Urticina felina and sand-tolerant fauna on sand-scoured or covered circalittoral rock

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

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Urticina felina **and sand-tolerant fauna on sand-scoured or covered circalittoral rock**
Photographer: Rohan Holt
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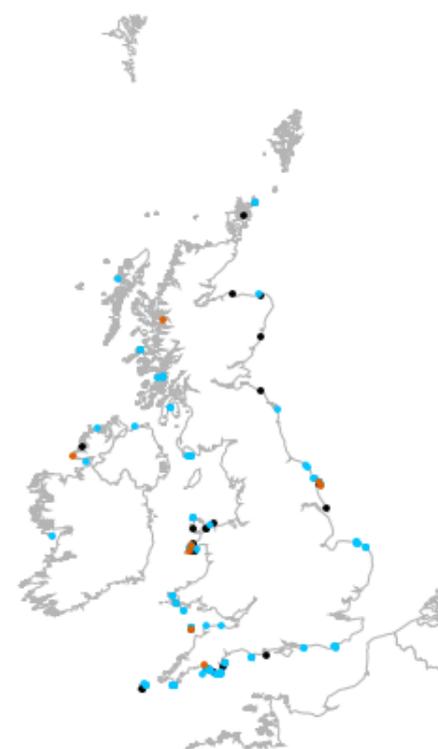
- Core records
- Non-core, certain determination
- Non-core, uncertain determination
- Predicted habitat extent

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

Researched by	Dr Heidi Tillin & Dr Keith Hiscock	**Refereed by**	This information is not refereed.

Summary

☰ UK and Ireland classification

EUNIS 2008	A4.213	*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock
JNCC 2015	CR.MCR.EcCr.UrtScr	*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock
JNCC 2004	CR.MCR.EcCr.UrtScr	Urticina felina and sand-tolerant fauna on sand-scoured or covered circalittoral rock
1997 Biotope	CR.MCR.ByH.Urt	Urticina felina on sand-affected circalittoral rock

🏷 Description

This biotope typically occurs on tide-swept circalittoral bedrock, rock adjacent to mobile sand/gravel in gullies, and cobbles on gravel and sand, characterized by scour-tolerant robust species. Although many of these species are found on subtidal rock, they tend to occur in larger

numbers in these highly sand-influenced conditions. The dominant species by far is the anemone *Urticina felina* which commonly occurs on rocks at the sand-rock interface, where the scour levels are at a maximum and few species can tolerate this abrasion. The sponge *Ciocalypta penicillus* is also very characteristic of shifting sand-covered rock. This biotope is only occasionally recorded as a separate entity, because its extent is typically restricted to a very narrow band of rock at the sediment interface. Only occasionally does it cover a large extent of rock (e.g. where the wave action is strong enough to cause sand abrasion well up the rock face or where the rock is low-lying). More often, this scoured zone is recorded as part of whatever biotope occurs on the nearby hard substrata. Other species (which are able to survive, and benefit from the reduced competition) include *Balanus crenatus*,*Spirobranchus triqueter*, *Cellepora pumicosa*, *Alcyonidium diaphanum*, *Cliona celata*, encrusting red algae and *Asterias rubens*. (Information from Connor *et al.*, 2004; JNCC, 2015).

↓ Depth range

0-5 m, 5-10 m, 10-20 m, 20-30 m, 30-50 m

🏛 Additional information

The sub-biotope MCR.Urt.Cio is a conspicuous and easily recognized entity occurring widely in south west Britain.

✔ Listed By

- none -

✆ Further information sources

Search on:

G ℊ G JNCC

Habitat review

⟳ Ecology

Ecological and functional relationships

The sub-biotopes of MCR.Urt are dominated by sessile, permanently fixed, suspension feeding invertebrates that are, therefore, dependant on water flow to provide: an adequate supply of food and nutrients; gaseous exchange; remove metabolic waste products; prevent accumulation of sediment, and disperse gametes or larvae. The majority of species found in this biotope are adapted to strong wave action, siltation and a degree of sediment scour. Little is known of ecological relationships in circalittoral faunal turf habitats (Hartnoll, 1998). Most species live independently except that they compete for space and for food. The following text indicates major feeding types.

- Suspension feeders on bacteria, phytoplankton and organic particulates and detritus include sponges (*Ciocalypta penicillus*, *Polymastia* spp. and *Cliona celata*) and soft corals (*Alcyonium digitatum*), erect and encrusting bryozoans (e.g. *Pentapora foliacea*, *Flustra foliacea*, and *Bugula* spp.), brittlestars (e.g. *Ophiothrix fragilis*), barnacles (e.g. *Balanus crenatus*), caprellid amphipods, porcelain crabs (e.g. *Pisidia longicornis*), and polychaetes (e.g. *Spirobranchus* spp.). However, the water currents they generate are probably localized , so that they are still dependant on water flow to supply adequate food.
- Passive carnivores of zooplankton and other small animals include, hydroids (e.g. *Nemertesia antennina*), soft corals (e.g. *Alcyonium digitatum*), while larger prey are taken by *Urticina felina* (Hartnoll, 1998).
- Sea urchins (e.g. *Echinus esculentus* are generalist grazers, removing barnacles, ascidians, hydroids and bryozoans and potentially removing all epifauna, leaving only encrusting coralline algae and bedrock. Sea urchins were shown to have an important structuring effect on the community and epifaunal community succession (Sebens, 1985; 1986; Hartnoll, 1998).
- Specialist predators of hydroids and bryozoans include the nudibranchs (e.g. *Janolus cristatus*, *Doto* spp. and *Onchidoris* spp.) and pycnogonids, (e.g. *Achelia echinata*), while the nudibranch *Tritonia hombergi* and the mesogastropod *Simnia patula* prey on *Alcyonium digitatum*.
- Scavengers include polychaetes, small crustaceans such as amphipods, starfish and larger decapods such as hermit crabs (e.g. *Pagurus bernhardus*) and crabs (e.g. *Cancer pagurus*).
- Mobile fish predators are likely to include gobies (e.g. *Pomatoschistus* spp.), butterfish (*Pholis gunnellus*), wrasse and eelpout (*Zoarces viviparus*) feeding mainly on small crustaceans, while species such as flounder (*Platichthys flesus*) are generalists feeding on ascidians, bryozoans, polychaetes and crustaceans (Sebens, 1985; Hartnoll, 1998)

Competition

Intra and interspecific competition occurs for food and space. Filter feeders reduce the concentration of suspended particulates and deplete food to other colonies/individuals downstream (intra and inter specific competition). Sebens (1985, 1986) demonstrated a successional hierarchy, in which larger, massive, thick growing species (e.g. large anemones, soft corals and colonial ascidians) grew over low lying, or encrusting growth forms such as halichondrine sponges, bryozoans, hydroids and encrusting corallines. The epifauna of vertical rock walls became dominated by large massive species, depending on the degree of predation, especially by sea urchins. However, encrusting bryozoans and encrusting corallines may survive

overgrowth (Gordon, 1972; Sebens, 1985; Todd & Turner, 1988). In the sub-biotopes of MCR.Urt, the degree of sediment scour and siltation probably exerts a controlling factor on the succession (see temporal change below) and are dominated by species tolerant of sediment scour and high water flow.

Seasonal and longer term change

No information on seasonal or temporal change in MCR.Urt.Cio or related biotopes was found and the following information has been inferred from available studies of subtidal epifaunal communities (Sebens, 1985, 1986; Hartnoll, 1983, 1998).

Seasonal changes
Most of the species in the biotope and sub-biotopes are perennial but may show seasonal changes. For instance, some hydroids and bryozoans, may show annual phases of growth and dormancy or regression. For example, *Flustra foliacea* becomes dormant in winter, *Bugula* species die back in winter to dormant holdfasts, while the uprights of *Nemertesia antennina* die back after 4-5 month and exhibit three generations per year (spring, summer and winter). Hartnoll (1975) found that, in *Alcyonium digitatum* studied in the Isle of Man, from February through to July all colonies expand and feed regularly. However, from late July through to December the colonies remain contracted, during which time they do not feed and assume a shrunken appearance with a reddish or brownish colour. The change of colour is a result of the periods of inactivity as the surface of the colonies become covered with a layer of epibiota (diatoms and prostrate thalloid and filamentous algae initially, from which arises a forest of erect algae and hydroids). The amphipod *Jassa falcata* also builds its mucous and detritus tubes amongst the other epibiota, adding to and consolidating the covering (Hartnoll, 1975). Once the colonies recommence expansion in December the epibenthic film is sloughed off. The season of prolonged inactivity coincides with the final months of gonad maturation and the shedding of the epibenthic film immediately precedes the spawning of the gametes (see reproduction) (Hartnoll, 1975; 1977) (see *MarLIN* reviews; Hughes, 1977; Hayward & Ryland, 1998; Hartnoll, 1975, 1998).

Succession
Sebens (1985, 1986) described successional community states in the epifauna of vertical rock walls. Clear space was initially colonized by encrusting corallines, rapidly followed by bryozoans, hydroids, amphipods and tube worm mats, halichondrine sponges, small ascidians (e.g. *Dendrodoa carnea* and *Molgula manhattensis*), becoming dominated by the ascidian *Aplidium* spp., or *Metridium dianthus* or *Alcyonium digitatum*. High levels of sea urchin predation resulted in removal of the majority of the epifauna leaving encrusting coralline dominated rock. Reduced predation allowed the dominant epifaunal communities to develop, although periodic mortality (through predation or disease) of the dominant species resulted in mixed assemblages or a transition to another assemblage (Sebens, 1985, 1986). Sea urchin predation may play a significant role in freeing space for colonization in this community. Succession will be dependant on species tolerance to silt and sediment scour.

Community stability
Long-term studies of fixed quadrats in epifaunal communities demonstrated that while seasonal and annual changes occurred, subtidal faunal turf communities were relatively stable, becoming more stable with increasing depth and substratum stability (i.e. bedrock and large boulders rather than small rocks) (Osman, 1977; Hartnoll, 1998). Many of the faunal turf are long-lived, e.g. 6 -12 years in *Flustra foliacea*, over 20 years in *Alcyonium digitatum*, 8-16 years in *Echinus esculentus* and probably many hydroids (Stebbing, 1971a; Gili & Hughes, 1995; Hartnoll, 1998).

Habitat structure and complexity

- The bedrock is covered by a layer of encrusting corallines overgrown by dominant erect bryozoans and hydroids (e.g. *Flustra foliacea*, *Bugula* species and *Nemertesia antennina*) interspersed with cushion-like sponges (e.g. *Ciocalypta penicillus*, *Polymastia* spp., *Cliona celata*), dead men's fingers *Alcyonium digitatum* and dahlia anemones *Urticina felina*. The coralline-encrusted rock and the bases of sponges are often covered by sediment.
- The faunal turf provides interstices and refuges for a variety of small organisms such as nemerteans, polychaetes, and amphipods, while the erect species provide substrata for caprellid amphipods, which use them as 'platforms' to suspension feed.
- The erect bryozoans and hydroids support a variety of epizoics that use them as substratum and in some cases affect their growth rates. For example, *Flustra foliacea* supported 25 species of bryozoan, 5 hydroid species, some sessile polychaetes, barnacles, lamellibranchs and tunicates (Stebbing, 1971b). The bryozoans *Bugulina flabellata*, *Crisia* spp. and *Scrupocellaria* spp. were major epizoics. *Scrupocellaria* spp. settled preferentially on the youngest, distal, portions of the frond, possibly to elevate their branches into faster flowing water (Stebbing, 1971b). Similarly, *Alcyonidium parasiticum* is epizoic on hydroid stems or the bryozoan *Cellaria* spp. and the sponge *Esperiopsis fucorum* may grow on the stem of *Tubularia* species or on the test of ascidians.
- Mobile species include decapods crustaceans such as shrimp, crabs and lobsters, sea urchins, starfish and fish.
- Gobies, shannies and butterfish probably utilize available rock ledges and crevices, while large species such as flounder and cod probably feed over a wide area.
- Pockets of sediment that accumulate between boulders or in crevices (where present) may support benthic infaunal species such as *Mya truncata* and *Sabella pavonina*.
- The biotope and sub-biotopes may show spatial variation in community complexity and exhibit a mosaic of different species patches (Hartnoll, 1998), due to colonization of areas recently cleared by predation, disease or physical disturbance in the process of re-colonization. The upper edges or boulders or rocky outcrops, most directly in water flow, tend to exhibit the most species rich and abundance faunal turfs, while species richness decreases with proximity to the sediment/ rock interface, which favours species such as the sponges *Polymastia* spp. or the anemone *Urticina felina*. Areas subject to increased scour or vertical surfaces tend to be dominated by tube worms such as *Spirobranchus triqueter* (Stebbing, 1971b, Eggleston, 1972b; Sebens, 1985, 1986; Connor *et al.*, 1997a; Brazier *et al.*, 1998; Hartnoll, 1998).
- Periodic disturbance of the community due to physical disturbance by storms, extreme scour, or fluctuations in predation, especially by sea urchins, may encourage species richness by preventing dominance by a few species (Osman, 1977; Sebens, 1985, 1986; Hartnoll, 1998).

Productivity

Circalittoral faunal turf biotopes are primarily secondary producers. Food in the form of phytoplankton, zooplankton and organic particulates from the water column together with detritus and abraded macroalgal particulates from shallow water ecosystems are supplied by water currents and converted into faunal biomass. Their secondary production supplies higher trophic levels such as mobile predators (e.g. fish) and scavengers (e.g. starfish and crabs) and the wider ecosystem in the form of detritus (e.g. dead bodies and faeces). In addition, reproductive products (sperm, eggs, and larvae) also contribute to the zooplankton (Hartnoll, 1998). However, no estimates of faunal turf productivity were found.

Recruitment processes

Most of the species within MCR.Urt.Cio produce short-lived, larvae with relatively poor dispersal capacity, resulting in good local recruitment but poor long range dispersal. Although, the biotope occurs within moderately strong to strong water flow that could remove a large proportion of the reproductive output, most reproductive propagules are probably entrained within the reduced flows within the faunal turf or in turbulent eddies produced by flow over the uneven substratum, resulting in turbulent deposition of propagules locally. Many species are capable of asexual propagation and rapidly colonize space. For example:

- Whilst very little is known about reproduction in the sponges that particularly characterise MCR.Urt.Cio, sponges may proliferate both asexually and sexually. A sponge can regenerate from a broken fragment, produce buds either internally or externally or release clusters of cells known as gemmules which develop into a new sponge. Most sponges are hermaphroditic but cross-fertilization normally occurs. There is a mass spawning of gametes through the osculum, which enter a neighbouring individual in the inhalant current. Fertilized eggs may be discharged into the sea where they develop into a planula larva. But in the majority of species development is viviparous, whereby the larva develops within the sponge and is then released. Larvae have a short planktonic life of a few hours to a few weeks, so that dispersal is probably limited and asexual reproduction probably results in clusters of individuals.
- Hydroids are often the first organisms to colonize available space in settlement experiments (Gili & Hughes, 1995). *Nemertesia antennina* releases planulae on mucus threads, that increase potential dispersal to 5 -50m, depending on currents and turbulence (Hughes, 1977). Most species of hydroid in temperate waters grow rapidly and reproduce in spring and summer. Few species of hydroids have specific substrata requirements and many are generalists. Hydroids are also capable of asexual reproduction and many species produce dormant, resting stages, that are very resistant of environmental perturbation (Gili & Hughes, 1995). Hughes (1977) noted that only a small percentage of the population of *Nemertesia antennina* in Torbay developed from dormant, regressed hydrorhizae, the majority of the population developing from planulae as three successive generations. Rapid growth, budding and the formation of stolons allows hydroids to colonize space rapidly. Fragmentation may also provide another route for short distance dispersal.
- The brooded, lecithotrophic coronate larvae of many bryozoans have a short pelagic lifetime of several hours to about 12 hours (Ryland, 1976). In temperate waters most bryozoans species tend to grow rapidly in spring and reproduce maximally in late summer, depending on temperature, day length and the availability of phytoplankton (Ryland, 1970).
- Echinoderms are highly fecund, producing long-lived planktonic larvae with high dispersal potential but recruitment in echinoderms is poorly understood, often sporadic, variable between locations and dependant on environmental conditions such as temperature, water quality and food availability. Recruitment was reported to be sporadic in *Echinus esculentus*, e.g. Millport populations showed annual recruitment, whereas few recruits were found in Plymouth populations between 1980-1981 (Nichols, 1984). Bishop & Earll (1984) suggested that the population of *Echinus esculentus* at St Abbs had a high density and recruited regularly whereas the Skomer population was sparse, ageing and had probably not successfully recruited larvae in the previous 6 years. In *Ophiothrix fragilis* recruitment success is heavily dependent on environmental conditions including temperature and food availability. In years after mild winters *Ophiothrix fragilis* occurred

in extremely high densities in the Oosterschelde estuary in Holland (Smaal, 1994). However, echinoderms such as *Echinus esculentus*, and *Asterias rubens* are mobile and widespread and are likely to recruit by migration from other areas.

- Anthozoans, such as *Alcyonium digitatum* and *Urticina felina are long lived with potentially highly dispersive pelagic larvae and are relatively widespread. They are not restricted to this biotope and would probably be able to recruit rapidly (refer to the Key Information reviews).*
- *Mobile epifauna will probably recruit from the surrounding area as the community develops and food, niches and refuges become available, either by migration or from planktonic larvae. For example, Hatcher (1998) noted that the number of mobile epifaunal species steady increased over the year following deployment of settlement panels in Poole Harbour.*

Time for community to reach maturity

No information was found on the development of MCR.Urt.Cio and the following has been inferred from studies of similar epifaunal communities (Sebens, 1985, 1986; Hartnoll, 1998).

The recolonization of epifauna on vertical rock walls was investigated by Sebens (1985, 1986). He reported that 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 dianthus* colonized within 4 years (Sebens, 1986) and would probably take longer to reach pre-clearance levels.

Jensen *et al.* (1994) reported the colonization of an artificial reef in Poole Bay, England. They noted that erect bryozoans, including *Crisularia plumosa*, began to appear within 6 months, reaching a peak in the following summer, 12 months after the reef was constructed. Similarly, ascidians colonized within a few months e.g. *Aplidium* spp. Sponges were slow to establish with only a few species present within 6-12 months but beginning to increase in number after 2 years, while anemones were very slow to colonize with only isolated specimens present after 2 years (Jensen *et al.*, 1994.). In addition, Hatcher (1998) reported a diverse mobile epifauna after a years deployment of her settlement panels.

Hydroids are often initial colonizing organisms in settlement experiments and fouling communities (Standing, 1976; Brault & Bourget, 1985; Sebens, 1986; Jensen *et al.*, 1994; Hatcher, 1998). In settlement experiments the hydroids *Cordylophora caspia*, *Obelia dichotoma* and *Obelia longissima* colonized artificial substrata within ca 1-3 months of deployment (Standing, 1976; Brault & Bourget, 1985: Sandrock *et al.*, 1991). Once colonized the hydroids ability to grow rapidly and reproduce asexually is likely to allow them to occupy space and sexually reproduce quickly.

Flustra foliacea is the dominant species in this biotope. New colonies of *Flustra foliacea* take at least 1 year to develop erect growth and 1-2 years to reach maturity, grow slowly (Stebbing, 1971a; Eggleston, 1972a), and would probably several years to reach high abundance, depending on environmental conditions. Recruitment may be enhanced in areas subject to sediment abrasion, where less tolerant species are removed, making more substratum available for colonization, especially if larval release in spring coincides with the end of winter storms. The wreck of a small coaster (the M.V. *Robert*) off Lundy became dominated by erect bryozoans, including occasional *Flustra foliacea*, within 4 years of sinking, when it was first surveyed (Hiscock, 1981).

Overall, encrusting bryozoans, hydroids, and ascidians will probably develop a faunal turf within

less than 2 years, and *Flustra foliacea* can evidently colonize and reach an abundance of occasional (1-5% cover) within 4 years. Slow growing species such as *Flustra foliacea*, *Pentapora foliacea*, and some sponges and anemones, will probably take many years to develop significant cover, so that this biotope may take between 5 -10 years to develop an stable community after disturbance, depending on local conditions.

Additional information

None

🖼 Preferences & Distribution

Habitat preferences

Depth Range	0-5 m, 5-10 m, 10-20 m, 20-30 m, 30-50 m
Water clarity preferences	
Limiting Nutrients	
Salinity preferences	Full (30-40 psu), Reduced (18-30 psu)
Physiographic preferences	
Biological zone preferences	Infralittoral
Substratum/habitat preferences	Bedrock, Cobbles
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Strong 3 to 6 knots (1.5-3 m/sec.)
Wave exposure preferences	Exposed, Extremely exposed, Extremely sheltered, Moderately exposed, Sheltered, Very exposed, Very sheltered
Other preferences	

Additional Information

This biotope tends to be found in close proximity to mobile sand or gravel, producing scour that tends to limit the number of species found.

🐾 Species composition

Species found especially in this biotope

- *Adreus fascicularis*

Rare or scarce species associated with this biotope

- *Adreus fascicularis*

Additional information

Rocky substratum biotopes covered or partly covered by sand occur at locations all around Britain

Date: 2016-03-30

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and Ireland and share many characteristic species with MCR.Urt.Cio. However, the presence of the sponge *Ciocalypta penicillus*, a southern species, means that this biotope is restricted to southern England, Wales and Ireland. It is believed that the sponge *Adreus fascicularis* is found only in this biotope.

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

The biotope description and characterizing species is taken from Connor *et al.*, (2004). This biotope typically occurs on tide-swept circalittoral scoured bedrock and is characterized by scour-tolerant robust species. The dominant species is the anemone *Urticina felina* which commonly occurs on rocks at the sand-rock interface, where the scour levels are at a maximum and few species can tolerate this abrasion. The sponge *Ciocalypta penicillus* is also very characteristic of shifting sand-covered rock. Little evidence was found to assess sensitivity and only general assessments, with low confidence could be made for these species and the biotope. The sensitivity assessments are based on these two characterizing species. Other species (which are able to survive, and benefit from the reduced competition) include *Balanus crenatus* and *Spirobranchus* (*Pomatoceros) triqueter*, *Cellepora pumicosa*, *Alcyonidium diaphanum*, *Cliona celata*, encrusting red algae and *Asterias rubens*. The sensitivity of *Balanus crenatus* and *Spirobranchus triqueter* are considered generally within assessments to represent the associated fauna. The sensitivity of the encrusting red algae (Corallinacea) within the biotope is also discussed.

Water movement and abrasion resulting from sediment scour are key factors structuring the biotope and significant alteration to these is likely to change the character of the biotope. Where pressures may alter these factors this is identified and discussed within the sensitivity assessments.

Resilience and recovery rates of habitat

The characterizing anemone, *Urticina felina*, is poorly studied and little information was found to assess resilience. No evidence was found for longevity. Aquaria reports suggest that, protected from predation, animals can live for tens of years (P.G. Moore, pers comm.). Some individuals may be hundreds of years old, given their ability to regenerate (Francis, 1976). *Urticina felina* will readily repair damage to the body: removal of tentacles by clipping does not alter the behaviour or *Urticina felina* and the tentacle regenerates within a few days (Mercier *et al.*, 2011). *Urticina felina* internally broods young which when released settle close to the adult. Brooding prevents predation of juveniles and in areas of high wave action and water flows counteracts removal and predation and supports the formation of aggregations of anemones in harsh environments (Kaliszewicz *et al.*, 2012). However, brooding does limit dispersal (Kaliszewicz *et al.*, 2012) and may inhibit recovery where a population is entirely removed. The large size, slow growth rate and evidence from aquarium populations (see life-history characteristics) suggest that *Urticina felina* is long lived. Dispersal ability is considered to be poor in the similar species *Urticina eques* (Solé-Cava *et al.* 1994). Adults can detach from the substratum and relocate but locomotive ability is very limited. Impacts that remove large proportions of the population over a wide area will effectively reduce the availability of colonists. *Urticina felina* colonized the ex-*HMS Scylla*, that was purposely sunk, to create an artificial reef, in Whitsand Bay, West Cornwall, in the second year of the vessel being on the seabed and had increased in numbers four years after (Hiscock *et al.*, 2010).

No evidence was found to assess the resilience of the characterizing sponge *Ciocalypta penicillus*. Sponges are known to be highly resilience to physical damage with an ability to survive severe damage, regenerate and reorganize to function fully again (Wulff, 2006). However, the ability to resist damage and recover varies between species (Wulff, 2006). Sponge fragments of coral reef species torn from adults during hurricanes have been observed to re-attach and continue growing (Wulff, 2006).

Populations of *Spirobranchus triqueter* have a spring reproductive maxima from March-April although breeding can occur throughout the year. Populations of *Spirobranchus* (studied as *Pomatoceros*) *triqueter* in Bantry Bay, Ireland exhibited an extended reproductive season, with numerous small scale peaks, the timing of which varied between years (Cotter *et al*., 2003). *Spirobranchus triqueter* is a protandrous hermaphrodite, with older, larger individuals more likely to be female (Cotter *et al*., 2003). *Spirobranchus triqueter* lives for 2 to 4 years (Dons, 1927; Castric-Fey, 1983; Hayward & Ryland, 1995b) and matures at 4 months (Hayward & Ryland, 1995b; Dons, 1927). *Spirobranchus triqueter* is considered to be a primary fouling organism (Crisp, 1965) colonising artificial commercially important structures such as buoys, ships hulls, docks and offshore oil rigs (OECD 1967). *Spirobranchus triqueter* are commonly the initial recruits to new substrata (Sebens, 1985; Sebens, 1986; Hatcher, 1998). For example, *Spirobranchus triqueter* colonized artificial reefs soon after deployment in summer (Jensen *et al*., 1994), colonized settlement plates within 2-3.5 months and dominated spring recruitment (Hatcher, 1998). 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 triqueter*.

Balanus crenatus produce a single, large brood annually with peaks in April – May (Salman, 1982); although subsidiary broods may be produced, the first large brood is the most important for larval supply (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, ex-*HMS Scylla*, was colonized by *Balanus crenatus* 4 weeks after sinking in March; the timing of the sinking would have ensured a good larval supply from the spring spawning. The presence of adult *Balanus crenatus* enhances settlement rate of larvae on artificial panels (Miron *et al*., 1996), so that surviving adults enhance recovery rates.

Spirobranchus 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 was recolonized in May to June (Warner, 1985). Warner (1985) reported that the community did not contain any persistent individuals, being dominated by rapidly colonising 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.

Although ubiquitous in marine coastal systems, little is understood about the taxonomy, biology and ecology of the associated crustose corallines (Littler & Littler, 2013). Coralline crust is a generic term that in UK biotopes refers to nongeniculate (crustose) species from the family Corallinacea that could include *Lithophyllum incrustans* which is noted to form thick crusts in

tidepools, especially in the south west (Adey & Adey, 1973), *Lithothamnion* spp. and *Phymatolithon* spp. Due to the lack of evidence for species the assessments for encrusting corallines are generic, although species specific information is presented where available. A number of papers by Edyvean & Ford (1984a & b; 1986; 1987) describe aspects of reproduction and growth of encrusting coralline, *Lithophyllum incrustans*. Studies by Edyvean & Forde (1987) in populations of *Lithophyllum incrustans* in Pembroke south-west Wales suggest that reproduction occurs on average early in the third year. Reproduction may be sexual or asexual. Populations release spores throughout the year but abundance varies seasonally, with the populations studied in Cullercoats Bay and Lannacombe Bay (North East and South West England, respectively) producing less spores in the summer. Spore release is initiated by changes in temperature or salinity (see relevant pressure information) at low tide so that spore dispersal is restricted to within the tide pool enhancing local recruitment. Within subtidal biotopes this is not possible and recruitment success may be altered (although this may be compensated by avoidance of desiccation). Spore survival is extremely low with only a tiny proportion of spores eventually recruiting to the adult population (Edyvean & Ford, 1986). The spores are released from structures on the surface called conceptacles; these are formed annually and subsequently buried by the new layer of growth. Plants can be aged by counting the number of layers of conceptacles. Edyvean & Ford (1984a) found that the age structure of populations sampled from Orkney (Scotland) Berwick (northern England) and Devon (England) were similar, mortality seemed highest in younger year classes with surviving individuals after the age of 10 years appear relatively long-lived (up to 30 years). In St Mary's Northumberland, the population was dominated by the age 6-7 year classes (Edyvean & Ford, 1984a). Growth rates were highest in young plants measured at Pembroke (south-west Wales) with an approximate increase in diameter of plants of 24 mm in year class 0 and 155 mm in year 1 and slowing towards an annual average horizontal growth rate of 3mm/year (Edyvean & Ford, 1987). Some repair of damaged encrusting coralline occurs through vegetative growth. Chamberlain (1996) observed that although *Lithophyllum incrustans* was quickly affected by oil during the *Sea Empress* spill, recovery occurred within about a year. The oil was found to have destroyed about one third of the thallus thickness but regeneration occurred from thallus filaments below the damaged area. Recolonization by propagules is an important recovery mechanism. Airoldi (2000) observed that encrusting coralline algae recruited rapidly on to experimentally cleared subtidal rock surfaces in the Mediterranean Sea, reaching up to 68% cover in 2 months.

Resilience assessment. Where resistance is 'High', resilience is assessed as 'High' by default. Where resistance is 'Medium' then recovery is considered to be 'High' based on reproduction and recolonization from the remaining population of the anemone *Urticina felina* and the sponge *Ciocalypta penicillus*. Where resistance is 'Low' or 'None', recovery to pre-impact abundance and density of the key characterizing anemone and sponge may be delayed and resilience is assessed as 'Medium' based on the observation of Hiscock *et al*. (2010). The resilience assessment is also considered applicable to the associated crustose corallines. Both *Balanus crenatus* and *Spirobranchus triqueter* are rapid colonizers and likely to recover quickly, probably within months. Therefore, resilience, of these species, is assessed as 'High' for any level of perturbation. However, a biotope consisting of only *Balanus crenatus* and *Spirobranchus triqueter* would not be classified as the assessed biotope.

NB: The resilience and the ability to recover from human induced pressures is a combination of the environmental conditions of the site, the frequency (repeated disturbances versus a one-off event) and the intensity of the disturbance. Recovery of impacted populations will always be mediated by stochastic events and processes acting over different scales including, but not limited to, local habitat conditions, further impacts and processes such as larval-supply and recruitment between

populations. Full recovery is defined as the return to the state of the habitat that existed prior to impact. This does not necessarily mean that every component species has returned to its prior condition, abundance or extent but that the relevant functional components are present and the habitat is structurally and functionally recognizable as the initial habitat of interest. It should be noted that the recovery rates are only indicative of the recovery potential.

🚢 Hydrological Pressures

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

Within the biotope the key characterizing species *Urticina felina* and the associated barnacles *Balanus crenatus* have a more northern distribution and are absent from warmer Mediterranean and equatorial waters. *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.

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 $^\circ$C (Davenport & Davenport, 2005) confirming the observations of Southward (1955).

The characterizing sponge *Ciocalypta penicillus* and the associated *Spirobranchus triqueter* are found in both warmer and colder waters experienced in the UK. *Ciocalypta penicillus* is found throughout the European seaboard of the Atlantic from Helgoland, south to Spain, Portugal and the Mediterranean (Van Soest, 2016). *Spirobranchus triqueter* occurs from the Arctic, the eastern North Atlantic up to the Mediterranean, Adriatic, Black and Red Sea, the English Channel, the whole North Sea, Skagerrak, Kattegat, the Belts and Öresund up to Bay of Kiel (de Kluijver *et al.*, 2016).

The encrusting coralline, *Lithophyllum incrustans*, is close to the northern edge of its reported distribution range in the UK (Kain, 1982; Guiry & Guiry, 2015) and is therefore considered likely to be tolerant of an increase in temperature, particularly in this subtidal biotope, where it is protected

from desiccation.

Sensitivity assessment. Typical surface water temperatures around the UK coast vary, seasonally from 4-19 $^{\circ}$C (Huthnance, 2010). The biotope is considered to tolerate a 2 $^{\circ}$C increase in temperature for a year. 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 $^{\circ}$C in summer would be close to the lethal thermal temperature for *Balanus crenatus* and may be damaging for *Urticina felina* (based on distribution and observations of Gosse (1860)). Loss of *Urticina felina* could lead to reclassification of the biotope. Biotope resistance is, therefore, assessed as 'Low' and resilience as 'Medium' and biotope sensitivity is 'Medium'.

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

Within the biotope, the key characterizing species *Urticina felina* and the associated barnacles *Balanus crenatus* have a more northern distribution and are absent from warmer Mediterranean and equatorial waters. *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). Although *Urticina felina* was apparently unaffected by the extremely cold winter of 1962/3 (Crisp, 1964), Gosse (1860) observed that 'after the intense and protracted frost of February 1855, the shores of South Devon were strewn with dead and dying anemones, principally of this species'. Bearing in mind the equivocal observations from two cold winters, it is suggested that at least some individuals might be killed by extreme cold (exceeding the pressure benchmark).

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. *Balanus crenatus* is relatively tolerant of lower temperatures. *Balanus crenatus* was unaffected during the severe winter of 1962-63, when average temperatures were 5 to 6 °C below normal (Crisp, 1964). The tolerance of *Balanus crentaus* collected from the lower intertidal in the winter (and thus acclimated to lower temperatures) to low temperatures was tested in the laboratory. The median lower lethal temperature tolerance was -1.4 $^{\circ}$C (Davenport & Davenport, 2005). An acute or chronic decrease in temperature, at the pressure benchmark, is therefore unlikely to negatively affect this species. Meadows (1969) noted that the severe winter of 1962-63 decreased sea temperatures at Newcastle but did not affect fauna, including *Balanus crenatus*, on settlement panels that were deployed in the area.

The characterizing sponge *Ciocalypta penicillus* and the associated *Spirobranchus triqueter* are found in both warmer and colder waters experienced in the UK. *Ciocalypta penicillus* is found throughout the European seaboard of the Atlantic from Helgoland, south to Spain, Portugal and the Mediterranean (Van Soest, 2016). *Spirobranchus triqueter* occurs from the Arctic, the eastern North

Atlantic up to the Mediterranean, Adriatic, Black and Red Sea, the English Channel, the whole North Sea, Skagerrak, Kattegat, the Belts and Öresund up to Bay of Kiel (de Kluijver *et al*., 2016). Thomas (1940) noted that *Spirobranchus* (as *Pomatoceros*) *triqueter* could not form tubes below 7°C, however, this effect is not considered to lead to mortality in adults at the duration of the acute pressure benchmark.

Lithophyllum incrustans are close to the northern edge of their reported distribution range in the UK (Guiry & Guiry, 2015). Edyvean & Forde (1984b) suggest that populations of *Lithophyllum incrustans* are affected by temperature changes and salinity and that temperature and salinity 'shocks' induce spawning but no information on thresholds was provided (Edyean & Ford, 1984b).

Sensitivity assessment. Overall, a long-term chronic change in temperature at the pressure benchmark is considered likely to fall within natural variation and to be tolerated by the characterizing and associated species although, *Lithothyllum incrustans* may experience reduced growth (as it is primarily a southern species). An acute change at the pressure benchmark is considered unlikely to adversely affect the biotope as the characterizing species can potentially adapt to a wide range of temperatures experienced in both northern and southern waters (*Spirobranchus triqueter* and *Ciocalypta penicillus*), or are found primarily in colder, more northern waters (*Urticina felina* and *Balanus crenatus*). Lithophyllum incrustans may be less tolerant but changes in growth of this specie or some mortality would not alter biotope classification. Biotope resistance is, therefore, assessed as 'High' and resilience as 'High'. This biotope is therefore considered to be 'Not Sensitive'.

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

This biotope is recorded in full salinity (30-35 ppt) and reduced salinity (18-30 ppt) habitats (Connor *et al*., 2004). No evidence was found to assess the sensitivity of *Ciocalypta penicillus* or *Urticina felina.* The sensitivity assessment considers both an increase from variable to full salinity and an increase from full to >40 ppt.

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.

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 exposed to salinities of 50‰, and 60 ‰ eggs exposed at an early developmental stage did not produce viable larvae 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).

The crustose corallines that occur in this biotope may also be found on rocky shores and in rockpools where salinities may fluctuate markedly during exposure to the air. Kinne (1971a) cites maximal growth rates for *Corallina officinalis* between 33 and 38 psu in Texan lagoons.

Edyvean & Ford (1984b) suggest that populations of *Lithophyllum incrustans* are affected by temperature changes and salinity and that temperature and salinity 'shocks' induce spawning but no information on thresholds was provided (Edyvean & Ford, 1984b). Populations of *Lithophyllum incrustans* were less stable in rockpools with a smaller volume of water that were more exposed to temperature and salinity changes due to lower buffering capacity. Sexual plants (or the spores that give rise to them) were suggested to be more susceptible than asexual plants to extremes of local environmental variables (temperature, salinity etc.) as they occur with greater frequency at sites where temperature and salinity were more stable (Edyvean & Ford, 1984b).

Sensitivity assessment. Some increases in salinity may be tolerated by the associated species present and the biotope is considered not sensitive to a change from reduced to full salinity, based on the range of habitats in which the biotope is found. This biotope is considered to be sensitive to a persistent increase in salinity to > 40 ppt (based on species distribution and evidence for impacts on larval supply (Barnes & Barnes 1974)). Resistance is therefore assessed as 'Low' and recovery as 'Medium' (following restoration of usual salinity). Sensitivity is, therefore, assessed as 'Medium'.

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

This biotope is recorded in full salinity (30-35 ppt) and reduced salinity (18-30 ppt) habitats (Connor *et al.*, 2004). At the pressure benchmark, a change from full to reduced salinity is assessed and a change from reduced to low (<18 ppt). No evidence was found to assess the sensitivity of *Ciocalypta penicillus.*

The key characterizing species, *Urticina felina*, occurs in estuaries e.g. the Thames estuary at Mucking and the River Blackwater estuary (Davis, 1967). Braber and Borghouts (1977) found that *Urticina* (as *Tealia*) *felina* penetrated to about the11 ppt chlorinity isohaline (corresponding to about 20 psu based on conversion rates) at mid tide during average water discharge in the Westerschelde estuary. These observations suggest that it would be tolerant of low 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. Therefore, the species seems to have a high tolerance to a reduction in salinity but may have to retract tentacles and suffer reduced opportunity to feed.

Other species within the biotope are likely to be more sensitive and a change at the pressure benchmark is considered likely to reduce species richness and result in the loss of associated species. Available evidence for sensitivities is described below. *Balanus crenatus* occurs in estuarine areas and responds to variations in salinity by closing the 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 14psu 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". In this state the animals may survive (Barnes & Barnes, 1974) 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", 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).

Spirobranchus (syn. *Pomatoceros*) *triqueter* has not been recorded from brackish or estuarine waters. Therefore, it is likely that the species will be very intolerant of a decrease in salinity. However, Dixon (1985, cited in Riley & Ballerstedt, 2005) views the species as able to withstand significant reductions in salinity. The degree of reduction in salinity and time that the species could tolerate those levels were not recorded. Therefore, there is insufficient information available to assess the intolerance of *Spirobranchus triqueter* to a reduction in salinity.

Edyvean & Ford (1984b) suggest that populations of the crustose coralline *Lithophyllum incrustans* are affected by temperature changes and salinity and that temperature and salinity 'shocks' induce spawning but no information on thresholds were provided (Edyvean & Ford, 1984b). Populations of *Lithophyllum incrustans* were less stable in tide pools with a smaller volume of water that were more exposed to temperature and salinity changes due to lower buffering capacity. Sexual plants (or the spores that give rise to them) were suggested to be more susceptible than asexual plants to extremes of local environmental variables (temperature, salinity etc.) as they occur with greater frequency at sites where temperature and salinity were more stable (Edyvean & Ford, 1984b).

Sensitivity assessment. As the biotope is found in both full and variable salinity, the biotope is considered 'Not sensitive' to a decrease in salinity from full to variable. However, a reduction in salinity from reduced to low, is considered likely to negatively affect the characterizing and associated species, based on evidence from Braber and Borghouts (1977), species distribution and the larval development evidence from (Barnes & Barnes, 1974). Biotope resistance is therefore assessed as 'Low' as some individuals may acclimate and survive but it is likely that the populations will decline. Resilience is assessed as 'Medium' and biotope sensitivity is assessed as 'Medium'.

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

This biotope occurs across a range of flow speeds, from strong (1.5- 3 m/s) to moderately strong (0.5-1.5 m/s) (Connor *et al.*, 2004). The suspension feeders within the biotope benefit from high water flows supplying food.

The characterizing anemone *Urticina felina* favours areas with strong tidal currents (Holme & Wilson, 1985; Migné & Davoult, 1998), although it is also found in calmer and sheltered areas as well as deep water. Records from the MNCR database were used as a proxy indicator of the resistance to water flow changes by this species by Tillin & Tyler-Walters (2014). The records indicate the water flow categories for biotopes characterized by *Urticina felina* range from very weak (negligible) to very strong (negligible to >3 m/s), suggesting that a change in water flow eat the pressure benchmark would not have negative effects (Tillin & Tyler-Walters, 2014). Similarly, *Spirobranchus triqueter* is found in biotopes that are exposed to flow speeds varying from very weak to moderately strong (negligible - >1.5m/s) and was considered 'Not sensitive' at the pressure benchmark (Tillin & Tyler-Walters, 2014).

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 rates (measured by the increase in basal area) of *Balanus crenatus*, (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).

The coralline crusts characterizing this biotope are securely attached and as these are flat they are subject to little or no drag compared to upright growth forms of algae. They are therefore unlikely to be removed by changes in flow at the pressure benchmark. Colonies of *Lithophyllum incrustans* appear to thrive in conditions exposed to strong water movement (Irvine & Chamberlain, 1994).

Scour is a key factor structuring this biotope (Connor *et al.*, 2004), changes in flow exceeding the pressure benchmark may increase or decrease sediment transport and associated scour may lead to indirect changes in the character of the biotope.

Sensitivity assessment. As the biotope and the associated species can occur in a range of flow speeds, resistance of the biotope to changes in water flow is assessed as 'High' and resilience as 'High' (by default) so that the biotope is assessed as 'Not sensitive'.

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

Changes in emergence are not relevant to this biotope (group) which is restricted to fully subtidal habitats. However, note that a 100% mortality could be expected in adult *Spirobranchus triqueter* after 24.1 h and 35.4 h when exposed to air at 7°C and 13 °C, respectively (Campbell & Kelly, 2002).

Wave exposure changes (local)	High	High	Not sensitive
	Q: High A: Low C: High	Q: High A: High C: High	Q: High A: Low C: High

This biotope is recorded from locations that are judged to range from extremely exposed, very exposed to extremely sheltered (Connor *et al.*, 2004). Areas with high water velocities provide food to suspension feeders within the biotope such as sponges and anemones and tidal streams rather than wave action is a key factor structuring this biotope.

Urticina felina, *Balanus crenatus* and *Spirobranchus triqueter* are firmly attached to the substratum and are unlikely to be dislodged by an increase in wave action at the pressure benchmark. These species are found in biotopes that experience a range of wave exposures, from extremely sheltered to very exposed, and were therefore considered 'Not sensitive' to this pressure (at the pressure benchmark), by a previous review (Tillin & Tyler-Walters, 2014). The crustose corallines associated with this biotope have a flat growth form and are unlikely to be dislodged by increased wave action.

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

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

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 levels of heavy metals in nature, they are found in Dulas Bay, Anglesey, for example, where copper reaches concentrations of 24.5 μg/l, due to acid mine drainage (Foster *et al.*, 1978).

No information was found concerning the effects of heavy metals on encrusting coralline algae. Bryan (1984) suggested that the general order for heavy metal toxicity in seaweeds is: organic Hg> inorganic Hg > Cu > Ag > Zn> Cd>Pb. Contamination at levels greater than the pressure benchmark may adversely impact the biotope. Cole *et al.* (1999) reported that Hg was very toxic to macrophytes. The sub-lethal effects of Hg (organic and inorganic) on the sporelings of intertidal red algae, *Plumaria elegans*, were reported by Boney (1971). 100% growth inhibition was caused by 1 ppm Hg.

Hydrocarbon & PAH contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

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

However contamination at levels that exceed the benchmark may lead to greater impacts. One month after the *Torrey Canyon* oil spill the dahlia anemone, *Urticina felina*, was found to be one of the most resistant animals on the shore, being commonly found alive in pools between the tide-marks which appeared to be devoid of all other animals (Smith, 1968). However, the species may be susceptible to smothering effects and, in the case of thick oil, mortality seems likely.

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.

Where exposed to direct contact with fresh hydrocarbons, encrusting coralline algae appear to have a high intolerance. Crump *et al.* (1999) described 'dramatic and extensive bleaching' of '*Lithothamnia*' following the *Sea Empress* oil spill. Observations following the *Don Marika* oil spill (K. Hiscock, pers. comm.) were of rockpools with completely bleached coralline algae. However, Chamberlain (1996) observed that although *Lithophyllum incrustans* was affected in a short period of time by oil during the *Sea Empress* spill, recovery occurred within about a year. The oil was found to have destroyed about one third of the thallus thickness but regeneration occurred from thallus filaments below the damaged area.

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

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

Very little information has been found on biotope sensitivity to contaminants that exceed the pressure benchmark. Hoare and 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.

Barnacles have a low resilience to chemicals such as dispersants, dependant on the concentration and type of chemical involved (Holt *et al.*, 1995). They are less intolerant than some species (e.g. *Patella vulgata*) to dispersants (Southward & Southward, 1978) and *Balanus crenatus* was the dominant species on pier pilings at a site subject to urban sewage pollution (Jakola & Gulliksen, 1987). Hoare and 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. Holt *et al.* (1995) concluded that barnacles are fairly sensitive to chemical pollution; therefore intolerance is reported as high. The species is an important early colonizer of sublittoral rock surfaces (Kitching, 1937) and it heavily recolonized a site that was dredged for gravel within 7 months (Kenny & Rees, 1994). Therefore, recovery is predicted to be high.

Cole *et al.* (1999) suggested that herbicides were (not surprisingly) very toxic to algae and macrophytes. Hoare and Hiscock (1974) noted that with the exception of *Phyllophora* species, all red algae including encrusting coralline forms were excluded from the vicinity of an acidified halogenated effluent discharge in Amlwch Bay, Anglesey. The intertidal populations of *Corallina officinalis* , however occurred in significant amounts only 600m east of the effluent. Chamberlain (1996) observed that although *Lithophyllum incrustans* was quickly affected by oil during the *Sea Empress* spill, recovery occurred within about a year. The oil was found to have destroyed about one third of the thallus thickness but regeneration occurred from thallus filaments below the damaged area.

Most pesticides and herbicides were suggested to be very toxic for invertebrates, especially crustaceans (amphipods isopods, mysids, shrimp and crabs) and fish (Cole *et al.*, 1999).

Radionuclide contamination	No evidence (NEv)	Not relevant (NR)	No evidence (NEv)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

No evidence.

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

This pressure is **Not assessed**.

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

Specific information concerning oxygen consumption and reduced oxygen tolerances were not found for the key characterizing species within the biotope. This pressure is not assessed due to

lack of evidence.

NB. *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).

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

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 increasing food supplies. *Balanus crenatus* was the dominant species on pier pilings, which were subject to urban pollution (Jakola & Gulliksen, 1987). Over geological timescales, periods of increased nutrient availability have experienced increases in the distribution of crustose coralline species at the expense of corals (Littler & Littler, 2013), suggesting that this group have some tolerance for enhanced nutrient levels. Overall, Littler and Littler (2013) suggested that corallines as a group can tolerate both low and elevated levels of nutrients. The encrusting coralline *Lithophyllum incrustans* were present at sites dominated by *Ulva* spp. in the Mediterranean exposed to high levels of nutrient enrichment from domestic sewage (Arévalo *et al.*, 2007).

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' at the benchmark level.

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

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, characterizing animal species; *Urticina felina; Balanus crenatus and Spirobranchus triqueter* were assigned to AMBI Group II 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). The crusting coralline *Lithophyllum incrustans* were present at sites dominated by *Ulva* spp. in the Mediterranean exposed to high levels of organic pollution from domestic sewage (Arévalo *et al.*, 2007).

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. Based on the AMBI categorisation (Borja *et al.*, 2000;Gittenberger & Van Loon, 2011), this ecological group is assessed as 'Not Sensitive' to this pressure based on 'High' resistance and 'High' resilience as there is no impact to recover from. 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.

	Resistance	Resilience	Sensitivity
Physical change (to another seabed type)	Low Q: High A: High C: High	Very Low Q: High A: Low C: High	High Q: High A: Low C: High

This biotope is characterized by the hard rock substratum to which the characterizing and associated species can firmly attach. Changes to a sedimentary habitat or an artificial substratum would significantly alter the character of the biotope through the loss of habitat.

Tillin & Tyler-Walters (2014) used records from the MNCR database as a proxy indicator of the resistance to physical change by *Urticina felina*, *Balanus crenatus* and *Spirobranchus triqueter*. These species were reported from a variety of substratum types including fine (muddy sand, sandy mud and fine sands) and coarse sediments, where some hard surfaces (such as pebbles or shells) are present for the attached species. The characterizing sponge *Ciocalypta penicillus*, is a scour tolerant species typically found with its base buried in sand and gravel and the finger like growths projecting above. Fine muds are not a suitable habitat for this species and siltation may lead to smothering and clogging (with degree of impact likely to depend on the exposure duration).

The characterizing and associated species have also been observed as fouling organisms on artificial structures, for example *Urticina felina*, *Balanus crenatus*, *Cellepora pumicosa*, were observed on the submerged ex-*HMS Scyll*a (Hiscock et al., 2010). *Alcyonidium diaphanum* has, however, only been observed once on ex-*HMS Scylla*, despite being common on wrecks and reefs in the area (Hiscock et al., 2010) and *Cliona celata* had not colonized the wreck (Hiscock *et al.*, 2010). *Ciocalypta penicillus* was present on nearby bedrock but had not colonized ex-*HMS Scylla* by March, 2009 (Hiscock *et al.*, 2010). Evidence for substratum preferences for this characterizing species is limited.

Balanus crenatus and *Spirobranchus triqueter* are fouling organisms and occur on a wide variety of substrata (Harms & Anger, 1983; Andersson *et al.*, 2009). As well as artificial and natural hard substrata *Balanus crenatus* and *Spirobranchus triqueter* also encrust a range of invertebrates; for example, *Spirobranchus triqueter* has been recorded on the hermit crab, *Pagurus bernhardus* (Fernandez-Leborans & Gabilondo, 2006) among other species. Similarly, *Balanus crenatus* has been reported to encrust empty shells of the invasive non-indigenous species *Ensis americanus* (Donovan, 2011) and *Carcinus maenas* (Heath, 1976).

Sensitivity assessment. It should be noted that the basis of the sensitivity assessment for this pressure is the sensitivity of the biotope to changes in substratum type, rather than the sensitivity of the species. A permanent change in substratum type to artificial or sedimentary would lead to re-classification of the biotope. Biotope resistance to this pressure is therefore assessed as 'None' (loss of >75% of extent), as the change at the benchmark is permanent, resilience is assessed as

'very Low'. Sensitivity, based on combined resistance and resilience is therefore assessed as 'High'.

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

Not relevant to biotopes occurring on bedrock.

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

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

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

The species characterizing this biotope occur on the rock and therefore have no protection from surface abrasion. High levels of abrasion from scouring by mobile sands and gravels is an important structuring factor in this biotope (Connor *et al*., 2004) and prevents replacement by less scour-tolerant species, such as red algae .

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).

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 *Pomatocero*s) *triqueter*. Off Chesil Bank, the epifaunal community dominated by *Spirobranchus* (as *Pomatoceros triqueter*, *Balanus crenatus* decreased in cover in October as it was scoured away in winter storms, but recolonised 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 & Ballerstedt, 2005). Re-sampling of grounds that were historically studied (from the 1930s) indicated that some encrusting species including serpulid worms and 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. This observation is supported by experimental trawling, carried out in shallow, wave

disturbed areas using a toothed, clam dredge, which found that *Spirobranchus* spp. decreased in intensively dredged areas over the monitoring period (Constantino *et al.*, 2009). In contrast, a study of *Spirobranchus* spp. aggregations found that the tube heads formed were not significantly affected by biannual beam trawling in the eastern Irish Sea (Kaiser *et al.*, 1999). No changes in the number or size of serpulid tube heads was apparent throughout the course of the study, and no significant changes were detectable in the composition of the tube head fauna that could be attributed to fishing disturbance (Kaiser *et al.*, 1999). Subsequent laboratory experiments on collected tube heads found that these were unlikely to resettle on the seabed in an orientation similar to that prior to disturbance (Kaiser *et al.*, 1999). This may lead to the death of the resident serpulids and sessile associated fauna.

Mechanical abrasion from scuba divers was reported to impact encrusting corallines, with cover of *Lithophyllum stictaeforme* greater in areas where diving was forbidden than visited areas (abundance, 6.36 vs 1.4; it is presumed this refers to proportion of cover, although this is not clear from the text, Guarinieri *et al.*, 2012). Dethier (1994) experimentally manipulated surface abrasion on a range of encrusting algae including *Lithophyllum impressum.* Crusts were brushed with either a nylon or steel brush for 1 minute a month for 24 months. Unbrushed controls grew by approximately 50% where the cover of nylon brushed crusts and steel brushed crusts decreased by approximately 25% and 40% respectively (interpreted from figures in Dethier, 1994). In laboratory tests on chips of *Lithophyllum impressum* brushing with a steel brush for 1 minute once a week for 3 weeks, resulted in no cover loss of two samples while a third 'thinned and declined' (Dethier, 1994).

Sensitivity assessment. The impact of surface abrasion will depend on the footprint, duration and magnitude of the pressure. High levels of abrasion from scouring by mobile sands and gravels is an important structuring factor in this biotope (Connor *et al.*, 2004), however, increased abrasion could lead to loss of more sensitive species, so that only the most tolerant species (*Spirobranchus triqueter* and *Balanus crenatus*) could survive. This could result in biotope reclassification to the more scoured IR.FIR.SG.CC.BalPom. Evidence for the effects of severe scour and trawling on *Balanus crenatus and Spirobranchus triqueter*, suggest that resistance, to a single abrasion event is 'Low' and recovery is 'High', so that sensitivity is assessed as 'Low'. Other species within the biotope are considered to be more sensitive (based on lower recovery rates). Based on epifaunal position, erect growth form and relatively soft, unprotected body, resistance of the characterizing *Urticina felina* and *Ciocalypta penicillus*, and associated species that share these traits such as *Alcyonidium diaphanum*, is assessed as 'Low' , resilience is assessed as 'Medium' and therefore biotope sensitivity (based on these species) is assessed as 'Medium'.

Penetration or disturbance of the substratum subsurface	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

The species characterizing this biotope group are epifauna occurring on rock which is resistant to subsurface penetration. Therefore, 'penetration' is **'Not relevant'**. The assessment for abrasion at the surface only is, therefore, considered to equally represent sensitivity to this pressure'. Please refer to 'abrasion' above.

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 scoured 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. A significant increase in suspended solids may result in smothering (see siltation pressures) where these are deposited. 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 *Urticina felina*, *Balanus crenatus* and *Spirobranchus triqueter* are recorded from the lower eulittoral or the lower circalittoral. The biotope occurs in shallow waters where light attenuation due to increases in turbidity is probably low and the characterizing and associated animals are unlikely to be affected by increased or decreased clarity. Red algae and encrusting coralline algae especially, are known to be shade tolerant and are common components of the understorey on seaweed dominated shores. Therefore, an increase or decrease in light intensity is unlikely to adversely affect the crustose corallines as plants can acclimate to different light levels.

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. The characterizing sponge *Ciocalypta penicillus*, is a scour tolerant species typically found with its base buried in sand and gravel and the finger like growths projecting above. Fine muds are not a suitable habitat for this species and siltation may lead to smothering and clogging (with degree of impact likely to depend on the exposure duration).

Available evidence indicates that *Spirobranchus triqueter* is tolerant of a wide range of suspended sediment concentrations (Riley and Ballerstedt, 2005). Stubbings and Houghton (1964) recorded *Spirobranchus* (as *Pomatoceros*) *triqueter* in Chichester harbour, which is a muddy environment. However, *Spirobranchus* (as *Pomatoceros*) *triqueter* has been noted to occur in areas where there is little or no silt present (Price *et al.*, 1980). Barnes and Bagenal (1951) found that 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 is problematic, however (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.

A prolonged increase or reduction in suspended solids that resulted in changes in scour may result in a change in species composition (see abrasion pressure). However, where the levels of scour that structure the biotope are unaffected it is judged that these changes would not be significant.

Sensitivity assessment. Overall biotope resistance is assessed as 'High' to an increase in suspended solids. Resilience is categorised as 'High' (by default) as adults are likely to remain *in situ* from which recruitment can occur. 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	High	Not sensitive
	Q: High A: High C: High	Q: High A: High C: High	Q: High A: High C: High

This biotope is described as sand covered or sand scoured (Connor *et al.*, 2004). The characterizing and associated species are therefore likely to tolerate intermittent episodes of sediment deposition. Communities dominated by the anemone *Urticina felina* were described on tide swept seabed, exposed to high levels of suspended sediment, sediment scour and to periodic smothering by thin layers of sand, up to ca 5 cm in the central English Channel (Home & 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.

The characterizing sponge *Ciocalypta penicillus*, is a scour tolerant species typically found with its base buried in sand and gravel and the finger like growths projecting above. Fine muds are not a suitable habitat for this species and sedimentation may lead to smothering and clogging (with degree of impact likely to depend on the exposure duration).

As small, sessile species attached to the substratum, siltation at the pressure benchmark would bury *Balanus crenatus* and *Spirobranchus triqueter*. 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 & 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 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 from sediment dumping was problematic (Witt *et al.*, 2004).

In a review of the effects of sedimentation on rocky coast assemblages, Airoldi (2003) outlined the evidence for the sensitivity of encrusting coralline algae to sedimentation. The reported results are

contradictory with some authors suggesting that coralline algae are negatively affected by sediments while others report that encrusting corallines are often abundant or even dominant in a variety of sediment impacted habitats (Airoldi, 2003 and references therein). Crustose corallines have been reported to survive under a turf of filamentous algae and sediment for 58 days (the duration of experiment) in the Galapagos (species not identified, Kendrick, 1991). The crustose coralline *Hydrolithon reinboldii*, has also been reported to survive deposition of silty sediments on subtidal reefs off Hawaii (Littler, 1973). In an experimental study, Balata *et al.* (2007) enhanced sedimentation on experimental plots in the Mediterranean (close to Tuscany) by adding 400 g of fine sediment every 45 days on plots of 400 cm^2 for 1 year. Nearby sites with higher and lower levels of sedimentation were assessed as control plots. Some clear trends were observed. Crustose corallines declined at medium and high levels of sedimentation (Balata *et al.*, 2007). The experiment relates to chronic low levels of sedimentation rather than a single acute event, as in the pressure benchmark, however the trends observed are considered to have some relevance to the pressure assessment.

Sensitivity assessment. Based on biotope exposure to high levels of water flow which will remobilise sediments and remove these, and the presence of *Urticina felina* and other characterizing and associated species in biotopes subject to sedimentation and scour (including the assessed biotope), 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 and encrusting corallines 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.This biotope is described as sand covered or sand scoured (Connor *et al.*, 2004). The characterizing and associated species are therefore likely to tolerate intermittent episodes of sediment deposition

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

This biotope is described as sand covered or sand scoured (Connor *et al.*, 2004). The characterizing and associated species are therefore likely to tolerate intermittent episodes of sediment deposition. The available evidence for siltation pressures is outlined for the 'light' deposition pressure. At the pressure benchmark 'heavy deposition' represents a considerable thickness of deposit. Complete burial of characterizing and associated species would occur. Removal of the sediments by wave action and tidal currents would result in considerable scour. The effect of this pressure will be mediated by the length of exposure to the deposit and the nature of the deposit.

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.

The characterizing sponge *Ciocalypta penicillus*, is a scour tolerant species typically found with its

base buried in sand and gravel and the finger like growths projecting above. Fine muds are not a suitable habitat for this species and sedimentation may lead to smothering and clogging (with degree of impact likely to depend on the exposure duration).

As small, sessile species attached to the substratum, siltation at the pressure benchmark would bury *Balanus crenatus* and *Spirobranchus triqueter*. 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 & 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 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 from sediment dumping was problematic (Witt *et al.*, 2004).

In a review of the effects of sedimentation on rocky coast assemblages, Airoldi (2003) outlined the evidence for the sensitivity of encrusting coralline algae to sedimentation. The reported results are contradictory with some authors suggesting that coralline algae are negatively affected by sediments while others report that encrusting corallines are often abundant or even dominant in a variety of sediment impacted habitats (Airoldi, 2003 and references therein). Crustose corallines have been reported to survive under a turf of filamentous algae and sediment for 58 days (the duration of experiment) in the Galapagos (species not identified, Kendrick, 1991). The crustose coralline *Hydrolithon reinboldii*, has also been reported to survive deposition of silty sediments on subtidal reefs off Hawaii (Littler, 1973). In an experimental study, Balata *et al.* (2007) enhanced sedimentation on experimental plots in the Mediterranean (close to Tuscany) by adding 400 g of fine sediment every 45 days on plots of 400 cm^2 for 1 year. Nearby sites with higher and lower levels of sedimentation were assessed as control plots. Some clear trends were observed. Crustose corallines declined at medium and high levels of sedimentation (Balata *et al.*, 2007). The experiment relates to chronic low levels of sedimentation rather than a single acute event, as in the pressure benchmark, however the trends observed are considered to have some relevance to the pressure assessment.

 Sensitivity assessment. Resistance is assessed as 'Medium' as the biotope is exposed to frequent abrasion and possibly smothering from mobile sediments (the impact may be mitigated by rapid removal of the deposit) but some removal and mortalities may occur. Resilience is assessed as 'High' based on repair of damaged individuals (*Urticina felina, Ciocalyptus penicillus*), re-growth from the scour-tolerant, surviving bases of the encrusting corallines and fragments of sponges and larval recolonization (*Balanus crenatus* and *Spirobranchus triqueter)*. Biotope sensitivity is therefore assessed as 'Low'.

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

Not assessed.

Electromagnetic changes	No evidence (NEv)	Not relevant (NR)	No evidence (NEv)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

No evidence.

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

Not relevant.

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

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. Similarly, *Spirobranchus triqueter* is found in a variety of light environments from shallow sublittoral biotopes where light levels are relatively high, to deeper sites that are aphotic (de Kluijver, 1993).

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).

Encrusting corallines can occur in deeper water than other algae where light penetration is limited. Samples of *Lithophyllum impressum* suspended from a raft and shaded (50-75% light reduction) continued to grow over two years (Dethier, 1994). Similarly, *Plocamium cartilagineum* grows in shaded conditions beneath laminarian canopies: where irradiance is greater, growth is lower and it appears that light levels of 0.5 mmol/m^2/s are inhibitory (Kain, 1987). In areas of higher light levels, the fronds and bases may be lighter in colour due to bleaching (Colhart & Johansen, 1973). Other red algae in the biotope are flexible with regard to light levels and can also acclimate to different light levels.

Sensitivity assessment. As the key characterizing species and associated species colonize a broad range of light environments, from intertidal to deeper sub tidal and shaded understorey habitats, the biotope is considered to have 'High' resistance and, by default, 'High' resilience and therefore is 'Not sensitive' to this pressure.

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

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. Barriers and changes in tidal excursion are

not considered relevant to *Urticina felina* and the characterizing crusting
corallines as species dispersal is limited by brooding or the rapid rate of settlement and vegetative growth from bases rather than reliance 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)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: 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)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

Not relevant.

NB. *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). Therefore in the area where light availability is lower, the more sensitive area can detect shading from predator movements (Forbes *et al*., 1971).

🐛 Biological Pressures

	Resistance	Resilience	Sensitivity
Genetic modification & translocation of indigenous species	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

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

The high levels of scour in this biotope will limit the establishment of all but the most scour resistant invasive non-indigenous species (INIS) from this biotope and no direct evidence was found for effects of INIS on this biotope.

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 *Austrominus modestus* recruit at different times of the year in some sites and this alters seasonal dominance

patterns (Witte *et al.*, 2010). Free-living aggregations (Balanuliths) of *Balanus crenatus* have been observed growing on shell fragments of the INIS, *Ensis directus* (Cadee, 2007).

Sensitivity assessment. As sand scouring of this biotope limits establishment of all but robust species, resistance to INIS is assessed as 'High' and resilience as 'High' (by default) so that the biotope is considered to be 'Not sensitive'.

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

No evidence was found that microbial pathogens cause high levels of disease or mortality in this biotope. Diseased encrusting corallines were first observed in the tropics in the early 1990's when the bacterial pathogen Coralline Lethal Orange Disease (CLOD) was discovered (Littler & Littler, 1995). All species of articulated and crustose species tested to date are easily infected by CLOD and it has been increasing in occurrence at sites where first observed and spreading through the tropics. Another bacterial pathogen causing a similar CLOD disease has been observed with a greater distribution and a black fungal pathogen first discovered in American Samoa has been dispersing (Littler & Littler, 1998). An unknown pathogen has also been reported to lead to white 'target-shaped' marks on corallines, again in the tropic (Littler *et al.*, 2007). No evidence was found that these are impacting temperate coralline habitats.

Sensitivity assessment. Based on the lack of reported mortalities of the characterizing and associated species and the available evidence for the characterizing coralline crust, 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)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: 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 was described in the literature, this pressure is therefore considered to be 'Not relevant'.

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

Incidental removal of the key characterizing species and associated 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 species would also be lost.

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 'Medium' so that biotope sensitivity is assessed as 'Medium'.

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Urticina felina and sand-tolerant fauna on sand-scoured or covered circalittoral rock - Marine Life Information Network

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