities and amongst those organisms most resistant to antifouling measures, such as copper containing anti-fouling paints. Bryozoans were also shown to bioaccumulate heavy metals to a certain extent (Soule & Soule, 1979; Holt et al., 1995).

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.

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).

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).

Banks & Brown (2002) found that exposure to crude oil significantly impacted recruitment in the bryozoan *Membranipora savartii*.

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).

Little information on the effects of hydrocarbons on bryozoans was found. Ryland & de Putron (1998) did not detect adverse effects of oil contamination on the bryozoan *Alcyonidium* spp. or other sessile fauna in Milford Haven or St. Catherine's Island, south Pembrokeshire. Houghton *et al.* (1996) reported a reduction in the abundance of intertidal encrusting bryozoa (no species given) at oiled sites after the *Exxon Valdez* oil spill. Soule & Soule (1979) reported that the encrusting bryozoan *Membranipora villosa* was not found in the impacted area for 7 months after the December 1976 *Bunker C* oil spill in Los Angeles Harbour. Additionally, Soule & Soule (1979) reported that *Bugula neritina* was lost from breakwater rocks in the vicinity (in December 1979) of

the *Bunker C* oil spill and had not recovered within a year. However, *Bugula neritina* had returned to a nearby area within 5 months (May 1977) even though the area was still affected by sheens of oil. Furthermore, only three of eight recorded species two weeks after the incident were present in April within the affected breakwater area. By June all the species had been replaced by dense growths of the erect bryozoan *Scrupocellaria diegensis*.

Mohammad (1974) reported that *Bugula* spp. and *Membranipora* spp. were excluded from settlement panels near an oil terminal in Kuwait subject to minor but frequent oil spills. Encrusting bryozoans are also probably intolerant of the smothering effects of acute hydrocarbon contamination and pollution, resulting in suffocation of colonies and communities may be lost or damaged. Circalittoral communities are likely to be protected from the direct effects of oil spills by their depth. However, the biotope may be exposed to emulsified oil treated with dispersants, especially in areas of turbulence, or may be exposed to water soluble fractions of oils, PAHs or oil adsorbed onto particulates (Tyler-Walters, 2002).

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 (1981a) cited reports of growth stimulation in *Obelia geniculata* caused by methyl cholanthrene and dibenzanthrene. Hoare & Hiscock (1974) suggested that the Bryozoa (as Polyzoa) were amongst the most intolerant species to acidified halogenated effluents in Amlwch Bay, Anglesey, e.g. *Electra pilosa* occurred at lower abundance on laminarian holdfasts within the bay, compared to sites outside the affected area.

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' was found.

Introduction of other substances	Not Assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR	Not assessed (NA) Q: NR A: NR C: NR

This pressure is **Not assessed**.

De-oxygenation	Medium Q: Low A: NR C: NR	High Q: Medium A: Medium C: Medium	Low 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 2mg/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 bryozoans 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, although bryozoans were more abundant in the area with generally higher oxygen. However, estuarine species are likely to be better adapted to periodic changes in oxygenation.

Sensitivity assessment. Whilst hydroids and bryozoans have been shown to tolerate short anoxic events (Sagasti et al., 2000) and the sand scoured nature of the biotope would likely result in occasional burial, an event at the benchmark level would likely result in quite significant mortality. Resistance is therefore assessed as '**Medium**', resilience as '**High**' and sensitivity as '**Low**'.

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

Hartikainen *et al.* (2009) reported that increased nutrient concentrations resulted in freshwater bryozoans achieving higher biomass. O'Dea & Okamura (2000) found that annual growth of *Flustra foliacea* in western Europe has substantially increased since 1970. They suggest that this could be due to eutrophication in coastal regions due to organic pollution, leading to increased phytoplankton biomass (see Allen *et al.*, 1998).

Gochfeld *et al.* (2012) studied the effect of nutrient enrichment (≤0.05 to 0.07 ⊔M for nitrate and ≤0.5 ⊔M 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 (