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Tubularia indivisa and cushion sponges on tide-swept turbid circalittoral bedrock

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

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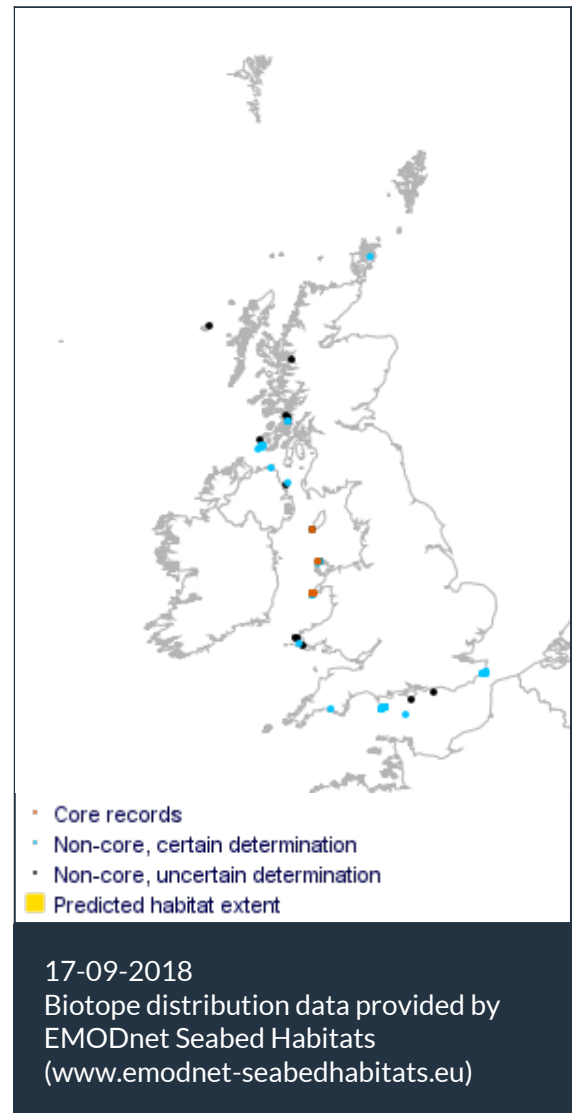
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Researched by Thomas Stamp and Dr Harvey Tyler-Walters

Refereed by Admin

Summary

☰ UK and Ireland classification

EUNIS 2008	A4.1121	<i>Tubularia indivisa</i> and cushion sponges on tide-swept turbid circalittoral bedrock
JNCC 2015	CR.HCR.FaT.CTub.CuSp	<i>Tubularia indivisa</i> and cushion sponges on tide-swept turbid circalittoral bedrock
JNCC 2004	CR.HCR.FaT.CTub.CuSp	<i>Tubularia indivisa</i> and cushion sponges on tide-swept turbid circalittoral bedrock
1997 Biotope	CR.ECR.BS.TubS	<i>Tubularia indivisa</i> , sponges and other hydroids on tide-swept circalittoral bedrock

🔍 Description

This biotope is typically found on the vertical and upper faces of strongly tide-swept, exposed circalittoral bedrock and boulders. It is commonly associated with areas where turbidity levels are high for much of the year, for example, around Anglesey and the Lleyn Peninsula. From afar, this

variant appears as a dense carpet of *Tubularia indivisa* covering tide-swept gully walls, floors and boulders. *Tubularia indivisa* is frequently observed growing through sheets of sponges such as *Myxilla incrustans* and *Halichondria panicea* as well as through dense patches of the barnacle *Balanus crenatus* and tubes of the amphipod *Jassa* spp. Several other species of sponge appear to be tolerant of the high turbidity in areas where this variant occurs, many of which are common in other biotopes. These include *Esperiopsis fucorum*, *Pachymatisma johnstonia*, *Hemimycale columella*, *Dysidea fragilis* and *Clathrina coriacea*. Robust hydroids (other than *Tubularia indivisa*) such as *Nemertesia antennina* and *Sertularia argentea* occur in patches. The anemones *Urticina felina*, *Actinothoe sphyrodeta* and *Sagartia elegans* are typically common. A short bryozoan turf consisting of crisiid bryozoans, *Alcyonidium diaphanum*, *Bicellariella ciliata*, *Bugulina turbinata* and *Bugulina flabellata* may be present. *Alcyonium digitatum* may occasionally be seen although it doesn't tend to be as dominant as in CTub.Adig. Individual *Corynactis viridis* may be seen scattered across the gully walls and boulders. The starfish *Henricia oculata* may be seen on boulders and gully floors whilst typical under-boulder fauna includes the crab *Cancer pagurus*. *Laminaria* forest (LhypR) may be found above this biotope. (Information from Connor *et al.*, 2004; JNCC, 2015).

↓ Depth range

10-20 m, 20-30 m

Additional information

-

✓ Listed By

- none -

Further information sources

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Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

CR.HCR.FaT.CTub occurs on exposed circalittoral bedrock and boulders in sounds, narrows and around tide-swept promontories in accelerated tidal streams. High water flow facilitates the high abundance and dominance of a filter feeding community. CR.HCR.FaT.CTub is characterized by a dense carpet of *Tubularia indivisa*. Other hydroids such as *Sertularia argentea* and *Nemertesia antennina* also occur, together with a scattered bryozoan turf. Where relevant, the topography of the substratum may provide shelter for erect bryozoans (e.g. *Flustra foliacea* and *Alcyonidium diaphanum*) and crabs (e.g. *Cancer pagurus*). Mobile scavengers (e.g. *Asterias rubens*) and mobile faunal grazers (e.g. *Calliostoma zizyphinum*) may be present. Other important species within CR.HCR.FaT.CTub include *Sagartia elegans*, *Urticina felina*, *Metridium senile*, *Actinothoe sphyrodeta* and *Corynactis viridis*. Massive sponges such as *Pachymatisma johnstonia* and *Esperiopsis fucorum* may also be present with other encrusting species but these are not present in all examples of the biotope and are not considered to be important characterizing species.

Two sub-biotopes are distinguished based on slight differences in tidal flow or wave exposure. In areas of slightly reduced tidal streams but increase wave exposure, anthozoans such as *Alcyonium digitatum* increase in abundance and the biotope is recognised as CR.HCR.FaT.CTub.Adig. However, in areas of higher tidal streams and seasonal turbidity, the abundance of encrusting and massive sponges increases forming the biotope CR.HCR.FaT.CTub.CuSp. CR.HCR.FaT.CTub are high energy (water movement) biotopes dominated by epifaunal communities. The biotope and its sub-biotopes are characterized by dense turfs of the hydroid *Tubularia indivisa*. Therefore, the sensitivity assessment concentrates on *Tubularia indivisa* and relevant examples of the epifaunal community, in particular, the anthozoans (e.g. *Alcyonium digitatum* in CTub.Adig) and sponges (e.g. in CTub.CuSp). Examples of other important species groups are mentioned where appropriate.

Resilience and recovery rates of habitat

Hydroids exhibit rapid rates of recovery from disturbance through repair, asexual reproduction and larval colonization. Sparks (1972) reviewed the regeneration abilities and rapid repair of injuries. Fragmentation of the hydroid provides a route for short distance dispersal, for example, each fragmented part of *Sertularia cupressina* can regenerate itself following damage (Berghahn & Offermann, 1999). New colonies of the same genotype may, therefore, arise through damage to existing colonies (Gili & Hughes, 1995). Many hydroid species also produce dormant, resting stages that are very resistant of environmental perturbation (Gili & Hughes, 1995). Although colonies may be removed or destroyed, the resting stages may survive attached to the substratum and provide a mechanism for rapid recovery (Cornelius, 1995a; Kosevich & Marfenin, 1986). The lifecycle of hydroids typically alternates between an attached solitary or colonial polyp generation and a free-swimming medusa generation. Planulae larvae produced by hydroids typically metamorphose within 24 hours and crawl only a short distance away from the parent plant (Sommer, 1992). Gametes liberated from the medusae (or a vestigial sessile medusae) produce gametes that fuse to form zygotes that develop into free-swimming planula larvae (Hayward & Ryland, 1994) that are present in the water column between 2-20 days (Sommer, 1992). It has also been suggested that rafting on floating debris as dormant stages or reproductive adults (or on ships hulls or in ship ballast water), together with their potentially long lifespan, may have allowed hydroids to disperse over a wide area in the long-term and explain the near cosmopolitan distributions of many hydroid species (Cornelius, 1992; Boero & Bouillon 1993). Hydroids are therefore classed as potential fouling organisms, rapidly colonizing a range of substrata placed in

marine environments and are often the first organisms to colonize available space in settlement experiments (Gili & Hughes, 1995).

Tubularia indivisa is a common athecate hydroid distributed across the North East Atlantic from the Arctic Ocean to the Mediterranean (WORMS, 2015). *Tubularia indivisa* is a short-lived species, and recruitment is seasonally variable with settlement peaking in early spring (March) however, other smaller recruitment events occur during summer and autumn (Hughes, 1983). *Tubularia spp.* are considered to be opportunistic species and are often the first to colonize bare surfaces and to reach sexual maturity rapidly. In some habitats *Tubularia spp.* are transient and are replaced by more competitive species, however, in other tide-swept or scoured habitats (e.g. CR.HCR.FaT.CTub) they represent a permanent feature of an annual cycle and tend to dominate in specific seasons e.g. spring-autumn (Zintzen *et al.*, 2008a&b; Hiscock *pers comm*). The season in which settlement occurs has a direct relationship with life expectancy. High gastropod grazing pressure in spring and summer can cause a mortality rate of 70% (Hughes, 1983). Therefore, post-settlement life expectancy can vary from 30 (spring recruitment) to 160 days (autumn recruitment). Observations of *Tubularia indivisa* from the spring settlement cohort indicate that reproduction can occur within 6-8 weeks, however, autumn cohorts are likely to persist throughout the winter and begin reproduction the following spring. *Tubularia indivisa* has a large larval dispersal capacity, and larvae can potentially settle 1-10 km from the parental source (Zintzen *et al.*, 2008a&b).

Alcyonium digitatum is a colonial species of soft coral with a wide distribution in the North Atlantic, recorded from Portugal (41°N) to Northern Norway (70°N) as well as on the east coast of North America (Hartnoll, 1975). Colonies consist of stout "finger-like" projections (Hartnoll, 1975) which can reach up to 20 cm tall and can dominate circalittoral rock habitats (as in CR.HCR.FaT.CTub.Adig; Connor *et al.*, 2004). *Alcyonium digitatum* colonies are likely to have a lifespan which exceeds 20 years as colonies have been followed for 28 years in marked plots (Lundälv, *pers. comm.*, in Hartnoll, 1998). Those colonies which are 10-15 cm in height have been aged at between 5 and 10 years old (Hartnoll, unpublished). The majority of colonies are unisexual, with the majority of individuals being female. Sexual maturity is predicted to occur, at its earliest when the colony reaches its second year of growth, however, the majority of colonies are not predicted to reach maturity until their third year when they attain a biomass of approx 20-30g (Hartnoll, 1975).

Alcyonium digitatum spawns from December and January. Gametes are released into the water and fertilization occurs externally. The embryos are neutrally buoyant and float freely for seven days. The embryos give rise to actively swimming lecithotrophic planulae which may have an extended pelagic life before they eventually settle (usually within one or two further days) and metamorphose to polyps (Matthews, 1917; Hartnoll, 1975). In laboratory experiments, several larvae of *Alcyonium digitatum* failed to settle within 10 days, presumably finding the conditions unsuitable, these larvae proved to be able to survive 35 weeks as non-feeding planulae. After 14 weeks some were still swimming and after 24 weeks the surface ciliation was still active although they rested on the bottom of the tanks, by the end of the experiment at 35 weeks the larvae had shrunk to a diameter of 0.3 mm. This ability to survive for long periods in the plankton may favour the dispersal and eventual discovery of a site suitable for settlement (Hartnoll, 1975). The combination of spawning in winter and the long pelagic lifespan may allow a considerable length of time for the planulae to disperse, settle and metamorphose ahead of the spring plankton bloom. Young *Alcyonium digitatum* will consequently be able to take advantage of an abundant food resource in spring and be well developed before the appearance of other forms that may otherwise compete for the same substrata. In addition, because the planulae do not feed whilst in the pelagic

zone they do not suffer by being released at the time of minimum plankton density and they may also benefit by the scarcity of predatory zooplankton which would otherwise feed upon them (Hartnoll, 1975).

Little information on sponge longevity and resilience exists. Reproduction can be asexual (e.g. budding) or sexual (Naylor, 2011) and individual sponges are usually hermaphrodites (Hayward & Ryland, 1994). Many sponges recruit annually and growth can be rapid, with a lifespan of one to several years (Ackers, 1983). However, sponge longevity and growth have been described as highly variable depending on the species and environmental conditions (Lancaster *et al.*, 2014). 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 considered an important form of reproduction (Fish & Fish, 1996).

Amphilectus fucorum (syn. *Esperiopsis fucorum*) is found in wide variety of situations and is distributed across the Atlantic coasts of Europe, from Norway to France (Ackers *et al.*, 1992). Picton & Morrow (2015b) 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 and 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.

Halichondria panicea is very polymorphic, varying from thin sheets, massive forms and cushions to branching. It crumbles readily and branches are brittle (breaking if bent through 20°). An opportunistic species, it is found in wide range of niches on rock or any other hard substratum (Ackers *et al.*, 1992). It reaches its maximal development in harbours and estuaries, being very tolerant of muddy and brackish conditions and can be partly embedded in mud. Barthel (1986) reported that *Halichondria panicea* in the Kiel Bight went through annual cycles, with growth occurring between March and July. After July, a strong decline in mean individual weight occurred until the end of September. No change in individual weight was observed over winter, although changes in biochemical composition (condition index and protein lipid and glycogen content) were noted. Reproductive activity occurred in August and September with young colonies appearing in early autumn. Adult *Halichondria panicea* degenerated and disintegrated after reproduction. Fish & Fish (1996), however, suggested a lifespan of about 3 years and Vethaak *et al.*, (1982) reported that, unlike *Halichondria bowerbanki*, *Halichondria panicea* survives the winter in a normal, active state in the Oosterschelde. Vethaak *et al.* (1992) later reported that *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. Fell & Lewandrowski (1981) observed the population dynamics of *Halichondria* spp. within an eelgrass bed in the lower Mystic Estuary, Connecticut over a 2 year period. Large numbers of larval derived specimens developed on the eelgrass during the summer, and many of these sponges became sexually reproductive, further increasing the size of the population. However, mortality was high, and at the end of the summer, only a relatively small sponge population remained. Sexual reproduction by larva-derived specimens of *Halichondria* spp. occurred primarily after breeding by the parental generation had declined. The larva-derived sponges grew rapidly, and the percentage of specimens containing large, female reproductive elements increases with specimen size. *Halichondria* spp. exhibited an opportunistic life strategy with a 'high rate of turnover'. Sutherland (1981) investigated the fouling community in North Carolina, the US using short and long-term plates to observe recruitment to artificial surfaces. *Halichondria* assemblages recruited sporadically between June/July and end of October in some

years but were not observed in others. Thomassen & Riisgard (1995) described a number of studies looking at the growth rates of *Halichondria* spp. with rates of between 1% and 3.3% of total volume per day.

Whomersley & Picken (2003) documented epifauna colonization of offshore oil platforms in the North Sea from 1989-2000. On all platforms, *Mytilus edulis* dominated the near surface community. For the first 3 years, hydroids and tubeworms dominated the community below the mussel band. However, the hydroid community was later out-competed by other species. Recruitment of *Alcyonium digitatum* and *Metridium dianthus* began at 2-5 years (dependent on the oil rig). At 45-57m below sea level an "anemone" zone also began recruiting within 1-2 years, and on some rigs dominated that depth by year 6. The community structure and zonation differed between the 4 rigs. However, generally after four years, *Metridium dianthus* had become the dominant organism below the mussel zone to approximately 60-80 m. However, zonation differed between oil rigs and, from approximately 60-90 m, *Alcyonium digitatum* was the dominant organism.

The *HMS Scylla* was intentionally sunk on the 27th March 2004 in Whitsand Bay, Cornwall to act as an artificial reef. Hiscock *et al.* (2010) recorded the succession of the biological community on the wreck for five years following the sinking of the ship. Initially, the wreck was colonized by opportunistic species /taxa; filamentous algae, hydroids, serpulid worms and barnacles. *Tubularia* sp. were early colonizers, appearing within a couple of months after the vessel was sunk. *Metridium dianthus* appeared late in the summer of the first year but did not become visually dominant until 2007 (3 years after the vessel was sunk). *Sagartia elegans* was recorded within the summer of 2005, and by the end of 2006 was well established. *Corynactis viridis* was first recorded in the summer of the first year and quickly formed colonies via asexual reproduction. *Urticina felina* was first recorded at the end of August 2006 (two years after the vessel was sunk), and by summer 2008 had increased in abundance. *Alcyonium digitatum* was first recorded in early summer 2005, a year after the vessel was sunk. Within one year of growth colonies had grown to nearly full size, however, did not become a visually dominant component of the community until 2009, five years after the vessel had been sunk (Hiscock, *et al.*, 2010).

Sedentary anthozoans such as *Sagartia elegans*, *Urticina felina*, *Metridium dianthus*, *Actinothoe sphyrodeta* and *Corynactis viridis* are also important species within CR.HCR.FaT.CTub, and other tide-swept biotopes (Connor *et al.*, 2004; Wood, 2005). Information concerning the recovery of mixed anthozoan communities such as that found in CR.HCR.FaT.CTub is limited (Whomersley & Picken, 2003; Hiscock *et al.*, 2010). Little is known of the recovery capability of *Actinothoe sphyrodeta*, however, this species was recorded with *Corynactis viridis* as early colonizers of the wreck of the *Scylla*, appearing within a couple of months of the vessel sinking. *Sagartia elegans* was first recorded within 1 year of the vessel sinking (10/06/2005), however, did not become fully established until the next summer (2006). *Urticina felina* was not recorded on the wreck until 2 years after the vessel sunk (28/08/2006) (Hiscock *et al.*, 2010). *Metridium dianthus* has rapid growth rates. Bucklin (1985), working in Britain, found that newly settled *Metridium dianthus* f. *dianthus* and *Metridium dianthus* f. *pallidum* had a growth rate of up to 0.6 mm and 0.8 mm in pedal diameter per day (respectively). However, they may take up to 2 years to recruit and 5 years to become visually dominant within the community (Whomersley & Picken, 2003; Hiscock *et al.*, 2010). *Sagartia elegans*, *Urticina felina*, *Metridium dianthus*, *Actinothoe sphyrodeta* and *Corynactis viridis* can reproduce via asexual budding (Wood 2005). Therefore, if members of these species remain within the community it is likely all could recolonize without the need of larval recruitment.

Spirobranchus (formerly *Pomatoceros*) *triqueter* and *Balanus crenatus* are both relatively short-lived

species that mature rapidly and have long reproductive seasons and produce pelagic larvae. *Balanus crenatus* and *Spirobranchus triqueter* can utilise a variety of substrata including artificial and natural hard substratum, bivalves and other animals. The life history traits and broad habitat preferences mean that populations of both species can recover rapidly following disturbance. Off Chesil Bank, the epifaunal community dominated by *Spirobranchus triqueter*, *Balanus crenatus* and *Electra pilosa*, decreased in cover in October as it was scoured away in winter storms, and recolonized in May to June (Warner, 1985). Warner (1985) reported that the community did not contain any persistent individuals, being dominated by rapidly colonizing organisms. While larval recruitment was patchy and varied between the years studied, recruitment was sufficiently predictable to result in a dynamic stability, so that although abundance varies throughout the year similar communities were present in 1979, 1980 and 1983 (Warner, 1985). Holme & Wilson (1985) suggested that the fauna of the *Balanus-Pomatoceros* assemblage in the central English Channel was restricted to rapid growing colonizers able to settle rapidly and utilize space in short periods of stability in the summer months.

Sebens (1985; 1986) described the recolonization of epifauna on vertical rock walls. Rapid colonizers such as encrusting corallines, encrusting bryozoans, amphipods and tubeworms recolonized within 1-4 months. Ascidians such as *Dendrodoa carnea*, *Molgula manhattensis* and *Aplidium* spp. achieved significant cover in less than a year, and, together with *Halichondria panicea*, reached pre-clearance levels of cover after 2 years. A few individuals of *Alcyonium digitatum* and *Metridium senile* colonized within 4 years (Sebens, 1986) and would probably take longer to reach pre-clearance levels.

Resilience assessment. *Tubularia indivisa* is an early colonizing species and as noted by Hiscock *et al.* (2010) settled within a couple of months of the vessel *HMS Scylla* was sunk. Such rapid settlement is likely to be a result of the timing of the sinking of the ship, spring being a period of peak *Tubularia indivisa* recruitment. However, as highlighted by Hughes (1983) *Tubularia indivisa* can reproduce within 6-8 weeks of settlement and, therefore, recovery following disturbance is likely to occur within a year. Other hydroids, barnacles and tube worms are also likely to recover rapidly from any level of disturbance. *Alcyonium digitatum* has been observed to recruit within 2 years, but to establish a dense population of typical size and age-structure will require longer, where populations have suffered significant losses (Whomersley & Picken, 2003; Hiscock *et al.*, 2010). Similarly, other important species within CR.HCR.FaT.CTub such as *Sagartia elegans*, *Urticina felina*, *Metridium senile*, *Actinothoe sphyrodeta* and *Corynactis viridis* can colonize bare surfaces within a 1 year but may take up to 5 years to establish mature populations.

Therefore, if the assemblage is significantly damaged or completely removed from the habitat (resistance is assessed as 'Low' or 'None') resilience is assessed as '**Medium**' (2-10 years). However, if resistance is assessed as 'Medium' or 'High' then resilience is assessed as '**High**' as there is less impact for populations to recover from and re-establishment of typical biomass will be driven by surviving individuals as well as recruitment.

Hydrological Pressures

	Resistance	Resilience	Sensitivity
Temperature increase (local)	Medium Q: Low A: NR C: NR	High Q: High A: High C: Medium	Low Q: Low A: Low C: Low

This biotope occurs in the subtidal and is, therefore, protected from exposure to air so that the

thermal regime is more stable and desiccation is not a factor. Examples of distribution and thermal tolerances tested in laboratory experiments are provided as evidence to support the sensitivity assessment. In general, populations can acclimate to prevailing conditions which can alter tolerance thresholds and care should, therefore, be used when interpreting reported tolerances.

Tubularia indivisa is recorded from the Arctic Ocean to the Mediterranean (WORMS, 2015). *Alcyonium digitatum* is described as a northern species by Hiscock *et al.* (2004) and is distributed from Portugal (41°N) to Northern Norway (70°N) (Hartnoll, 1975). Across this latitudinal gradient, both species are likely to experience a range of temperatures from approx. 5-18°C (Seatemperature, 2015). Zintzen *et al.* (2008a) that the *Tubularia indivisa* dominated communities on shipwrecks in the North Sea experienced a range of water temperature from 4.2°C in March to 20.3°C in August. The seasonal changes in *Tubularia* abundance were, however, probably correlated with fluctuations in predation and competition, coupled with lack of recruitment and dormancy in *Tubularia indivisa* in summer (Zintzen *et al.*, 2008a).

A *Metridium dianthus* population at Barnstable, Massachusetts is reported to persist within a temperature range of 1.8 to 21.8°C (Sassaman & Mangum, 1970; Walsh & Somero, 1981). There is evidence to suggest *Metridium dianthus* temperature response can vary with latitude and acclimation (Walsh & Somero, 1981; Chomsky *et al.*, 2004). For example, Sassaman & Mangum (1970) demonstrated *Metridium dianthus* "maintained" within 10°C prior to experimentation incurred 100% mortality when exposed to 27.5°C for 120 to 240 minutes, whereas *Metridium senile* "maintained" within 20°C prior to experimentation all survived (Sassaman & Mangum, 1970; Walsh & Somero, 1981). It is, therefore, possible that *Metridium dianthus* would be susceptible to acute temperature changes at the pressure benchmark. *Actinothoe sphyrodeta* has been recorded from Cabo Pino, Mediterranean coast of Spain (Williams, 1997), where sea temperature range from 14 to 24°C (Seatemperature, 2015), and is, therefore, unlikely to be affected at the benchmark level. *Urticina felina* is distributed from the Arctic Ocean (Ofwegen *et al.*, 2001) to Portugal (Ramos, 2010). Gosse (1860) observed that *Urticina felina* (as *Actinia crassicornis*) was "one of the most difficult (anemones) to keep in an aquarium" and that "the heat of the summer is generally fatal to our captive specimens". It is, therefore, likely that local warming may adversely affect individuals, especially in southern examples of this biotope, and some mortality might occur.

CR.HCR.FaT.CTub is recorded from North Scotland to Pembrokeshire, Wales. Sea surface temperature across this distribution ranges from northern to southern Sea Surface Temperature (SST) ranges of 8-16°C in summer and 6-13°C in winter (Bieszczynska-Möller & Dye, 2013). In addition, Goodwin *et al.* (2013) found little evidence to suggest that rising seawater temperatures (ca 1-2°C) had an effect on subtidal benthic assemblages in Northern Ireland between pre-1986 and post-2006 surveys. However, significant effects were noted in rarer species at the edge of the biogeographic ranges (Goodwin *et al.*, 2013).

Sensitivity assessment. An increase in sea surface temperature of 2°C for a period of one year with high temperatures within the south of the UK may approach the upper temperature threshold of *Alcyonium digitatum* and *Urticina felina*, which may, therefore, cause minor declines in abundance in the CTub.Adig, while CTub.CuSp may not be adversely affected. An increase in temperature may affect reproduction and growth in *Tubularia indivisa* as it becomes dormant in summer months (Zintzen *et al.*, 2008a). Biotopes in the north of the UK are unlikely to be affected at the benchmark level. A short-term increase in temperature may cause mortality of *Urticina felina*, however, the effect on the rest of the community is not known. Therefore, a precautionary resistance is assessed as 'Medium', resilience 'High' and sensitivity assessed as 'Low'.

**Temperature decrease
(local)****Medium**

Q: Low A: NR C: NR

High

Q: High A: High C: Medium

Low

Q: Low A: Low C: Low

CR.HCR.FaT.CTub is recorded from North Scotland to Pembrokeshire, Wales. Sea surface temperature across this distribution ranges from Northern to southern Sea Surface Temperature (SST) ranges from 8-16 °C in summer and 6-13 °C in winter (Beszczynska-Möller & Dye, 2013). *Alcyonium digitatum* is described as a northern species by Hiscock *et al.* (2004), however, is distributed from Portugal (41°N) to Northern Norway (70°N) (Hartnoll, 1975). Similarly, *Tubularia indivisa* is recorded from the Arctic Ocean to the Mediterranean (WORMS, 2015). Across this latitudinal gradient, both species are likely to experience a range of temperatures from approx. 5-18°C. *Alcyonium digitatum* was also reported to be apparently unaffected by the severe winter of 1962-1963 where air temperature reached -5.8°C (Crisp, 1964). Zintzen *et al.* (2008a) that the *Tubularia indivisa* dominated communities on shipwrecks in the North Sea experienced a range of water temperature from 4.2°C in March to 20.3°C in August. The seasonal changes in *Tubularia* abundance were, however, probably correlated with fluctuations in predation and competition, coupled with lack of recruitment and dormancy in *Tubularia indivisa* in summer (Zintzen *et al.*, 2008a). Palerud *et al.* (2004) described the presence of the characterizing hydroids *Halecium halecinum* and *Nemertesia* sp. in Svalbard, suggesting that these hydroids are probably tolerant of the lowest temperatures they are likely to encounter in Britain and Ireland of ca 4°C (Beszczynska-Möller & Dye, 2013).

The characteristic sponges (*Pachymastia johnstonia* and *Halichondria panacea*) are widely distributed across the coasts of the British Isles and are all found from the Channel Isles to Northern Scotland (NBN, 2015). Some sponges 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 *et al.* (1964) observed the effects of an unusually cold winter (1962-3) on the marine life in Britain, including Porifera in North Wales. Whilst difficulty in distinguishing between mortality and delayed development was noted, Crisp *et al.* found that *Pachymastia johnstonia* and *Halichondria panacea* were wholly or partly killed by frost and several species appeared to be missing including *Amphilectus fucorum*. Barthel (1986) reported that *Halichondria panacea* in the Kiel Bight degenerated and disintegrated after reproduction before winter, however, young colonies were observed from September.

Metridium dianthus and *Urticina felina* are recorded within the Arctic circle (Stephenson, 1935; Walsh & Somero, 1981) and are therefore unlikely to be affected at the benchmark level. *Actinothoe sphyrodeta* most northerly record is the Shetland Isles (Williams, 1997). Indicating *Actinothoe sphyrodeta* could be sensitive to a temperature decrease within the UK. However, due to a general lack of information concerning the resilience of *Actinothoe sphyrodeta*, it has not been included in this assessment.

Sensitivity assessment. *Tubularia indivisa*, *Alcyonium digitatum*, *Metridium dianthus*, *Urticina felina* and other anthozoans are recorded to the north of the British Isles and are considered unlikely to be affected at the benchmark level for either acute or chronic decrease in temperature. However, some of the characteristic sponges may be lost or regress due to a decrease in temperature at the benchmark level. Therefore, a cautious resistance assessment of 'Medium' is applied, albeit with a 'Low' confidence due to the lack of evidence. Resilience is probably 'High' and sensitivity is assessed as 'Low'.

Salinity increase (local)**High**

Q: Low A: NR C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

Tubularia indivisa and *Alcyonium digitatum* are recorded from a few variable salinity (18-40) biotopes but probably at lower abundance than in the full salinity biotopes in which the majority of their records occur. *Metridium dianthus* is recorded from the intertidal (Bucklin, 1987), and Shumway (1978) found in low salinity *Metridium dianthus* could retract to a 1/3 of its body size, which may be a behaviour adaptation to variable salinity. Therefore, *Metridium dianthus* may be tolerant of short-term variation in salinity, however at the time of writing there was no available evidence to assess the effect of long-term hypersaline environments on *Metridium dianthus*.

Although *Urticina felina* occurs in rockpools where some increases in salinity from evaporation may occur, it is typically found in those on the low shore, where fluctuations in salinity are limited by the short emergence time.

An increase in salinity at the benchmark level would result in a salinity of >40 psu for one year.

Hypersaline water is likely to sink to the seabed and the biotope could be affected by hypersaline effluents (brines). Ruso *et al.* (2007) reported that changes in the community structure of soft sediment communities due to desalination plant effluent in Alicante, Spain. In particular, in close vicinity to the effluent, where the salinity reached 39 psu, the community of polychaetes, crustaceans and molluscs was lost and replaced by one dominated by nematodes. Roberts *et al.* (2010b) suggested that hypersaline effluent dispersed quickly but was more of a concern at the seabed and in areas of low energy where widespread alternations in the community of soft sediments were observed. In several studies, echinoderms and ascidians were amongst the most sensitive groups examined (Roberts *et al.*, 2010b).

Sensitivity assessment. The majority of species present are probably sensitive to an increase in salinity of >40 psu, especially if persistent. However, hypersaline effluents are likely to be dispersed quickly in the high energy environments that this biotope and its sub-biotopes occur. Therefore, resistance is assessed as '**High**', resilience as '**High**' and the biotope is probably '**Not sensitive**' to this pressure. The confidence in the assessment is 'Low' due to the lack of direct evidence.

Salinity decrease (local)**Low**

Q: Low A: NR C: NR

Medium

Q: High A: High C: Medium

Medium

Q: Low A: Low C: Low

The effects of decreased salinity on *Tubularia indivisa* are unclear. *Tubularia indivisa* is recorded as abundant at a number of locations within the Mersey estuary (Bassindale, 1938). However, the majority of hydroids are subtidal and, although some brackish water species exist (Gili & Hughes, 1995) they are probably intolerant of prolonged decreases in salinity. *Alcyonium digitatum* does inhabit situations such as the entrances to sea lochs (Connor *et al.*, 2004) or the entrances to estuaries (Braber & Borghouts, 1977) where salinity may vary occasionally. However, its distribution and the depth at which it occurs suggest that *Alcyonium digitatum* is unlikely to survive significant reductions in salinity. *Tubularia indivisa* and *Alcyonium digitatum* are recorded from a few variable salinity (18-40) biotopes but probably at lower abundance than in the full salinity biotopes in which the majority of their records occur.

Metridium dianthus is predominantly marine, however, does penetrate into estuaries and can be found in the intertidal (Shumway, 1978). Braber & Borghouts (1977) found that *Metridium dianthus* occurred in about 10ppt Chlorinity (about 19 psu) in the Delta Region of the Netherlands

suggesting that it would be tolerant of reduced salinity conditions. Shumway (1978) found that, during exposure to 50% seawater, animals retracted their tentacles whilst animals exposed to fluctuating salinity, contracted their body wall and produced copious mucus. Therefore, the species seems to have a high tolerance to a reduction in salinity but may have to retract tentacles, suffer reduced opportunity to feed and expend energy to produce mucus.

Zintzen *et al.* (2008a&b) examined *Tubularia* spp. dominated epifaunal communities on ship wrecks in the Southern Bight of the North Sea. While *Tubularia indivisa* dominated offshore and intermediate sites, coastal sites were dominated by *Metridium dianthus* and had a lower biomass of turfs of *Tubularia* spp. The coastal sites were characterized by periodic salinity decreases, large seasonal temperature fluctuations, high total suspended sediment and reduced current velocity when compared to offshore and intermediate sites (Zintzen *et al.*, 2008b). Salinity alone does not explain the differences in abundance but is a factor.

Although *Urticina felina* is predominantly marine, the species does penetrate into estuaries (e.g. the Thames estuary at Mucking; NMMP, 2001) and the River Blackwater estuary (Davis, 1967). Braber & Borghouts (1977) found that *Urticina* (as *Tealia*) *felina* penetrated to about the 11 ppt Chlorinity (about 20 psu) isohaline at mid-tide during average water discharge in the Westerschelde estuary suggesting that, during high river flow, it would be tolerant of reduced salinity conditions. Intertidal and rock pool individuals will also be subject to variations in salinity because of precipitation on the shore; albeit for short periods on the lower shore.

Sensitivity review. CR.HCR.FaT.CTub is recorded exclusively in full marine conditions (30-40 psu) (Connor *et al.*, 2004). There is also little available evidence which suggests that the characterizing fauna of CR.HCR.FaT.CTub are abundant at sites of reduced salinity (18-40 psu). Therefore the many of the species that characterize the biotope, and especially the *Tubularia* turf may not tolerate decreases in salinity at the benchmark level. The community may begin to change to one typical of variable or reduced salinity conditions. Therefore, resistance has been assessed as 'Low', resilience as 'Medium' and sensitivity assessed as 'Medium'.

Water flow (tidal current) changes (local)

High

Q: High A: Low C: NR

High

Q: High A: High C: Medium

Not sensitive

Q: Low A: Low C: Low

CR.HCR.FaT.CTub and its sub-biotopes CTub.Adig and CTub.CuSp are recorded from very strong (>3 m/s) and strong (1.5-3 m/s) tidal streams (Connor *et al.*, 2004). *Alcyonium digitatum*, *Tubularia indivisa* and Actinarians are suspension feeders relying on water currents to supply food. These taxa, therefore, thrive in conditions of vigorous water flow e.g. around Orkney and St Abbs, Scotland, where the community may experience tidal currents of 3 and 4 knots during spring tides (Kluijver, 1993). *Tubularia indivisa* is also a dominant species on the wreck of *Kilmore*, Belgium, where tidal velocities can vary between 0.86-0.5 m/s (Zintzen *et al.*, 2008).

Sensitivity assessment. The available evidence suggests an increase in tidal velocity may benefit the characterizing species of CR.HCR.FaT.CTub and its sub-biotopes. A significant decrease in water movement due to a reduction in tidal streams is likely to result in loss of the biotope and its replacement by an epifaunal community typical of lower energy habitats. However, a decrease in tidal velocity of 0.1-0.2 m/s is probably not significant where the tidal streams are in excess of 1.5 m/s. A decrease may favour the development of CTub.Adig over CTub.CuSp. Biotope resistance has, therefore, been assessed as 'High', resilience has been assessed as 'High' (by default) and the biotope is, therefore, considered to be 'Not sensitive' at the benchmark level.

Emergence regime changes

Not relevant (NR)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

Changes in emergence are **not relevant** to CR.HCR.FaT.CTub.Adig, which is restricted to fully subtidal/circalittoral conditions. The pressure benchmark is relevant only to littoral and shallow sublittoral fringe biotopes.

Wave exposure changes (local)

High

Q: Medium A: Low C: Low

High

Q: High A: High C: High

Not sensitive

Q: Medium A: Low C: Low

CR.HCR.FaT.CTub. and its sub-biotopes are recorded from extremely exposed to moderately exposed sites (Connor *et al.*, 2004). *Alcyonium digitatum*, *Tubularia indivisa* and Actinarians are suspension feeders relying on water currents to supply food. These taxa, therefore, thrive in conditions of vigorous water flow. CTub.Adig is recorded from 5-30 m, however, the majority of core records occur from 10-20 m and CTub.CuSp is typically recorded deeper at 10-30 m (Connor *et al.*, 2004). The depth at which the biotope is recorded may therefore also negate the effects of a localised change in wave height; wave attenuation is directly related to water depth (Hiscock, 1985).

Metridium dianthus occurs in greatest abundance in wave sheltered situations with significant tidal flow. Those wave sheltered situations may, from time-to-time, be subject to strong wave action when non-prevailing winds blow. For instance, on the open east coast of Lundy, *Metridium dianthus* occurs on shallow jetty piles and on wrecks at 15 m depth where they persist despite occasional strong wave action during easterly winds. It seems most likely that individuals close and shrink-down during strong wave action but survive. *Metridium dianthus* is strongly adherent and when closed probably produces little resistance to water flow. Therefore significant increases in wave height will most likely decrease feeding opportunities and perhaps a loss of condition but recovery will be rapid. Bucklin (1987) found that the small size of intertidal populations was imposed, most likely, by limited food and feeding time and damage from wave action, which stimulates budding. *Urticina felina* favours areas with strong wave action (Manuel, 1988) and strong tidal currents (Migné & Davoult, 1997).

Sensitivity assessment. CTub and its sub-biotopes are high energy habitats so that a significant decrease in water movement (either tidal streams or wave action) will result in loss of the biotope. However, due to the high wave exposure levels at which CR.HCR.FaT.CTub.CuSp is recorded, an increase or a decrease in nearshore significant wave height of 3-5% is not likely to have a significant effect. Therefore, resistance is assessed as '**High**', resilience as '**High**' and the biotope (and its sub-biotopes) is assessed as '**Not sensitive**' at the benchmark level.

⚠ 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.

No information on the direct biological effects of heavy metal contamination on *Alcyonium digitatum*. Possible sub-lethal effects of exposure to heavy metals, may result in a change in morphology, growth rate or disruption of reproductive cycle. The vulnerability of this species to concentrations of pollutants may also depend on variations in other factors e.g. temperature and salinity conditions outside the normal range. French & Evans (1986) conducted a colonization experiment on panels coated in copper and zinc based anti-fouling paints and compared the community to panels which weren't covered in anti-fouling paint. *Tubularia indivisa* was an abundant species on the panels not coated in anti-fouling paint, indicating *Tubularia indivisa* is highly sensitive to anti-fouling chemicals.

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.HCR.FaT.CTub are a sub-tidal biotopes (Connor *et al.*, 2004) and, because oil pollution is mainly a surface phenomenon its impact upon circalittoral turf communities is likely to be limited (Hartnoll, 1998). However, Smith (1968) reported dead colonies of *Alcyonium digitatum* at a depth of 16 m in the locality of Sennen Cove, Cornwall resulting from the offshore spread and toxic effect of detergents sprayed along the shoreline to disperse oil from the *Torrey Canyon* tanker spill. No additional information concerning the direct biological effects of hydrocarbon and PAH contamination on *Tubularia indivisa* was found.

One month after the *Torrey Canyon* oil spill *Urticina felina* was thought to be one of the most resistant animals on the rocky shore, being commonly found alive in pools between the tide-marks which appeared to be devoid of all other animals (Smith, 1968).

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.

Smith (1968) reported dead colonies of *Alcyonium digitatum* at a depth of 16 m in the locality of Sennen Cove, Cornwall resulting from the offshore spread and toxic effect of detergents (a mixture of a surfactant and an organic solvent) e.g. BP 1002 sprayed along the shoreline to disperse oil from the *Torrey Canyon* tanker spill. Possible sub-lethal effects of exposure to synthetic chemicals may result in a change in morphology, growth rate or disruption of the reproductive cycle. No additional information concerning the direct biological effects of synthetic compound contamination on *Tubularia indivisa* was found.

Very little information has been found. Hoare & Hiscock (1974) observed that *Urticina felina* survived near to an acidified halogenated effluent discharge in a 'transition' zone where many other species were unable to survive, suggesting a tolerance to chemical contamination. However, *Urticina felina* was absent from stations closest to the effluent which were dominated by pollution tolerant species particularly polychaetes. Those specimens closest to the effluent discharge appeared generally unhealthy.

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
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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
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This pressure is **Not assessed**.

De-oxygenation	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low
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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 mg/l or even less (Herreid, 1980; Rosenberg *et al.*, 1991; Diaz & Rosenberg, 1995). Species such as *Metridium senile* are thought of as resistant to severe hypoxia. Most epifauna are suspension feeders adapted to water flow, although their tolerance or requirement for water flow varies with species or taxonomic group. For example, Gray *et al.* (2002) concluded that fish were more sensitive to hypoxia than crustaceans and echinoderms, which in turn were more sensitive than annelids with molluscs the most tolerant. Riedel *et al.* (2012) noted that infauna were generally more tolerant than epifauna. They also noted that decapods, echinoderms, and polychaetes showed lower tolerance while ascidians and anthozoans showed higher tolerance to hypoxia and anoxia (Riedel *et al.*, 2012). Mobile species, such as fish, would probably move away from the affected area.

Hydroids mainly inhabit environments in which the oxygen concentration exceeds 5 ml/l (ca 7 mg/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 bryozoans and several hydroids and *Obelia bidentata* (as *bicuspidata*) in the York River, Chesapeake Bay, tolerated summer hypoxic episodes of between 0.5 and 2 mg O₂/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. Diaz & Rosenberg (1995) reported that the abundance of crustaceans and echinoderms decreased in hypoxic conditions, and suggested that the amphipods *Gammarus tigrinus* and *Ampelisca agassizi* were intolerant of hypoxia. Echinoderms are probably intolerant of hypoxia (see reviews). Mobile fauna are also likely to begin to leave the habitat once the oxygen falls below ca 2.8 mg/l (Diaz & Rosenberg, 1995).

Alcyonium digitatum mainly inhabits environments in which the oxygen concentration usually exceeds 5 ml/l and respiration is aerobic. In August 1978, a dense bloom of a dinoflagellate, *Gyrodinium aureolum* occurred surrounding Geer reef in Penzance Bay, Cornwall and persisted until September that year. Observations by local divers indicated a decrease in underwater visibility (< 1 m) from below 8m BSL (Griffiths *et al.*, 1979). It was also noted that many of the faunal species appeared to be affected, e.g. no live *Echinus esculentus* were observed whereas on surveys prior to August were abundant, *Alcyonium sp.* were also in an impoverished state. During follow-up surveys conducted in early September *Alcyonium sp.* were noted to be much healthier and feeding. It was suggested the decay of *Gyrodinium aureolum* either reduced oxygen levels or physically clogged faunal feeding mechanisms. Adjacent reefs were also surveyed during the same time

period and the effects of the *Gyrodinium aureolum* bloom were less apparent. It was suggested that shallow water on reefs more exposed to wave action were less affected by the phytoplankton bloom (Griffiths *et al.*, 1979). As no mass mortality occurred. Indicating *Alcyonium sp.* can potentially survive short-term hypoxic events.

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 citrina*, *Kirchenpaueria pinnata*, *Hymeniacidon pereleve*, *Polymastia boletiformis* or *Ascidia mentula* were recorded at depths below 10 to 11 m.

Demosponges maintained under laboratory conditions can tolerate hypoxic conditions for brief periods. Gunda & Janapala (2009) investigated the effects of variable oxygen levels on the survival of the marine sponge, *Haliclona pigmentifera*. Under hypoxic conditions (1.5-2.0 ppm O₂), *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 O₂).

Sensitivity assessment. This biotope (CTub) and its sub-biotopes occur in areas of high energy, that is moderate to strong water flow and wave exposure. The epifauna are probably dependent on water movement to supply oxygen and nutrients and remove waste products. However, the high energy of the habitat suggests that any low oxygen episodes would be very transient due to the rapid mixing of the water column by wave action and/or its replacement due to mass transport of water by the strong tidal flow. Therefore, the biotope and its sub-biotopes are probably resistant of deoxygenation and resistance is assessed as 'High'. Resilience is assessed as 'High' (by default) and the biotope is considered to be 'Not sensitive' at the benchmark level.

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

Alcyonium digitatum and *Tubularia indivisa* are passive suspension feeders on phytoplankton and zooplankton. Nutrient enrichment of coastal waters that enhances the population of phytoplankton may be beneficial to *Alcyonium digitatum* and *Tubularia indivisa* in terms of an increased food supply but the effects are uncertain (Hartnoll, 1998). However, the survival of *Alcyonium digitatum* and *Tubularia indivisa* may be influenced indirectly. High primary productivity in the water column combined with high summer temperature and the development of thermal stratification (which prevents mixing of the water column) can lead to hypoxia of the bottom waters which faunal species are likely to be highly intolerant of periods of hypoxia (see de-oxygenation pressure).

Johnston & Roberts (2009) conducted a meta-analysis, which reviewed 216 papers to assess how a variety of contaminants (including sewage and nutrient loading) affected 6 marine habitats (including subtidal reefs). A 30-50% reduction in species diversity and richness was identified from all habitats exposed to the contaminant types.

Sensitivity assessment. The pressure benchmark is relatively protective and the 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: Low A: NR C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

The animals found within the biotope may be able to utilise the input of organic matter as food, or are likely to be tolerant of inputs at the benchmark level. In a recent review, assigning species to ecological groups based on tolerances to organic pollution, *Alcyonium digitatum* were described as 'very sensitive to organic enrichment and present under unpolluted conditions' while the associated animal species; *Urticina felina*; *Balanus crenatus* and *Spirobranchus triqueter* were described as 'species indifferent to enrichment, always present in low densities with non-significant variations with time, from initial state, to slight unbalance' (Gittenberger & Van Loon, 2011).

Sensitivity assessment. It is not clear whether the pressure benchmark would lead to enrichment effects in this dynamic habitat. High water movements would disperse organic matter particles, mitigating the effect of this pressure. Although species within the biotope may be sensitive to gross organic pollution resulting from sewage disposal and aquaculture they are considered to have '**High**' resistance to the pressure benchmark which represents organic enrichment. Therefore, resilience is assessed as '**High**' and the biotope is considered to be '**Not Sensitive**' at the benchmark level.

A Physical Pressures**Resistance****None**

Q: High A: High C: High

Resilience**Very Low**

Q: High A: High C: High

Sensitivity**High**

Q: High A: High C: High

Physical loss (to land or freshwater habitat)

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. Therefore, resistance to the pressure is considered '**None**', and resilience '**Very low**' (as the change at the pressure benchmark is permanent) and sensitivity is 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

Habitat structure changes - removal of substratum (extraction)

Low

Q: High A: Medium C: Medium

Medium

Q: High A: High C: Medium

Medium

Q: High A: Medium C: Medium

The species characterizing this biotope are epifauna or epiflora occurring on rock and would be sensitive to the removal of the habitat. Extraction of bedrock substratum is considered unlikely and this pressure is considered to be **'Not relevant'** to hard substratum habitats. However, Picton & Goodwin (2007) noted that an area of boulders with a rich fauna of sponges and hydroids on the east coast of Rathlin Island, Northern Ireland was significantly altered since the 1980s. Scallop dredging had begun in 1989 and boulders were observed to have been turned and the gravel harrowed. In addition, many of the boulders had disappeared and rare hydroid communities were greatly reduced (Picton & Goodwin, 2007). Prior records indicated the presence of large sponges, mainly *Axinella infundibuliformis* (Picton & Goodwin, 2007). Freese *et al.* (1999) also noted that trawling could remove important substratum such as boulders. Therefore, **where this biotope occurs on boulders** that could be subject to removal or extraction, resistance is likely to be **'Low'**. Hence, as resilience is probably **'Medium'** (assuming suitable substratum remains) and sensitivity is assessed as **'Medium'**.

Abrasion/disturbance of the surface of the substratum or seabed

Medium

Q: High A: High C: NR

High

Q: High A: High C: Medium

Low

Q: High A: High C: Low

Alcyonium digitatum, *Tubularia indivisa* plus the anthozoan community are sedentary species that would likely suffer from the effects of abrasion. Boulcott & Howell (2011) conducted experimental Newhaven scallop trawling (a source of abrasion) over a circalittoral rock habitat in the sound of Jura, Scotland and recorded the damage to the resident community. The results indicated that the sponge *Pachymatisma johnstoni* was highly damaged by the experimental trawl, however, *Alcyonium digitatum* showed comparatively little damage; 13% of photographic samples showed visible damage to *Alcyonium digitatum*. Where *Alcyonium digitatum* damage was evident it tended to be small colonies that were ripped off the rock. The authors highlight that assessing physical damage to faunal turfs (erect bryozoans and hydroids) was difficult to quantify. However, the faunal turf communities did not show large signs of damage and were only damaged by the scallop dredge teeth, an impact which was often limited in extent (approx. 2cm wide tracts). The authors indicated that species such as *Alcyonium digitatum* and 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 species such as *Alcyonium digitatum* and faunal turf communities increasing with repeated trawls.

Sensitivity assessment. The evidence indicates that CR.HCR.FaT.CTub and its sub-biotopes, especially on vertical and steep faces, are relatively resistant to single abrasion events. Therefore, resistance is assessed as **'Medium'** based on Boulcott & Howell (2011), resilience assessed as **'High'** and sensitivity assessed as **'Low'**. Please note Boulcott & Howell (2011) did not mention the abrasion caused by fully loaded collection bags on the new haven dredges. A fully loaded Newhaven dredge may cause higher damage to the community as indicated in their study.

Penetration or disturbance of the substratum subsurface

Not relevant (NR)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

The species characterizing this biotope group are epifauna or epiflora occurring on rock, which is resistant to subsurface penetration. The assessment for abrasion at the surface only is therefore considered to equally represent sensitivity to this pressure.

Changes in suspended solids (water clarity)

High

Q: High A: High C: Medium

High

Q: High A: High C: High

Not sensitive

Q: High A: High C: Medium

This biotope occurs in tide-swept habitats and it is likely, depending on local sediment supply, that the biotope is exposed to chronic or intermittent episodes of high-levels of suspended solids as local sediments are re-mobilised and transported. Based on Cole *et al.* (1999) and Devlin *et al.* (2008) this biotope is considered to experience intermediate turbidity (10-100 mg/l) based on UK TAG (2014). An increase at the pressure benchmark refers to a change to medium turbidity (100-300 mg/l) and a decrease is assessed as a change to clear (<10 mg/l) based on UK TAG (2014). An increase in turbidity could be beneficial if the suspended particles are composed of organic matter, however, high levels of suspended solids with increased inorganic particles may reduce filter feeding efficiencies. A reduction in suspended solids will reduce food availability for filter feeding species in the biotope (where the solids are organic), although effects are not likely to be lethal over the course of a year. A reduction in light penetration could also reduce growth rate of phytoplankton and so limit zooplankton levels.

Little information could be found for the tolerance of *Tubularia indivisa* to changes in water clarity, other than survey reports of abundant *Tubularia indivisa* in Isle of Thanet, which is well known as an area characterized by poor underwater visibility (Howson *et al.*, 2005). Zintzen *et al.* (2008a&b) examined *Tubularia* spp. dominated epifaunal communities on ship wrecks in the Southern Bight of the North Sea. While *Tubularia indivisa* dominated offshore and intermediate sites, coastal sites were dominated by *Metridium dianthus* and had a lower biomass of turfs of *Tubularia* spp. The coastal sites were characterized by periodic salinity decreases, large seasonal temperature fluctuations, high total suspended sediment and reduced current velocity when compared to offshore and intermediate sites (Zintzen *et al.*, 2008b). Turbidity alone does not explain the differences in abundance but is a factor.

Alcyonium digitatum has been shown to be tolerant of high levels of suspended sediment. Hill *et al.* (1997) demonstrated that *Alcyonium digitatum* sloughed off settled particles with a large amount of mucous. *Alcyonium digitatum* is also known to inhabit the entrances to sea lochs (Budd, 2008) or the entrances to estuaries (Braber & Borghouts, 1977) where water clarity is likely to be highly variable. Repeated energetic expenditure in cleaning off silt particles may cause sub-lethal effects.

Metridium dianthus may benefit from increase in turbidity as algal growth on hard substrata will be reduced. For Instance, Svane & Groendahl (1988) found that, in comparison with records from 1926-29, *Metridium dianthus* had colonized areas in the Gullmar Fjord, Finland where it had not previously been recorded and suggested the reason was because of increases in turbidity (and tolerance of pollution).

Urticina felina occurs in clear to highly turbid waters and occurs down to depths of at least 100 m (Manuel, 1988) where light levels are low. The anemone is not known to contain symbiotic algae and is unlikely to be sensitive to changes in turbidity. *Urticina felina* is found in highly turbid areas associated with biotopes such as CR.MCR.SfR.Pol (Connor *et al.*, 2004) and is therefore considered to be unaffected by an increase in turbidity at the benchmark. Increases in siltation may begin to cover the anemone or interfere with feeding. An energetic cost will result from efforts to clean off the silt particles, e.g. through mucus production and sloughing. Repeated energetic expenditure in

cleaning off silt particles may cause sub-lethal effects.

Whilst many sponges are disadvantaged by sedimentation (as would be expected, being sessile filter feeders), many examples exist of sponges adapting to sediment presence (Bell *et al.*, 2015; Schönberg, 2015) and many encrusting sponges appear to be able to survive in highly sedimented conditions, and, in fact, 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 citrina*, *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.

Sensitivity assessment. Connor *et al.* (2004) noted that the sub-biotope CTub.CuSp was more prevalent in areas (of strong water movement) where turbidity was high for much of the year. Therefore, the above evidence suggests that, where water movement remains strong, an increase in turbidity could change the relative abundance of the *Tubularia* and bryozoan turf and sponge cover and favour CTub.CuSp over CTub or CTub.Adig. Overall biotope resistance is assessed as '**High**' to an increase in suspended solids at the benchmark level. Resilience is assessed as '**High**' (by default) and the biotope is considered to be '**Not sensitive**' at the benchmark level. The biotope is considered to be 'Not sensitive' to decreased suspended solids where periodic scour and abrasion are unaffected.

Smothering and siltation rate changes (light)

High

Q: Low A: NR C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

The anthozoan community of CR.HCR.FaT.CTub. (*Alcyonium digitatum*, *Tubularia indivisa*, hydroids and anemones) is largely sessile and thus would be unable to avoid the deposition of a smothering layer of material up to a depth of 5 cm. Some *Alcyonium digitatum* colonies can attain a height of up to 20 cm and mature *Tubularia indivisa* can attain a height of 10-15 cm (Edwards, 2008). Both would still be able to expand tentacles and columns of the polyps to filter feed, and materials may be sloughed off with a large amount of mucous. However, *Sagartia elegans*, *Urticina felina*, *Metridium senile*, *Actinothoe sphyrodeta*, *Corynactis viridis* and smaller / younger *Alcyonium digitatum* colonies (that initially form encrustation's between 5 and 10 mm thick) are likely to be smothered and respiration is likely to be hindered. However, CR.HCR.FaT.CTub and its sub-biotopes are recorded from very strong to moderately strong tidal streams (0.5->3 m/sec). A layer of deposited sediment (at the pressure benchmark) is likely to be removed from the biotope within a few tidal cycles.

Schönberg (2015) reviewed and observed the interactions between sediments and marine sponges in Australia and described the lack of research on Porifera. Bell *et al.* (2015) reviewed the effects and interactions of sponges with sediment in suspension and after deposition. Whilst many sponges are disadvantaged by sedimentation (as would be expected, being sessile filter feeders), many examples exist of sponges adapting to sediment presence (Bell *et al.*, 2015; Schönberg, 2015). Adaptations included sediment incorporation, sediment encrusting, structural modification (such as reduction in numbers of oscula, or repositioning of inhalant and exhalant openings), soft sediment anchoring using spicules, modification of spicules to shield the body from sediment, backwashing, mucus production, morphology (e.g. upright forms intercept less settling sediment) and living, at least partially, embedded within the sediment (Bell *et al.*, 2015; Schönberg, 2015). Despite sediment being considered to have a negative impact on suspension feeders

(Gerrodette & Flechsig 1979), many encrusting sponges appear to be able to survive in highly sedimented conditions, and, in fact, many species prefer such habitats (Bell & Barnes 2001; Bell & Smith 2004).

Urticina felina anemones adhere strongly to the substratum and would be entirely covered by smothering material. However, *Urticina felina* lives in situations where it may be covered from time-to-time by sediment, especially coarser substrata which suggests some ability to survive. For example, Holme & Wilson (1985) observed *Urticina felina* attached to pebbles, cobbles or rock subject to sand scour or periodic smothering by sand at 50-55 m depth, offshore, in the western English Channel. The tidal streams in the central parts of the Channel may reach 125 cm/s during neaps and 166 cm/s on springs. Therefore, they suggested that *Urticina felina* was tolerant of sand scour or periodic smothering by

Sensitivity assessment. Based on biotope exposure to high levels of water flow that will remobilise and remove sediments, biotope resistance is assessed as 'High' and resilience as 'High' (by default) and the biotope is considered to be 'Not Sensitive' at the benchmark level.

Smothering and siltation rate changes (heavy)

Medium

Q: Low A: NR C: NR

High

Q: High A: High C: Medium

Low

Q: Low A: Low C: Low

The epifaunal community of CR.HCR.FaT.CTub (*Alcyonium digitatum* and anemones, *Tubularia indivisa* and other hydroids, bryozoan turf and sponges) is sessile and thus would be unable to avoid the deposition of a smothering layer of material up to a depth of 30 cm. *Alcyonium digitatum* colonies can attain a height of up to 20 cm, *Tubularia indivisa* can attain a height of 10-15 cm (Edwards, 2008), and will, therefore, be inundated along with other important species within CR.HCR.FaT.CTub e.g. *Sagartia elegans*, *Urticina felina*, *Metridium senile*, *Actinothoe sphyrodeta*, *Corynactis viridis*.

Schönberg (2015) reviewed and observed the interactions between sediments and marine sponges in Australia and described the lack of research on Porifera. Bell *et al.* (2015) reviewed the effects and interactions of sponges with sediment in suspension and after deposition. Whilst many sponges are disadvantaged by sedimentation (as would be expected, being sessile filter feeders), many examples exist of sponges adapting to sediment presence (Bell *et al.*, 2015; Schönberg, 2015). Adaptations included sediment incorporation, sediment encrusting, structural modification (such as reduction in numbers of oscula, or repositioning of inhalant and exhalant openings), soft sediment anchoring using spicules, modification of spicules to shield the body from sediment, backwashing, mucus production, morphology (e.g. upright forms intercept less settling sediment) and living, at least partially, embedded within the sediment (Bell *et al.*, 2015; Schönberg, 2015). Despite sediment being considered to have a negative impact on suspension feeders (Gerrodette & Flechsig 1979), many encrusting sponges appear to be able to survive in highly sedimented conditions, and, in fact, many species prefer such habitats (Bell & Barnes 2001; Bell & Smith 2004).

The community forms on vertical and upper faces of bedrock and boulders, so that the deposit is only likely to affect a proportion of the biotope, that is the upper faces. However, CR.HCR.FaT.CTub and its sub-biotopes are recorded from very strong to moderately strong tidal streams (0.5->3 m/sec). A layer of deposited sediment (at the pressure benchmark) is likely to be removed from the biotope within a few tidal cycles and only remain at the base of boulders, crevices, or areas in the lee of the prevailing currents at the time of deposition. Therefore, a precautionary resistance of 'Medium' is suggested to represent the damage to some of the more

sensitive species in the assemblage. Nevertheless, recovery will probably be rapid and resilience is assessed as **'High'** and sensitivity as **'Low'**.

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
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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
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At the time of writing there is **no evidence** on which to assess this pressure.

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

Introduction of light or shading	High Q: High A: High C: High	High Q: High A: High C: High	Not sensitive Q: High A: High C: High
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CR.HCR.FaT.CTub and its sub-biotopes are circalittoral biotopes (Connor *et al.*, 2004) and the community is, therefore, not dependent on direct sunlight. Increased shading (e.g. by construction of a pontoon, pier etc) could benefit the characterizing species of this biotope.

Sensitivity assessment. Resistance is probably **'High'**, with a **'High'** resilience and a sensitivity of **'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
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Not Relevant.

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
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Not Relevant.

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
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Not Relevant.

Biological Pressures

Resistance

Resilience

Sensitivity

Genetic modification & translocation of indigenous species

No evidence (NEv)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

No evidence (NEv)

Q: NR A: NR C: NR

No evidence for translocation or genetic modification of *Alcyonium digitatum*, *Tubularia indivisa* or other important epifaunal species within this biotope was found.

Introduction or spread of invasive non-indigenous species

No evidence (NEv)

Q: NR A: NR C: NR

Not relevant (NR)

Q: NR A: NR C: NR

No evidence (NEv)

Q: NR A: NR C: NR

Species tolerant of tide-swept conditions that can occupy rock surfaces and out-compete native species pose the greatest threat to this biotope. The tunicates *Didemnum vexillum* and *Asterocarpa humilis*, the hydroid *Schizoporella japonica* and the bryozoan *Watersipora subatra* (Bishop, 2012c, Bishop, 2015a and b; Wood, 2015) are currently only recorded from artificial hard substratum in the UK and it is not clear what their established range and impacts in the UK would be.

Didemnum vexillum is an invasive colonial sea squirt native to Asia which was first recorded in the UK in Dartmouth Marina, Dartmouth in 2005. *Didemnum vexillum* can form extensive mats 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 (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. Therefore, it is possible that *Didemnum vexillum* could colonize more exposed locations within the UK and could pose a threat to CR.HCR.FaT.CTub.Adig. The tunicate *Styela clava* appears to prefer more sheltered conditions than this biotope (Bishop, 2012d).

However, there is 'No evidence' at present that this habitat has been affected by introduced non-native invasive species. Due to the constant risk of new invasive species, the literature for this pressure should be revisited.

Introduction of microbial pathogens

High

Q: Low A: NR C: NR

High

Q: High A: High C: High

Not sensitive

Q: Low A: Low C: Low

Alcyonium digitatum acts as the host for the endoparasitic species *Enalcyonium forbesiand* and *Enalcyonium rubicundum* (Stock, 1988). Parasitisation may reduce the viability of a colony but not to the extent of killing them but no further evidence was found to substantiate this suggestion. *Tubularia indivisa* and *Sagartia elegans* can host an array of potentially pathogenic bacteria, however there is insufficient evidence to suggest significant population wide mortality (Schuett & Doepke, 2010).

Sensitivity assessment. Based on the lack of reported mortalities of the characterizing and associated species, the biotope is judged to have 'High' resistance to this pressure. Resilience is assessed as 'High' and the biotope is classed as 'Not sensitive' at the pressure benchmark.

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

None of the characterizing species within CR.HCR.FaT.CTub and its sub-biotopes are commercially exploited. This pressure is, therefore, considered 'Not Relevant'.

Removal of non-target species

Low

Q: High A: High C: High

Medium

Q: High A: High C: High

Medium

Q: High A: High C: High

Alcyonium digitatum and faunal turf communities (which include hydroids such as *Tubularia indivisa*) have been found to be resistant to abrasion through bottom fishing (see abrasion pressure) and only biological effects are considered here.

Zintzen *et al.* (2008a&b) examined *Tubularia* spp. dominated epifaunal communities on ship wrecks in the Southern Bight of the North Sea. They noted that the *Tubularia* spp. turf supported a high diversity and biomass of epifaunal, including species that grew attached to *Tubularia* spp. (e.g. *Jassa* spp. and caprellids). Although not exactly equivalent, the *Tubularia* spp. and associated hydroid and bryozoan turf probably support numerous epifaunal and epiphytic species, together with faunal grazing gastropods and nudibranchs. Zintzen *et al.* (2008a) noted that during the summer months the *Tubularia* biomass decreased as it became dormant and was predated or out-competed by other species. Zintzen *et al.* (2008a) also noted that species richness and the density of 23% of the species in the community were positively correlated with *Tubularia* biomass. Similarly, *Alcyonium digitatum* goes through an annual cycle, from February to July all *Alcyonium digitatum* colonies are feeding, from July to November, an increasing number of colonies stop feeding. During this period a large number of polyps can retract and a variety of filamentous algae, hydroids and amphipods can colonize the surface of colonies epiphytically. From December-February the epiphytic community is, however, sloughed off (Hartnoll, 1975).

Metridium dianthus can aggressively out-compete other spatial competitors (Whomersley & Picken, 2003; Nelson & Craig 2011). Nelson & Craig (2011) found mature *Metridium dianthus* can have significant negative effects on invertebrate recruitment. If *Alcyonium digitatum* and *Tubularia indivisa* were removed from the biotope *Metridium dianthus* and other anthozoans could spread rapidly and dominate the biotope in the short-term. However, high water flow within this biotope may preclude the long-term dominance of *Metridium dianthus*.

Sensitivity assessment. If *Alcyonium digitatum* and *Tubularia indivisa* were removed the other epifaunal species would likely colonize rock surfaces as they are not dependent on the characterizing species. However, if *Tubularia indivisa*, *Alcyonium digitatum* or the characteristic sponges were removed or damaged this would alter the character of the biotope and potentially decrease species richness. Therefore, resistance has been assessed as 'Low', resilience assessed as 'Medium' and sensitivity assessed as 'Medium'.

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