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Balanus crenatus and *Tubularia indivisa* on extremely tide-swept circalittoral rock

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

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Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [https://www.marlin.ac.uk/habitats/detail/349]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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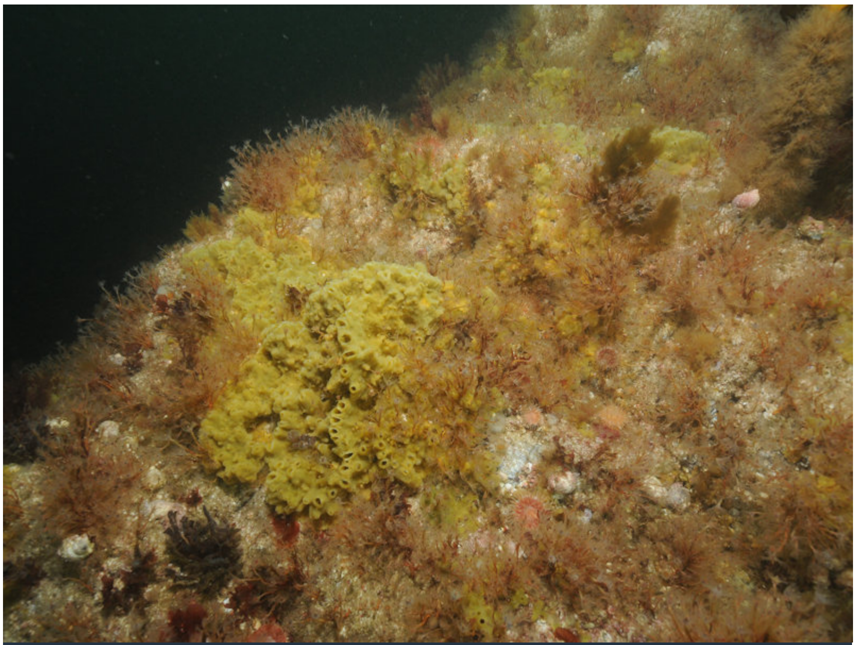

Balanus crenatus **and** ***Tubularia indivisa*** **on extremely tide-swept circalittoral rock**
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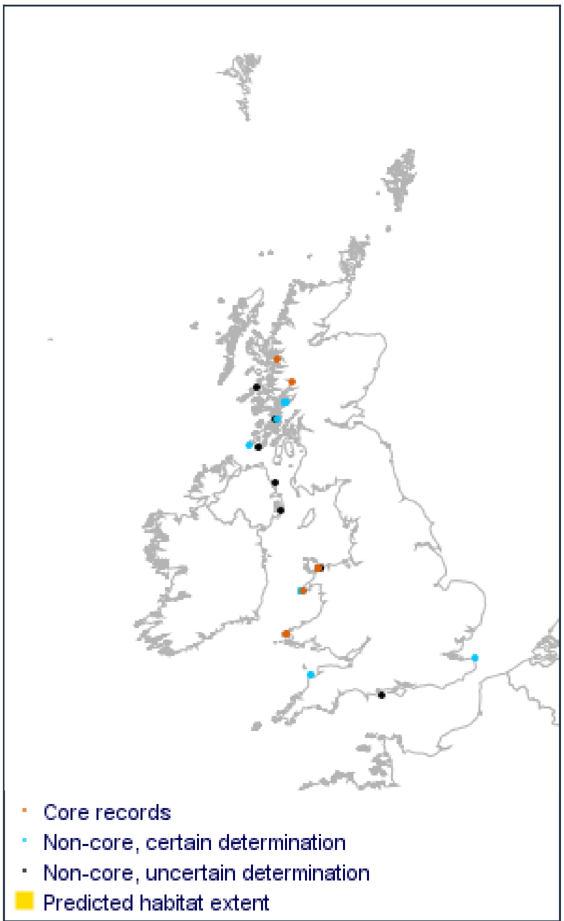

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

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

Summary

UK and Ireland classification

EUNIS 2008	A4.111	*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock
JNCC 2015	CR.HCR.FaT.BalTub	*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock
JNCC 2004	CR.HCR.FaT.BalTub	*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock
1997 Biotope	CR.ECR.BS.BalTub	*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock

Description

This biotope typically occurs on upward-facing, extremely tide-swept, circalittoral bedrock, boulders and cobbles found in a broad spectrum of wave-exposures. It is characterized by a few species that are capable of maintaining a foothold in strong tides. These species either form a flat, adherent crust in the case of the barnacle *Balanus crenatus*, or have strong attachment points and are flexible, bending with the tide, such as the turf of the hydroid *Tubularia indivisa*. Other species able to tolerate these very strong tides, or just situated slightly out of the main force of the current, include the sponge *Halichondria panicea*, the robust hydroid *Sertularia argentea* and current-tolerant anemones such as *Sagartia elegans*, *Urticina felina* and *Metridium senile*. Mobile species such as the starfish *Asterias rubens*, the crab *Cancer pagurus* and the whelk *Nucella lapillus* may also be present (JNCC, 2015).

Depth range

0-5 m, 5-10 m, 10-20 m, 20-30 m

Additional information

-

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.FaT.BalTub occurs on tide-swept bedrock, boulders and cobbles. High water flow facilitates the high abundance and dominance of a filter feeding community. CR.HCR.FaT.BalTub is characterized by a turf of *Tubularia indivisa*. *Balanus crenatus* distinguishes the biotope from other biotopes within the CR.HCR.FaT biotope complex that are domiated by cushion sponges or *Alcyonium digitatum*, and is therefore considered a key characterizing species. Other species typically present in the biotope include sponges, hydroids and the anemones *Sagartia elegans*, *Urticina felina* and *Metridium senile* (now *Metridium dianthus*). The sensitivity assessments focus on the key characterizing species *Tubularia indivisa* and *Balanus crenatus*, the sensitivity of the associated species is considered generally.

Resilience and recovery rates of habitat

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 within summer and autumn (Hughes, 1983). Hydroids as a general group are thought of as early colonizers of bare surfaces (Whomersley & Picken, 2003; Zintzen *et al*., 2008). *Tubularia spp.* specifically 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.Adig) they represent a permanent feature of an annual cycle and tend to dominate in specific seasons e.g. spring-autumn (Zintzen *et al*., 2008; 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 days (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 1-10km from the parental source (Zintzen *et al*., 2008).

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

Balanus crenatus produce a single, large brood annually with peak larval supply in April –May (Salman, 1982). Although subsidiary broods may be produced, the first large brood is the most important for larval supply (Salman, 1982; Barnes & Barnes, 1968). *Balanus crenatus* has a lifespan of 18 months (Barnes & Powell, 1953) and grows rapidly (except in winter). *Balanus crenatus* is a typical early colonizer of sublittoral rock surfaces (Kitching, 1937); for example, it heavily colonized a site that was dredged for gravel within 7 months (Kenny & Rees, 1994). *Balanus crenatus* colonized settlement plates or artificial reefs within 1-3 months of deployment in summer, and became abundant on settlement plates shortly afterwards (Brault & Bourget, 1985; Hatcher, 1998). The ship, *HMS Scylla*, was colonized by *Balanus crenatus* 4 weeks after sinking in March. The timing of the sinking in March would have ensured a good larval supply from the spring spawning. The presence of adult *Balanus crenatus* enhances the settlement rate of larvae on artificial panels (Miron *et al*., 1996), so that surviving adults enhance recovery rates.

Sedentary anthozoans such as *Sagartia elegens*, *Urticina felina and Metridium dianthus* (formerly *Metridium senile)* are also present in this and other tide-swept biotopes (Connor *et al*., 2004; Wood, 2005). Information concerning the recovery of mixed anthozoan communities is limited, and the available evidence is described below (Whomersley & Picken, 2003; Hiscock *et al*., 2010). 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). Anthozoans 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 elegens*, *Urticina felina* and *Metridium dianthus* can reproduce via a-sexual 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.

Very 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).

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 were later out-competed by other species. Recruitment of *Metridium dianthus* (formerly *Metridium senile)* 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 4 years *Metridium dianthus* had become the dominant organism below the mussel zone to approximately 60-80 m Below Sea Level (BSL).

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 didn't become visually dominant until 2007 (3 years after the vessel was sunk). *Sagartia elegens* 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 a-sexual 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.

Sensitivity assessment. Where resistance is 'High', resilience is assessed as 'High' by default. *Balanus crenatus* and *Tubularia indivisa* are rapid colonizers and likely to recover quickly. Therefore, resilience, of these species, is assessed as 'High' for any level of perturbation. As a recognizable assemblage would be present without sponges or anemones, the biotope resilience assessments are based on *Balanus crenatus* and *Tubularia indivisa.* Other species associated with this biotope such as *Sagartia elegens*, *Urticina felina and Metridium dianthus* can colonize bare surfaces within a 1 year but may take up to 5 years to establish mature populations.

Hydrological Pressures

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

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). Across this latitudinal gradient this species is likely to experience a range of temperatures. *Balanus crenatus* is described as a boreal species (Newman & Ross, 1976), it is found throughout the northeast Atlantic from the Arctic to the west coast of France as far south as Bordeaux; east and west coasts of North America and Japan. In Queens Dock, Swansea where the water was on average 10°C higher than average due to the effects of a condenser effluent, *Balanus crenatus* was replaced by the subtropical barnacle *Balanus amphitrite*. After the water temperature cooled *Balanus crenatus* returned (Naylor, 1965). The increased water temperature in Queens Dock is greater than an increase at the pressure benchmark (2-5°C). *Balanus crenatus* has a peak rate of cirral beating at 20°C and all spontaneous activity ceases at about 25°C (Southward, 1955). The tolerance of *Balanus crenatus*, collected in the summer (and thus acclimated to higher temperatures), to increased temperatures was tested in the laboratory. The median upper lethal temperature tolerance was -25.2°C (Davenport & Davenport, 2005) confirming the observations of Southward (1955).

The anemone *Metridium dianthus* (formerly *Metridium senile*) population at Barnstable, Massachusetts is reported to persist within a temperature range of 1.8-21.8°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 & Magnum (1970) demonstrated *Metridium dianthus* “maintained” within 10°C prior to experimentation incurred 100% mortality when exposed to 27.5°C for 120-240 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.The anemone *Urticina felina* has a boreal-arctic distribution and possibly a circumpolar distribution (Carlgren, 1949; Manuel, 1981). It is found throughout Europe from northern Russia to the Bay of Biscay (Fautin, 2016). 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 in summer may adversely affect individuals and that some mortality might occur.

Barthel (1986) reported that reproduction and growth in the sponge *Halichondria panicea* in the Kiel Bight were primarily driven by temperature, with higher temperatures corresponding with highest growth. In a review of the ecology of hydroids, Gili & Hughes, (1995) report that temperature is a critical factor stimulating or preventing reproduction and that most species have an optimal temperature for reproduction. However, little evidence for thermal thresholds and thermal ranges were available for the species recorded in this biotope. *Sertularia argentea* is found in the North Sea, Bay of Fundy and France and OBIS (2014) report minimum and maximum sea temperatures as 0.23- 22.19 respectively. It is not clear how these observations were derived (Tillin & Tyler-walters, 2014).

Sensitivity assessment. Typical surface water temperatures around the UK coast vary, seasonally from 4-19 °C (Huthnance, 2010). The characterizing and associated species are considered to tolerate a 2 °C increase in temperature for a year as this would fall within normal temperature variations. An acute increase at the pressure benchmark may be tolerated in winter, but a sudden return to typical temperatures could lead to mortalities among acclimated animals. No evidence was found to support this assessment, however an acute increase of 5 °C in summer would be close to the lethal thermal temperature for *Balanus crenatus* and loss of this species would alter the character of the biotope leading to reclassification. *Urticina felina* may also be impacted by acute increases in temerpature but the loss of this species would not alter the biotope character. Biotope resistance is therefore assessed as ‘Medium’ and resilience as ‘High’ and biotope sensitivity is therefore ‘Low’.

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

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.

Within the biotope, the key characterizing barnacles *Balanus crenatus* have a more northern distribution and are absent from warmer Mediterranean and equatorial waters. *Balanus crenatus* is described as a boreal species (Newman & Ross, 1976), it is found throughout the northeast Atlantic from the Arctic to the west coast of France, as far south as Bordeaux; east and west coasts of North America and Japan. *Tubularia indivisa* is also found from the Arctic to the Mediterranean (WoRMS, 2015). *Balanus crenatus* was unaffected during the severe winter of 1962-63, when average temperatures were 5 to 6 °C below normal for the British Isles and much of Europe (Crisp, 1964a). Meadows (1969) noted decreased temperatures in Newcastle (England) during the severe winter of 1962-63. *Balanus crenatus* were among the fauna on the settlement panels that were deployed in the area and not affected. The temperatures tolerances of *Balanus crenatus* collected from the lower intertidal in the winter (and thus acclimated to lower temperatures) was tested in the laboratory. The median lower lethal temperature tolerance was -1.4 °C (Davenport & Davenport, 2005). An acute or chronic decrease in temperature, at the pressure benchmark, is therefore unlikely to negatively affect this species. The anemones *Metridium dianthus* (formerly *Metridium senile*) and *Urticina felina* are also both recorded within the Arctic circle (Stephenson, 1935; Walsh & Somero, 1981) and are therefore unlikely to be affected at the benchmark level.

In a review of the ecology of hydroids, Gili & Hughes, (1995) report that temperature is a critical factor stimulating or preventing reproduction and that most species have an optimal temperature for reproduction. However, limited evidence for thermal thresholds and thermal ranges were available for the characterizing species recorded in this biotope.

Sensitivity assessment. Both *Balanus crenatus* and *Tubularia indivisa* are found in colder waters to the north of thre UK and are considered unlikely to be affected at the benchmark level for either acute or chronic decreases in temperature. Resistance has been assessed as 'High', and resilience as 'High' (by default). The biotope is therefore considered to be 'Not sensitive'.

Salinity increase (local)	Low Q: Low A: NR C: NR	Medium Q: High A: Low C: High	Medium Q: Low A: Low C: Low

The biotope CR.HCR.BalTub is recorded in full salinity habitats (Connor *et al*., 2004), an increase in salinity to >40‰ (the pressure benchmark) may cause a decline in the abundance of individuals within the community.

No evidence was found to assess the tolerance of *Tubularia indivisa*. *Balanus crenatus* occurs in estuarine areas and is therefore adapted to variable salinity (Davenport, 1976). When subjected to sudden changes in salinity *Balanus crenatus* closes its opercular valves so that the blood is maintained temporarily at a constant osmotic concentration (Davenport, 1976). Early stages may be more sensitive than adults. Experimental culturing of *Balanus crenatus* eggs, found that viable nauplii larvae were obtained between 25-40 ‰ but eggs did not develop to viable larvae when held at salinities above 40 ‰ and only a small proportion (7%) of eggs exposed at later stages developed into viable nauplii and these were not vigorous swimmers (Barnes & Barnes, 1974). When eggs were exposed to salinities of 50 ‰, and 60 ‰ at an early developmental stage, viable larvae were not produced and, again, only a small proportion (7 % and 1 %, respectively) of eggs exposed at a later developmental stage produced nauplii- these were deformed and probably non-viable. There was no development at 70 ‰ (Barnes & Barnes, 1974).

Metridium dianthus (formerly *Metridium senile*) is recorded from the intertidal (Bucklin, 1987), and Shumway (1978) found in low salinity *Metridium dianthus* could retract to a ▯ of it's 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 hyper salinity 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.

Sensitivity assessment. Some increases in salinity may be tolerated by the characterizing species, however the biotope is considered to be sensitive to a persistent increase in salinity to > 40 ppt (based on species distribution in the lower intertidal and subtidal and Barnes & Barnes, 1974). Resistance is therefore assessed as 'Low' and recovery as 'High' (following restoration of usual salinity). Sensitivity is therefore assessed as 'Low'.

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

The effects of deceases in 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. *Balanus crenatus* occurs in estuarine areas and is therefore adapted to variable salinity (Davenport, 1976). When subjected to sudden changes in salinity *Balanus crenatus* closes its opercular valves so that the blood is maintained temporarily at a constant osmotic concentration (Davenport, 1976). Acclimation to different salinity regimes alters the point at which opercular closure and resumption of activity occurs (Davenport, 1976). *Balanus crenatus* can tolerate salinities down to 14 psu if given time to acclimate (Foster, 1970). At salinities below 6 psu motor activity ceases, respiration falls and the animal falls in to a "salt sleep" (Barnes & Barnes, 1974). In this state the animals may survive in freshwater for 3 weeks, enabling them to withstand changes in salinity over moderately long periods (Barnes & Powell, 1953). Larvae are more sensitive than adults. In culture experiments, eggs maintained below 10 ‰ rupture, due to osmotic stress (Barnes & Barnes, 1974). At 15-17 ‰ there is either no development of early stages, or the nauplii larvae are deformed and "probably not viable" (Barnes & Barnes, 1974), similarly at 20 ‰ development occurs, but about half of the larvae are deformed and not viable. (Barnes & Barnes, 1974). Normal development resulting in viable larvae occurs between salinities of 25-40 ‰ (Barnes & Barnes, 1974).

Metridium dianthus (formerly *Metridium senile)* 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 reduction in salinity but may have to retract tentacles, suffer reduced opportunity to feed and expend energy to produce mucus. *Metridium dianthus* and the sponge *Halichondria panicea* occur in the reduced/low salinity biotope IR.LIR.IFaVS, suggesting these species are tolerant of long-term decreases in salinity.

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 11ppt Chlorinity (about 20psu) 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. As the characterizing and associated species are found in biotopes in both full and variable salinity habitats, the biotope is considered 'Not sensitive' to a decrease in salinity from full to variable. Biotope resistance is therefore assessed as 'High' and resilience is assessed as 'High' (by default) and the biotope is assessed as 'Not sensitive'.

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

CR.HCR.FaT.BalTub core records are recorded from very strong- strong tidal streams (1.5-3 m/s and >3 m/s) (JNCC, 2015).

Tubularia indivisa and the barnacles, sponges and hydroids 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). 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 down current and pushed together and feeding efficiency was reduced. In general, flow rates are an important factor for feeding in hydroids and prey capture appears to be higher in more turbulent conditions that prevent self-shading by the colony (Gili & Hughes, 1995). The capture rate of zooplankton by hydroids is correlated with prey abundance (Gili & Hughes, 1995), thus prey availability can compensate for sub-optimal flow rates. Water movements are also important to hydroids to prevent siltation which can cause death (Round, 1961). Tillin & Tyler-Walters (2014) suggest that the range of flow speeds experienced by biotopes in which hydroids are found indicate that a change (increase or decrease) at the pressure benchmark 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.

Balanus crenatus is found in a very wide range of water flows (Tillin & Tyler-Walters, 2014), although it usually occurs in sites sheltered from wave action (Eckman & Duggins, 1993) and can adapt feeding behaviour according to flow rates. In the absence of any current, the barnacle rhythmically beats its cirri to create a current to collect zooplankton. Growth of *Balanus crenatus* (measured as increase in basal area), maintained for 69 days at constant flow speeds in laboratory experiments was greatest at intermediate flow speeds (0.08 m/s) and decreased at higher speeds (Eckman & Duggins, 1993). Over the entire range of flow speeds measured (0.02 m/s – 0.25 m/s), *Balanus crenatus*, was able to control the cirrus, with little or no deformation by flow observed (Eckman, & Duggins, 1993).

Sensitivity assessment. Due to the range of tidal streams in which CR.HCR.FaT.BalTub is recorded, an increase or decrease in tidal velocity of 0.1-0.2 m/s is not thought biologically relevant to this biotope. 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**'. This biotope is characterized by the tide-swept conditions, a decrease in water flow (far exceeding the benchmark) which reduced exposutre to water flow would be likely to result in changes to the biological assemblage as the haitat would be less suitable for filter feeders.

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.BalTub, 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: High A: Medium C: High	High Q: High A: High C: High	Not sensitive Q: High A: Medium C: High

This biotope is recorded from tide-swept locations that are judged to range from extremely exposed to wave action to extremely sheltered (JNCC, 2015), suggesting that tidal currents are more important than wave action in structuring this biotope.

Sensitivity assessment. The biotope and characterizing and associated species are found across a range of wave exposures, populations occurring within the middle of the range are considered to have 'High' resistance to a change in significant wave height at the pressure benchmark. Resilience is assessed as 'High', by default, and the biotope is considered 'Not sensitive'

Chemical Pressures

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

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

Contamination at levels greater than the pressure benchmark may adversely impact the biotope. Barnacles accumulate heavy metals and store them as insoluble granules (Rainbow, 1987). Pyefinch & Mott (1948) recorded a median lethal concentration of 0.19 mg/l copper and 1.35 mg/l mercury, for *Balanus crenatus* over 24 hours. Barnacles may tolerate fairly high level of heavy metals in nature, for example they are found in Dulas Bay, Anglesey; where copper reaches concentrations of 24.5 µg/l, due to acid mine waste (Foster *et al.*, 1978).

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.BalTub is a sub-tidal biotope (Connor *et al.*, 2004), because oil pollution is mainly a surface phenomenon its impact upon circalittoral turf communities is likely to be limited (Hartnoll, 1998).No information is available on the intolerance of *Balanus crenatus* to hydrocarbons.

However, other littoral barnacles generally have a high tolerance to oil (Holt *et al*., 1995) and were little impacted by the *Torrey Canyon* oil spill (Smith, 1968), so *Balanus crenatus* is probably fairly resistant to oil.

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.

Barnacles have a low resilience to chemicals such as dispersants, dependant on the concentration and type of chemical involved (Holt *et al*., 1995). *Balanus crenatus* was the dominant species on pier pilings at a site subject to urban sewage pollution (Jakola & Gulliksen, 1987). Hoare & Hiscock (1974) found that *Balanus crenatus* survived near to an acidified halogenated effluent discharge where many other species were killed, suggesting a high tolerance to chemical contamination. Little information is available on the impact of endocrine disrupters on adult barnacles.

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

No Evidence

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

This pressure is **Not assessed**.

De-oxygenation	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

Little evidence was found to asses this pressure. *Balanus crenatus*, respires anaerobically so it can withstand some decrease in oxygen levels. When placed in wet nitrogen, where oxygen stress is maximal and desiccation stress is minimal, *Balanus crenatus* has a mean survival time of 3.2 days (Barnes *et al*., 1963) and this species is considered to be 'Not sensitive' to this pressure.

Sensitivity assessment.CR.HCR.BalTub is recorded from extremely exposed-exposed wave exposure and very strong-moderately strong (0.5->3 m/sec) tidal streams. Based on Balanus crenatus and mitigation of de-oxygenation by water movements, this biotope is considered to have 'High' resistance and High resilience (by default), and is therefore 'Not sensitive'.

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

Nutrient enrichment at the pressure benchmark is unlikely to affect the fauna within this biotope. A slight increase in nutrient levels could be beneficial for barnacles and other suspension feeders by promoting growth of phytoplankton and therefore indirectly increasing food supplies.

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 *Tubularia indivisa* in terms of an increased food supply but the effects are uncertain (Hartnoll, 1998). However, the survival of *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).

Sensitivity assessment. The pressure benchmark is relatively protective and the biotope is considered to have 'High' resistance and 'High' resilience (by default) and is judged to be 'Not sensitive'.

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

As the biotope occurs in tide swept or wave exposed areas (Connor *et al*., 2004), water movements will disperse organic matter reducing the level of exposure.

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,*Tubularia indivisa, Urticina felina* and *Balanus crenatus* 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 and therefore 'High' resilience. The biotope is therefore considered to be 'Not Sensitive'.

Physical Pressures

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

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

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

If rock were replaced with sediment, this would represent a fundamental change to the physical character of the biotope (JNCC, 2015) and lead to reclassification and loss of characterizing and associated species.

Sensitivity assessment. Resistance to the pressure is considered 'None', and resilience 'Very low' (as the change at the pressure benchmark is permanent). Sensitivity has been assessed as 'High'.

Physical change (to another sediment type)	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Not Relevant.

Habitat structure changes - removal of substratum (extraction)	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Not relevant to biotopes occurring on bedrock.

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

The species characterizing this biotope occur on the rock (JNCC, 2015) and therefore have no protection from surface abrasion.

Hiscock (1983) noted that a community, under conditions of scour and abrasion from stones and boulders moved by storms, developed into a community consisting of fast growing species such as *Spirobranchus* (as *Pomatoceros*) *triqueter*. Off Chesil Bank, the epifaunal community dominated by *Spirobranchus* (as *Pomatoceros) triqueter*, and *Balanus crenatus* decreased in cover in October as it was scoured away in winter storms, but recolonized in May to June (Gorzula, 1977). Warner (1985) reported that the community did not contain any persistent individuals but that recruitment was sufficiently predictable to result in a dynamic stability and a similar community, dominated by *Spirobranchus* (as *Pomatoceros triqueter*), *Balanus crenatus* and *Electra pilosa*, (an encrusting bryozoan), was present in 1979, 1980 and 1983 (Riley and Ballerstedt, 2005).

Re-sampling of fishing grounds that were historically studied (from the 1930s) indicated that some encrusting species including several species of barnacles had decreased in abundance in gravel substrata subject to long-term scallop fishing (Bradshaw *et al*., 2002). These may have been adversely affected by the disturbance of the stones and dead shells on to which they attach (Bradshaw *et al*. 2002). Where individuals are attached to mobile pebbles, cobbles and boulders rather than bedrock, surfaces can be displaced and turned over; preventing feeding and leading to smothering.

The abundance of *Urticina felina* has increased in gravel habitats on the Georges Bank, (Canada) closed to trawling by bottom gears (Collie *et al*., 2005), suggesting that this species is sensitive to fishing. In a recent review, assigning species to groups based on tolerances to bottom disturbance from fisheries, the anemone *Urticina felina* and the sponge *Halichondria panicea* were assigned to AMBI Fisheries Group II, described as 'species sensitive to fisheries in which the bottom is disturbed, but their populations recover relatively quickly' (Gittenberger & van Loon, 2011).

Sensitivity assessment. The impact of surface abrasion will depend on the footprint, duration and magnitude of the pressure. Evidence for the effects of severe scour and trawling on *Balanus crenatus*, suggest that resistance, to a single abrasion event is 'Low' and recovery is 'High', so that sensitivity is assessed as 'Low'. Based on epifaunal position, erect growth form and relatively soft, unprotected body, resistance of the characterizing *Urticina felina* and other associated species that share these traits, is also assessed as 'Low'. Biotope resilience is assessed as 'High', based on *Tubularia indivisa* and *Balanus crenatus* and therefore biotope sensitivity (based on these species) is assessed as 'Low'.

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

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. However, light penetration itself is unlikely to be an important factor as *Balanus crenatus* are recorded from the lower eulittoral to the lower circalittoral. Barnes and Bagenal (1951) found that the growth rate of *Balanus crenatus* epizoic on *Nephrops norvegicus* was considerably slower than animals on raft exposed panels. This was attributed to reduced currents and increased silt loading of water in the immediate vicinity of *Nephrops norvegicus.* In dredge disposal areas in the Weser estuary, Germany, where turbidity is 35% above the natural rate of 10-100 mg/l, the abundance of *Balanus crenatus* was lower than in reference areas (Witt et al., 2004). Separating the effect of increased suspended solids from increased sedimentation and changes in sediment from sediment dumping in this example is, however, problematic (Witt *et al*., 2004). Balanids may stop filtration after silt layers of a few millimetres have been discharged (Witt et al., 2004), as the feeding apparatus is very close to the sediment surface.

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 due to high levels of suspended solids (Howson *et al*., 2005).

The anemones can occur in turbid waters. *Metridium dianthus* (formerly *Metridium senile)* has been shown to benefit from increases in turbidity where algal growth was reduced so that there was less competition for hard substratum. 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 100m (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.

Despite sediment being considered to have a negative impact on suspension feeders (Gerrodette & Flechsig 1979), many encrusting sponges appear to be able survive in highly sedimented conditions, and in fact many species prefer such habitats (Bell & Barnes 2001; Bell & Smith 2004).In general it appears that hydroids are sensitive to silting (Boero 1984; Gili & Hughes 1995) and decline in beds in the Wadden Sea has been linked to environmental changes including siltation. Round *et al.* (1961) reported that the hydroid *Sertularia* (now *Amphisbetia*) *operculata* died when covered with a layer of silt after being transplanted to sheltered conditions. Boero (1984) suggested that deep water hydroid species develop upright, thin colonies that accumulate little sediment, while species in turbulent water movement were adequately cleaned of silt by water movement.

Sensitivity assessment. Overall biotope resistance is assessed as 'High' to an increase in suspended solids. Resilience is categorised as 'High' (by default) and the biotope is considered to be 'Not sensitive'. The biotope is considered to be 'Not sensitive' to decreased suspended solids where tidal flows are unaffected.

Smothering and siltation rate changes (light)	High Q: High A: Medium C: High	High Q: High A: High C: High	Not sensitive Q: High A: Medium C: High

Mature *Tubularia indivisa* can attain a height of 10-15cm (Edwards, 2008) and would therefore 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, *Balanus crenatus* and the anemones *Sagartia elegens*, *Urticina felina*, *Metridium senile*, are likely to be smothered and respiration and feeding is likely to be hindered. CR.HCR.FaT.BalTub is however recorded from very strong-moderately strong tidal streams (1.5->3 m/sec) (JNCC, 2015). A layer of deposited sediment (at the pressure benchmark) is therefore likely to be removed from the biotope within a few tidal cycles.

Barnacles may stop filtration after silt layers of a few millimetres have been discharged as the feeding apparatus is very close to the sediment surface (Witt *et al*., 2004). In dredge disposal areas in the Weser estuary, Germany, where the modelled exposure to sedimentation was 10 mm for 25 days, with the centre of the disposal ground exposed to 65 mm for several hours before dispersal, *Balanus crenatus* declined in abundance compared to reference areas (Witt *et al*., 2004). However, separating the effect of sedimentation from increased suspended solids and changes in sediment as a result of sediment dumping was problematic (Witt *et al*., 2004).

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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 50-55m 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, he suggested that *Urticina felina* was tolerant of sand scour or periodic smothering by < ca. 5cm of sand, being able to extend its column to maintain its disc above the sand surface (Holme & Wilson, 1985). *Urticina felina* is abundant in the sediment-scoured, silty rock communities CR.HCR.XFa.FluCoAs and CR.MCR.EcCr.UrtScr (Connor *et al*. 2004). Laboratory experiments have shown that another anemone *Sagartiogeton laceratus* is able to survive under sediments for 16 days and to be capable of re-emerging under shallow (2 cm) burial (Last *et al*., 2011). The percentage mortality increased with both depth and increasingly finer sediment fraction. Bijkerk (1988, results cited from Essink (1999)) indicated that the maximal overburden through which the anemone *Sagartia elegans* could migrate was <10 cm in sand. No further information was available on the rates of survivorship or the time taken to reach the surface.

Sensitivity assessment. Based on the presence of the characterizing and associated species in biotopes subject to sedimentation and scour (such as CR.MCR.EcCr.UrtScr), biotope resistance to this pressure, at the benchmark, is assessed as 'High', resilience is assessed as 'High' (by default) and the biotope is considered to be 'Not sensitive'. The assessment considers that sediments are rapidly removed from the biotope and that the scour tolerance of the characterizing animal species a would prevent significant mortalities although some damage and abrasion may occur. However, if the deposit remained in place; i.e. due to the scale of the pressure or where biotopes were sheltered, or only seasonally subject to water movements or where water flows and wave action were reduced e.g. by the presence of tidal barrages, then resistance would be lower and sensitivity would be greater.

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

The biological assemblage is largely sessile and thus would be unable to avoid the deposition of a smothering layer of material up to a depth of 30 cm. *Tubularia indivisa* can attain a height of 10-15cm (Edwards, 2008), and this species and the other typical species present will therefore be completely *buried.* CR.HCR.FaT.BalTub is recorded from habitats with very strong-moderately strong tidal streams (1.5->3 m/sec) (JNCC, 2015). As a result of these high tidal streams deposited sediment is likely to be removed relatively rapidly, however inundation of the community may hinder respiration and feeding and scour from sediments may cause some mortality.

As small, sessile species attached to the substratum, siltation at the pressure benchmark would bury *barnacles and spirorbids*. The lower limits of *Semibalanus balanoides* (as *Balanus balanoides*) appear to be set by levels of sand inundation on sand-affected rocky shores in New Hampshire (Daly & Mathieson, 1977. Holme and Wilson (1985) described a *Pomatoceros-Balanus* assemblage on 'hard surfaces subjected to periodic sever scour and 'deep submergence by sand or gravel' in the English Channel. They inferred that the *Pomatoceros-Balanus* assemblage was restricted to fast-growing settlers able to establish themselves in short periods of stability during summer months (Holme and Wilson, 1985), as all fauna were removed in the winter months. Barnacles may stop filtration after silt layers of a few millimetres have been discharged as the feeding apparatus is very close to the sediment surface (Witt *et al*., 2004). In dredge disposal areas in the Weser estuary, Germany, where the modelled exposure to sedimentation was 10mm for 25 days, with the centre of the disposal ground exposed to 65 mm for several hours before dispersal, *Balanus crenatus* declined in abundance compared to reference areas. (Witt *et al*., 2004). However, separating the effect of sedimentation from increased suspended solids and changes in sediment from sediment dumping was problematic (Witt *et al*., 2004).

In general it appears that hydroids are sensitive to silting (Boero 1984; Gili & Hughes 1995) and decline in beds in the Wadden Sea has been linked to environmental changes including siltation. Round *et al*. (1961) reported that the hydroid *Sertularia* (now *Amphisbetia*) *operculata* died when covered with a layer of silt after being transplanted to sheltered conditions. Boero (1984) suggested that deep water hydroid species develop upright, thin colonies that accumulate little sediment, while species in turbulent water movement were adequately cleaned of silt by water movement.

Sensitivity assessment. Sensitivity to this pressure will be mediated by site-specific hydrodynamic conditions and the footprint of the impact. Where a large area is covered sediments may be shifted by wave and tides rather than removed. Resistance is assessed as 'Medium' as the biotope is probably exposed to some abrasion and scouring (the impact may be mitigated by rapid removal of the deposit) but some mortality of characterizing and associated species and mortalities may occur. Resilience is assessed as 'High' based on rapid recvoery of *Balanus crenatus* and *Tubularia indivisa* and biotope sensitivity is therefore assessed 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

Not assessed.

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

No evidence.

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

Not Relevant

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

CR.HCR.FaT.BalTub is a circalittoral biotope (Connor *et al*., 2004) and the community is therefore not dependant on direct sunlight. Increased shading (e.g. by construction of a pontoon, pier etc) could benefit the characterizing species of this biotope in shallower waters by reducing algal growth and competition allowing the biotope to expand to shallower waters.

Balanus crenatus possesses a rudimentary eye and can detect and respond to sudden shading which may be an anti-predator defence (Forbes *et al*., 1971). *Balanus crenatus* tend to orient themselves when settling, with the least light sensitive area directed towards the light (Forbes *et al*., 1971). So that the more sensitive area can detect shading from predator movements in the area where light availability is lower (Forbes *et al*., 1971).

Urticina felina and other associated fauna are not considered sensitive to a change in light levels, although anemones in general can detect and respond to light stimuli (Tsutsui *et al*., 2015). The anemone *Metridium senile*, for example, is photosensitive and may react to light by bending or moving (North, 1957). As *Urticina felina* is found in a range of light environments, from the lower intertidal to deeper circalittoral habitats where light penetration is limited, it was not considered particularly sensitive to increases or decreases in shading.

Jones *et al*. (2012) compiled a report on the monitoring of sponges around Skomer Island and found that many sponges, particularly encrusting species, preferred vertical or shaded bedrock to open, light surfaces. Gili & Hughes (1995) reviewed the effect of light on a number of hydroids and found that there is a general tendency for most hydroids to be less abundant in well-lit situations. Hydroid larvae can be positively or negatively photoactic, (Hughes, 1977)

Sensitivity assessment. Increases in light may result in lower recruitment on the upward facing surfaces on which this biotope is found and increased light penetration of light at wavelengths that support photosynthesis may support algal recruitment. Increased light in general is considered unlikely to alter the biotope character as all characterizing and associated species occur in a range of habitats from the intertidal to the deeper subtidal and therefore tolerate a range of light levels. The characterizing species are found within caves and in deeper waters and are not directly dependent on light. Biotope resistance to reduced light penetration is, therefore assessed as 'High' and recovery as 'high' by default, so that the biotope is considered to be 'Not sensitive'.

Barrier to species movement	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

No direct evidence was found to assess this pressure. Barriers that reduce the degree of tidal excursion may alter larval supply to suitable habitats from source populations. Conversely the presence of barriers may enhance local population supply by preventing the loss of larvae from enclosed habitats. As the larvae of *Balanus crenatus* and *Tubularia indivisa* are planktonic and are transported by water movements, barriers that reduce the degree of tidal excursion may alter larval supply to suitable habitats from source populations. However the presence of barriers may enhance local population supply by preventing the loss of larvae from enclosed habitats. Barriers and changes in tidal excursion are not considered relevant to the anemone *Urticina felina* which broods young, as species dispersal is limited and may not rely on recruitment from outside of populations. Resistance to this pressure is assessed as 'High' and resilience as 'High' by default. This biotope is therefore considered to be 'Not sensitive'.

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

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

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

Some species within the biotope probably respond to light levels, detecting shade and shadow to avoid predators, and day length in their behavioural or reproductive strategies. However, their visual acuity is probably very limited and they are unlikely to respond to visual disturbance at the benchmark level. This pressure is, therefore, assessed as 'Not relevant'.

Balanus crenatus possesses a rudimentary eye and can detect and respond to sudden shading which may be an anti-predator defence (Forbes *et al*., 1971). *Balanus crenatus* tend to orient themselves when settling, with the least light sensitive area directed towards the light (Forbes *et al*., 1971), so that the more sensitive area can detect shading from predator movements in the area where light availability is lower (Forbes *et al*., 1971).

Biological Pressures

	Resistance	Resilience	Sensitivity
Genetic modification & translocation of indigenous species	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

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

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

There is no evidence regarding known invasive non-indigenous (INIS) species which may pose a threat to CR.HCR.FaT.BalTub. 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 & 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.The tunicate *Stylea clava* appears to prefer more sheltered conditions than this biotope (Bishop, 2012d).

Didemnum vexillum is an invasive colonial sea squirt native to Asia which was first recorded in the UK in Darthaven Marina, Dartmouth in 2005. *Didemnum vexillum* can form extensive 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 smother 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. It is therefore possible that *Didemnum vexillum* could colonize more exposed locations within the UK and could therefore pose a threat to CR.HCR.FaT.CTub.Adig.

The Australasian barnacle *Austrominius* (previously *Elminius*) *modestus* was introduced to British waters on ships during the second world war. Increased warming has allowed the Australian barnacle *Austrominius* (formerly *Elminius) modestus*, to dominate sites previously occupied by *Semibalanus balanoides* and *Balanus crenatus* (Witte *et al*., 2010). However, on settlement panels deployed in SW Ireland, *Austrominius modestus* initially dominated panels in the lower subtidal but post-recruitment mortality over a year allowed *Balanus crenatus* to become the dominant barnacle (Watson *et al*., 2005). *Balanus crenatus* and *Austrominius modestus* have shown recruitment differences which may alter the seasonal dominance patterns (Witte, 2010). In general its overall effect on the dynamics of rocky shores has been small as *Austrominius modestus* has simply replaced some individuals of a group of co-occurring barnacles (Raffaelli & Hawkins, 1999).

Sensitivity assessment. As the tide-swept conditions may prevent establishment of know INIS, this biotope is considered to have 'High' resistance to this pressure and 'High' resilience (by default), so that the biotope is judged to be 'Not sensitive'. This assessment may require updating as trends in distribution become clearer or if new species are found to be establishing in similar habitats.

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

No evidence was found that microbial pathogens cause high levels of disease or mortality in this biotope. *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). Decaying patches and white bacterial film were reported in *Haliclona oculata* and *Halichondria panicea* in North Wales, 1988-89, (Webster, 2007) but no mass mortalitites of sponges have been reported from UK waters.

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. By default 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

Direct, physical impacts from harvesting are assessed through the abrasion and penetration of the seabed pressures. The sensitivity assessment for this pressure considers any biological/ecological effects resulting from the removal of target species on this biotope. No commercial application or harvesting of characterizing or associated species is described in the literature, this pressure is therefore considered to be '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

Incidental removal of the key characterizing species would alter the character of the biotope, resulting in reclassification and the loss of species richness. The ecological services such as secondary production, provided by characterizing and associated species, would also be lost. As most species present in this biotope are relatively large, conspicuous and either sedentary, or attached to rock surfaces, they have little protection against removal.

Sensitivity assessment. Removal of a large percentage of the characterizing species resulting in bare rock would alter the character of the biotope, species richness and ecosystem function. Resistance is therefore assessed as 'Low' and recovery as 'High', so that biotope sensitivity is assessed as 'Low'.

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