Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock

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

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Faunal and algal crusts, *Echinus esculentus*, sparse *Alcyonium digitatum*, *Abietinaria abietina* and other grazing-tolerant fauna on moderately exposed circalittoral rock.
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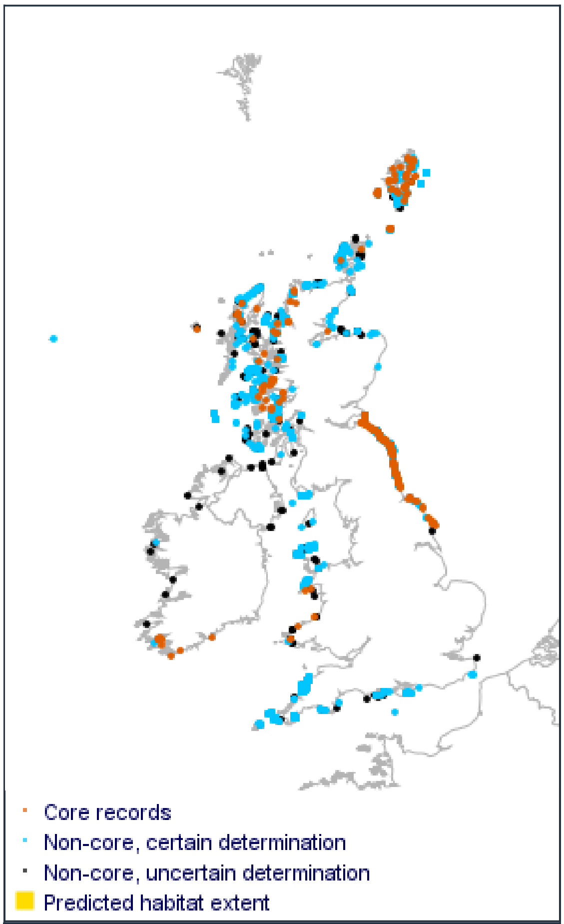

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by Thomas Stamp and Dr Harvey Tyler-Walters **Refereed by** This information is not refereed.

Summary

UK and Ireland classification

EUNIS 2008	A4.214	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
JNCC 2015	CR.MCR.EcCr.FaAlCr	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
JNCC 2004	CR.MCR.EcCr.FaAlCr	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
1997 Biotope	CR.MCR.GzFa.FaAlC	Faunal and algal crusts, *Echinus esculentus*, sparse *Alcyonium digitatum* and grazing-tolerant fauna on moderately exposed circalittoral rock

Description

This biotope typically occurs on the vertical and upper faces of wave-exposed and moderately wave-exposed circalittoral bedrock or boulders subject to mostly moderate to weak tidal streams (a variant of this biotope containing brittlestar is found on bedrock, boulders and cobbles). The biotope is dominated by faunal (e.g. *Parasmittina trispinosa*) and algal (Corallinaceae) crusts, and tends to have a grazed appearance; this may be partially attributable to the abundance of *Echinus esculentus* found in this biotope. Occasionally, the rock may appear pink from a distance, due to the expanses of encrusting red algae on the rock surface. *Alcyonium digitatum* is one of the few species to stand erect from the encrusted rock surface and are frequently encountered, on the tops of rocky outcrops and boulders. Hydroids do not form a prominent feature of this biotope, with only robust species such as *Abietinaria abietina* frequently recorded. Sponges and *Caryophyllia smithii* are rarely present while erect bryozoans and ascidians are scarce (although there are exceptions, see variants). The *Echinus esculentus* grazed substratum may be interspersed with other encrusting species such as the polychaete *Spirobranchus triqueter* and the saddle oyster *Pododesmus patelliformis*. Other species present include *Asterias rubens*, *Ophiothrix fragilis*, *Urticina felina*, *Ophiocomina nigra*, *Pagurus bernhardus*, *Flustra foliacea*, *Gibbula cineraria*, *Calliostoma zizyphinum*, *Ophiura albida*, *Ciona intestinalis* and *Antedon bifida*. Six sub-biotopes have been recorded. FaAlCr.Flu is dominated by the silt and scour tolerant bryozoan *Flustra foliacea*. FaAlCr.Adig is dominated by A. digitatum. FaAlCr.Sec is dominated by *Securiflustra securifrons*. FaAlCr.Spi looks extremely impoverished (even for a grazed community). FaAlCr.Bri has a dense covering of brittlestars while FaAlCr.Car is only found under weak/very weak tides and is dominated by *Caryophyllia smithii*. (Information from Connor *et al.*, 2004).

Depth range

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Additional information

The following sensitivity review focuses of sub-biotopes CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi and CR.MCR.EcCr.FaAlCr.Sec. CR.MCR.EcCr.FaAlCr.Car and CR.MCR.EcCr.FaAlCr.Bri are addressed in separate reviews.

Listed By

- none -

Further information sources

Search on:

Habitat review

Ecology

Ecological and functional relationships

This biotope is dominated by species able to tolerate intense sea-urchin grazing, such as red coralline encrusting algae or rapid growing species which colonize space and grow quickly before they are removed by grazers or predators. The fauna is relatively sparse in comparison to other faunal turf communities (see CR.Bug and MCR.Flu), but the epifauna is more developed on vertical surfaces, under overhangs or boulders, in crevices inaccessible to grazing sea urchins and in temporary escapes or predation refuges. Most of the epifauna are 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. Little is known of ecological relationships in circalittoral faunal turf habitats (Hartnoll, 1998) and the following has been inferred from studies of other epifaunal communities (Sebens, 1985; 1986).

- Large brown laminarians may be found on the tops of bedrock ridges in the photic zone, giving way to foliose and filamentous red and brown algae (e.g. the red algae *Delesseria sanguinea*, *Cryptopleua ramosa*, *Lomentaria* spp. and *Plocamium cartilagineum*, and the brown algae *Dictyota dichotoma*). But large foliose algae are relatively uncommon within the biotope. The dominant macroalgae are grazing tolerant encrusting corallines (e.g. *Lithothamnion* spp. and *Phymatolithon* spp.) or non-coralline encrusting algae, which may cover large areas of the rock surface giving it a pink appearance (Sebens, 1985; Hartnoll, 1998; JNCC, 1999).
- Active suspension feeders on bacteria, phytoplankton and organic particulates and detritus include sponges (e.g. *Pachymastia johnstonia*, and *Halichondria panicea*), the soft coral *Alcyonium digitatum*, encrusting bryozoans (e.g. *Parasmittia trispinosa*, *Bicellaria ciliata* and *Crisia eburnea*), occasional erect bryozoans (e.g. *Bugula* species and *Flustra foliacea*), barnacles (e.g. *Balanus crenatus*), porcelain crabs (e.g. *Pisidia longicornis*), and sea squirts (e.g. *Ascidia* spp., *Ascidiella* spp., *Clavelina lepadiformis*, *Ciona intestinalis*, and *Botrylloides leachi*). However, the water currents they generate are probably localized so that they are still dependant on water flow to supply adequate food.
- Passive suspension feeders on organic particulates, plankton and other small animals include, hydroids (e.g. *Abietinaria abietina*, *Halecium halecium*, *Kirchenpaueria pinnata* and *Nemertesia antennina*), soft corals (e.g. *Alcyonium digitatum*), feather stars (e.g. *Antedon bifida*) and brittlestars (e.g. *Ophiothrix fragilis*).
- Larger prey are taken by passive carnivores such as anemones and cup corals (e.g. *Caryophyllia smithii* and *Urticina felina*) (Hartnoll, 1998).
- Sea urchins (e.g. *Echinus esculentus*) are generalist grazers, removing young algae, barnacles, ascidians, hydroids and bryozoans and potentially all epifauna, leaving only encrusting corallines and bedrock. Sea urchins were shown to have an important structuring effect on algal and epifaunal communities and succession (Jones & Kain, 1967; Sebens, 1985; 1986; Hartnoll, 1998) and are no doubt important in this biotope (see seasonal/temporal change below).
- Other grazers include top shells (e.g. *Steromphala cineraria*), small crustaceans (e.g. amphipods) and *Calliostoma zizyphinum*, which grazes hydroids, while chitons (e.g. *Tonicella marmorea*) and the tortoise-shell limpet *Tectura testudinalis* graze encrusting coralline algae.

- Specialist predators of hydroids and bryozoans include the nudibranchs (e.g. *Doto* spp., and *Onchidoris* spp.) and pycnogonids, (e.g. *Nymphon brevirostre*), while the nudibranch *Tritonia hombergi* preys on *Alcyonium digitatum*, and some polychaetes also take hydroids.
- Starfish (e.g. *Asterias rubens* and *Crossaster papposus*, *Solaster endeca*), crabs and lobster are generalist predators feeding on most epifauna, including ascidians and sea urchins
- Scavengers include polychaetes, small crustaceans such as amphipods, starfish, brittlestars, and decapods such as hermit crabs (e.g. *Pagurus bernhardus*) and crabs (e.g. *Cancer pagurus* and *Necora puber*).
- Mobile fish predators include gobies (e.g. *Pomatoschistus* spp.), wrasse (e.g. *Ctenolabrus rupestris* and *Labrus bergylta*) and butterfish *Pholis gunnellus* 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. 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. In reduced or absent grazing, the epifauna of vertical rock walls became dominated by large massive species, depending on the degree of predation, especially by sea urchins. Sebens (1986) noted that *Lithothamnion* out-competed *Phymatolithon* for space, often overgrowing the thinner *Phymatolithon*. But the thicker, raised and often knobbly *Lithothamnion* suffered more from sea urchin grazing, so that a competitive equilibrium existed between the two encrusting coralline species in heavily grazed communities (Sebens, 1986).

Seasonal and longer term change

Seasonal change
Many of the species within the community demonstrate seasonal changes in abundance and reproduction. Many species of algae show marked seasonal variation in growth with a peak in summer (see Hiscock, 1986c), although in this biotope additional growth merely provides more food for sea urchins. In temperate waters, most bryozoan 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). Several species of bryozoans and hydroids demonstrate seasonal cycles of growth in spring/summer and regression (die back) in late autumn/winter, overwintering as dormant stages or juvenile stages (see Ryland, 1976; Gili & Hughes, 1995; Hayward & Ryland, 1998). For example, the fronds of *Bugula* species are ephemeral, surviving about 3-4 months but producing two frond generations in summer before dying back in winter, although, the holdfasts are probably perennial (Eggleston, 1972a; Dyrynda & Ryland, 1982). Similarly, *Bicellaria ciliata* produces 2 generation per year, larvae from the second generation producing small overwintering colonies (Eggleston, 1972a; Hayward & Ryland, 1998). The uprights of hydroid *Nemertesia antennina* die back after 4-5 months and exhibit three generations per year (spring, summer and winter) (see reviews; Hughes, 1977; Hayward & Ryland, 1998; Hartnoll, 1998). Many of the bryozoans and hydroid species are opportunists (e.g. *Bugulina flabellata*) adapted to rapid growth and reproduction (*r*-selected), taking advantage of the spring/summer phytoplankton bloom and more favourable (less stormy) conditions (Dyrynda & Ryland, 1982; Gili & Hughes, 1995). Some species such as the ascidians *Ciona intestinalis* and *Clavelina lepadiformis* are effectively annual (Hartnoll, 1998). Therefore, the biotope is likely to demonstrate seasonal changes in the abundance or cover of the dominant bryozoans and hydroids. Winter spawning species such as *Alcyonium digitatum* may take advantage of the available space

for colonization. Seasonal storms probably affect the community removing the uprights of hydroids, erect bryozoans, some ascidians, starfish, sea urchins and mobile epifaunal species, especially where the biotope occurs on boulders or stones that may be mobilized by extreme water movement.

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*. Sea urchins (e.g. *Echinus esculentus* in Britain and Ireland) most likely have a significant effect on community structure and succession and their grazing trails can often be seen through bryozoan turfs, leaving bare rock or encrusting corallines behind (Keith Hiscock pers comm.). Sebens (1985, 1986) noted that 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). Similarly, removal of sea urchins from a 10m wide strip of the Port Erin breakwater allowed macroalgae sporelings, including the kelp *Laminaria hyperborea*, to colonize the experimental area within a year and only survived within the experimental area (Jones & Kain, 1967). This biotope probably represents an early successional community dominated by encrusting red algae and rapidly colonizing hydroids and tubeworms due to intense grazing pressure. Sebens (1985) noted abrupt changes in the invertebrate communities between horizontal rock faces (as dominate in this biotope) and vertical surfaces and overhangs, which sea urchins find more difficult to traverse. Vertical surfaces and overhangs, and under boulders, exhibited a more developed epifaunal community (Sebens, 1985).

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; Lundälv, 1985; Hartnoll, 1998). Many of the faunal turf species are long-lived, e.g. 6 -12 years in *Flustra foliacea*, 5-8 years in *Ascidia mentula*, over 20 years in *Alcyonium digitatum*, 8-16 years in *Echinus esculentus* and probably many hydroids (Stebbing, 1971a; Gili & Hughes, 1995; Hartnoll, 1998). However, *Bugula* dominated communities recorded from the west Anglesey in 1996 were reported to be 'silted and ragged' in the same season the following year, suggesting some inter-annual variation may occur (Brazier *et al.*, 1999). Lundälv (1985) reported long-term stability in presence but short-term variation in population density of *Ascidia mentula*, *Ciona intestinalis*, *Boltenia echinata* and *Protanthea simplex* on rocky sublittoral communities over a 12 year period in the Skagerrak. It was suggested that variations in population density were due to physical disturbance of the communities by storms or grazing by sea urchins, variation decreasing with depth. Sebens (1996) also demonstrated that while epifaunal communities were dominated by the same set of species over a period of years the relative frequency of the different species varied. For example, the sea squirt *Aplidium* spp. showed a two year cycle of decline and re-growth, consistent with recovery after removal by sea urchin grazing. Therefore, the relative abundance of the epifaunal components of the community are likely to vary with the abundance and long-term changes in sea urchin abundance and grazing pressure.

Habitat structure and complexity

This is a rock biotope in which the main habitat complexity is provided by crevices, fissures and overhangs rather than epibiota. Fluctuations in sea urchin grazing will allow rapid colonizing species to develop epifaunal turfs, with occasional escapes of slow colonizing or slow growing species such as sponges and soft corals (e.g. *Alcyonium digitatum*), providing some epifaunal complexity in an otherwise sparse community. Well developed epifaunal communities may occur in grazing refuges such as crevices or under hangs.

- The bedrock is dominated by a layer of encrusting corallines, with encrusting bryozoans, and sometimes barnacles e.g. *Balanus crenatus*
- Where present, encrusting epifauna may be overgrown by erect bryozoans and hydroids (e.g. *Bugula* species and *Nemertesia antennina*) interspersed with encrusting sponges, ascidians (e.g. *Ascidia* spp.) and *Alcyonium digitatum*.
- Rock with patches of muddy shell gravel and sand may support *Urticina felina* (Connor *et al.*, 1997a).
- The faunal crust and sparse turf provides interstices and refuges for a variety of small organisms such as nemerteans, polychaetes, gastropods, and amphipods, while the erect species provide substrata for caprellid amphipods.
- Where present, underboulders and crevices may support the sea cucumber *Pawsonia saxicola*, squat lobsters (e.g. *Galathea* spp. and *Munida rugosa*), encrusting sponges, terebellids, the jingle shell *Pododesmus patelliformis* (Connor *et al.*, 1997a).
- Fissures and crevices provide shelter for mobile species including decapods crustaceans such as shrimp, crabs and lobsters, sea urchins, starfish and fish. Gobies, wrasse and butterfish probably utilize available rock ledges and crevices, while large species such as flounder and cod probably feed over a wide area, albeit in low numbers.

The biotope may show spatial variation in community complexity and exhibit a mosaic of different species patches (Hartnoll, 1998). For example, with areas recently cleared by predation, disease or physical disturbance in the process of re-colonization, together with areas dominated by *Bugula* species, sponges, or ascidians, or areas at intermediate stages of succession. The upper edges or boulders or rocky outcrops, most directly in water flow, tend to exhibit the most species rich and abundant faunal turfs with for example hydroids and perhaps feather stars (e.g. *Antedon bifida*). Where sediment scour and abrasion occur (e.g. the sediment/ rock interface), only a small range of species, such as the sponges *Polymastia* spp. or the anemone *Urticina felina* are able to survive (Stebbing, 1971b, Eggleston, 1972b; Sebens, 1985, 1986; Connor *et al.*, 1997a; Hartnoll, 1998; Brazier *et al.*, 1999).

Productivity

Any macroalgae (in shallower examples of this biotope) and encrusting coralline algae provide primary production that enters the food chain indirectly in the form of detritus, algal spores and abraded algal particulates, or directly as food for grazing gastropods, chitons, sea urchins or fish. However, circalittoral faunal turf biotopes are dominated by 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. starfish, sea urchins, and 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 in the literature.

Recruitment processes

Most of the species within this biotope produce short-lived, larvae with relatively poor dispersal capacity, resulting in good local recruitment but poor long range dispersal. 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:

- Hydroids are often the first organisms to colonize available space in settlement experiments (Gili & Hughes, 1995). For example, the hydroids *Kirchenpaueria pinnata* and *Abietinaria abietina* lack a medusa stage, releasing planula larvae (Cornelius, 1995b). Planula larvae swim or crawl for short periods (e.g. <24hrs) so that dispersal away from the parent colony is probably very limited (Sommer, 1992; Gili & Hughes, 1995). But *Nemertesia antennina* releases planulae on mucus threads, that increase potential dispersal to 5 -50m, depending on currents and turbulence (Hughes, 1977). Few species of hydroids have specific substrata requirements and many are generalists capable of growing on a variety of substrata. 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. However, it has been suggested that rafting on floating debris (or hitch hiking on ships hulls or in ship ballast water) as dormant stages or reproductive adults, together with their potentially long lifespan, may have allowed hydroids to disperse over a wide area in the long-term and explain the near cosmopolitan distributions of many hydroid species (Cornelius, 1992; Gili & Hughes, 1995).
- The brooded, lecithotrophic coronate larvae of many bryozoans (e.g. *Flustra foliacea*, and *Bugula* species), have a short pelagic lifetime of several hours to about 12 hours (Ryland, 1976). Recruitment is dependant on the supply of suitable, stable, hard substrata (Eggleston, 1972b; Ryland, 1976; Dyrynda, 1994). However, even in the presence of available substratum Ryland (1976) noted that significant recruitment in bryozoans only occurred in the proximity of breeding colonies. For example, Hatcher (1998) reported colonization of slabs, suspended 1 m above the sediment, by *Bugula fulva* within 363 days while Castric-Fey (1974) noted that *Bugulina turbinata*, *Crisularia plumosa* and *Bugula calathus* did not recruit to settlement plates after ca two years in the subtidal even though present on the surrounding bedrock. Similarly, Keough & Chernoff (1987) noted that *Bugula neritina* was absent from areas of seagrass bed in Florida even though substantial populations were present <100m away.
- Echinoderms are highly fecund, producing long lived planktonic larvae with high dispersal potential. However, recruitment in echinoderms is poorly understood, often sporadic and variable between locations and dependant on environmental conditions such as temperature, water quality and food availability. For example, in *Echinus esculentus* recruitment was sporadic and 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. However, echinoderms such as *Echinus esculentus*, and *Asterias rubens* are mobile and widespread and are likely to recruit be migration from other areas.
- 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, depending on species. Most sponges are hermaphroditic but cross-fertilization normally occurs. The process may be oviparous, where there is a mass spawning of gametes through the osculum which enter a neighbouring individual in the inhalant current. Fertilized eggs are discharged into the sea where they develop into a planula larva. However, in the majority 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.
- Anthozoans, such as *Alcyonium digitatum* and *Caryophyllia smithii* 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 within 2-5 years (refer to the Key Information reviews; Sebens, 1985; Jensen *et al*., 1994). Juvenile anthozoans are susceptible to predation by sea urchins or overgrowth by ascidians (Sebens, 1985; 1986).
- Ascidians such as *Molgula manhattensis*, *Ciona intestinalis* and *Clavelina lepadiformis* have external fertilization but short lived larvae (swimming for only a few hours), so that dispersal is probably limited (see *MarLIN* reviews). Where neighbouring populations are present recruitment may be rapid but recruitment from distant populations may take a long time.
- 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.

Recruitment is partly dependant on the availability of free space, provided by grazing, predation, physical disturbance or seasonal die back on some species. The presence of erect species may interfere with recruitment of others, e.g. the dense stands of the hydroid *Obelia longissima* inhibited settlement by *Balanus crenatus* cyprid larvae but encouraged settlement by ascidian larvae (Standing, 1976). In addition, filter feeding hydroids and anthozoans probably take the larvae of many organisms. Once settled the slow growing species may be overgrown or devoured by predator/grazers, e.g. juvenile *Alcyonium digitatum* are highly susceptible to being smothered or eaten when small but can survive intense sea urchin predation when large (Sebens, 1985, 1986). Overall, rapid growth and reproduction secures space in the community for many species e.g. hydroids and bryozoans while ascidians and anthozoans are better competitors but more susceptible to predation (Sebens, 1985; 1986).

Time for community to reach maturity

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 colonized 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.

The addition of sea urchins to vertical rock wall communities previously devoid of urchins resulted in removal of the ascidian *Aplidium*, the mats of tubiculous amphipods and tubeworms leaving only bare rock within 2-3 months. Only a few large *Alcyonium digitatum* and fleshy red encrusting algae remained (Sebens, 1985). Overall a reduction in or absence of sea urchin grazing would allow opportunistic, bryozoans, hydroids, tubeworms and ascidians to grow and colonize space rapidly, probably developing a faunal turf within 1-2 years. Mobile epifauna and infauna will probably colonize rapidly from the surrounding area. However, slow growing species such as some sponges and anemones, will probably take many years to develop significant cover, so that a diverse community may take up to 5 -10 years to develop, depending on local conditions. But on their return, grazing by sea urchins could probably restore the biotope to bare rock dominated by encrusting algae within a few months.

Additional information

None entered.

Preferences & Distribution

Habitat preferences

Depth Range	
Water clarity preferences	
Limiting Nutrients	Data deficient
Salinity preferences	Full (30-40 psu)
Physiographic preferences	Open coast
Biological zone preferences	Circalittoral
Substratum/habitat preferences	Bedrock, Large to very large boulders, Small boulders
Tidal strength preferences	Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Exposed, Moderately exposed
Other preferences	None known

Additional Information

This biotope has been recorded from wave exposed to moderately wave exposed coasts, although it probably occurs at greater depth with greater surface wave exposure. It is recorded from moderately strong to very weak tidal streams. Water movement, either wave or current induced, is essential for suspension feeders such as hydroids, bryozoans, sponges, amphipods and ascidians to supply adequate food, remove metabolic waste products, prevent accumulation of sediment and disperse larvae or medusae. Therefore, records in very weak tidal streams are probably in areas of moderate to strong wave exposure.

Species composition

Species found especially in this biotope

- *Alcyonium digitatum*
- *Antedon bifida*
- *Asterias rubens*
- *Caryophyllia smithii*
- *Clavelina lepadiformis*
- *Crossaster papposus*
- *Echinus esculentus*
- *Parasmittina trispinosa*
- *Pododesmus patelliformis*
- *Pomatoceros triqueter*

Rare or scarce species associated with this biotope

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Additional information

The MNCR recorded 497 species within this biotope although not all species occurred in all records of the biotope.

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Sec, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Car are within the "Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock" FaAlCr habitat complex. All these biotopes have a sparse appearance due to grazing, mainly by *Echinus esculentus*, which combined with water depth, is thought to be a limiting factor controlling the growth of algal and increasing the dominance of faunal turfs. *Alcyonium digitatum* is common to all biotopes however colonies are generally smaller and have lower biomass within CR.MCR.EcCr.FaAlCr.Spi. *Securiflustra securifrons* is also an important erect faunal species within CR.MCR.EcCr.FaAlCr.Sec. In CR.MCR.EcCr.FaAlCr.Car *Caryophyllia smithii* is an important characterizing species. Encrusting fauna such as *Spirobranchus triqueter* (syn. *Pomatoceros triqueter)* and the bryozoan *Parasmittina trispinosa* are also important characterizing species across these biotopes (Connor *et al*., 2004).

For this sensitivity assessment, *Alcyonium digitatum*, *Caryophyllia smithii*, *Echinus esculentus*, the encrusting bryozoan *Parasmittina trispinosa*, *Securiflustra securifrons* and *Spirobranchus triqueter* and are the primary foci of research as the key characterizing species defining CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Sec, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Car. Grazing pressure is the most important structuring feature of the biotope after depth. Therefore, the sensitivity of grazers, e.g. *Echinus esculentus* is probably crucial to the sensitivity of the biotope. Other erect hydroids and bryozoans, e.g. *Abietinaria abietina*, *Nemertesia antennina*, *Thuiaria thuja* and *Cellepora pumicosa* are also thought important to the character of these biotopes, however, were not assessed within this review.

Resilience and recovery rates of habitat

Alcyonium digitatum is a colonial species of soft coral with a wide distribution in the North Atlantic, recorded from Portugal (41°N) to Northern Norway (70°N) as well as on the east coast of North America (Hartnoll, 1975; Budd, 2008). Colonies consist of stout "finger-like" projections (Hartnoll, 1975) which can reach up to 20 cm tall (Budd, 2008) and can dominate circalittoral rock habitats (as in CR.HCR.FaT.CTub.Adig; Connor *et al*., 2004). *Alcyonium digitatum* colonies are likely to have a lifespan that exceeds 20 years as colonies have been followed for 28 years in marked plots (Lundälv, pers. comm., in Hartnoll, 1998). Colonies that were 10-15 cm in height were aged at between 5 and 10 years old (Hartnoll, unpublished). Most colonies are unisexual, with the majority of individuals being female. Sexual maturity is predicted to occur, at its earliest, when the colony reaches its second year of growth. However, the majority of colonies are not predicted to reach maturity until their third year (Hartnoll, 1975).

Alcyonium digitatum spawns from December and January. Gametes are released into the water where fertilization occurs. The embryos are neutrally buoyant and float freely for 7 days when they give rise to actively swimming lecithotrophic planulae which may have an extended pelagic life before they eventually settle (usually within 1 or 2 further days) and metamorphose to polyps (Matthews, 1917; Hartnoll, 1975; Budd, 2008). In laboratory experiments, several larvae of *Alcyonium digitatum* failed to settle within 10 days, presumably finding the conditions unsuitable. These larvae were able to survive 35 weeks as non-feeding planulae. After 14 weeks some were still swimming and after 24 weeks the surface cilia were still active although they rested on the bottom of the tanks. By the end of the experiment, at 35 weeks the larvae had shrunk to a diameter of 0.3 mm. The ability to survive for long periods in the plankton may favour the dispersal and eventual discovery of a site suitable for settlement (Hartnoll, 1975). The combination of spawning in winter and the long pelagic lifespan may allow a considerable length of time for the planulae to disperse, settle and metamorphose ahead of the spring plankton bloom. Young *Alcyonium digitatum* will consequently be able to take advantage of an abundant food resource in spring and be well developed before the appearance of other organisms that may otherwise compete for the same substrata. In addition, because the planulae do not feed whilst in the pelagic zone they do not suffer by being released at the time of minimum plankton density. They may also benefit by the scarcity of predatory zooplankton which would otherwise feed upon them (Hartnoll, 1975).

Securiflustra securifrons is an erect bryozoan with a wide distribution across the North East Atlantic, recorded from Kongsfjorden, Svalbard (Gontar et al., 2001) to the Iberian peninsula, Spain (Ramos, 2010) and within the eastern Mediterranean (Antoniadou *et al.*, 2010). Colonies form an erect fan like structure which can grow to approximately 10 cm in length (Porter, 2012). Antoniadou *et al.* (2010) recorded the successional community on settlement panels deployed in Porto Koufo Bay, Mediterranean Sea. Among other early pioneer species. After 1-2 years immersion, the panels were colonized by further faunal species including *Securiflustra securifrons*. Little further information was found on the life history or recovery rates of *Securiflustra securifrons*. Where information regarding *Securiflustra securifrons* was not available evidence has been inferred from the life history traits of closely related species *Flustra foliacea* and *Chartella papyracea*. Please note, there are stark differences in the life history traits of *Flustra foliacea* and *Chartella papyracea*, for example, *Flustra foliacea* fronds can survive for up to 12 years whereas *Chartella papyracea* fronds survive for 2-3 years (Dyrynda & Ryland, 1982). Due to this variability where sensitivity assessments are based on the recovery of *Flustra foliacea* and/or *Chartella papyracea*, as proxy species for *Securiflustra securifrons*, confidence is assessed as low.

Flustra foliacea and *Chartella papyracea* are perennial species which brood their larvae (Eggleston, 1972; Dyrynda & Ryland, 1982). The brooded lecithotrophic larvae of bryozoans have a short pelagic lifetime to about 12 hours, and may, therefore, have poor dispersal capabilities (Ryland, 1976). *Chartella papyracea* and *Flustra foliacea* colonies begin as encrusting sheets (Tyler-Walters & Ballerstedt, 2007). Colonies have a growth season from late April–October, however new frond growth typically occurs in early Autumn. The first larvae can be released when fronds are approximately 1 year old (Eggleston, 1972). Once larval production has begun it can continue throughout the growth season, however, there is a major peak in Autumn and minor peak in Spring (Dyrynda & Ryland, 1982). Larval settlement is probably related to surface contour, chemistry and the proximity of conspecific colonies (Tyler-Walters & Ballerstedt, 2007). Stebbing (1971) noted that *Flustra foliacea* colonies regularly reached 6 years of age, although 12 year old specimens were reported off the Gower peninsula, Wales.

Fariñas-Franco *et al.* (2014) recorded the colonization of an artificial reef constructed of 16 tonnes of king scallop shells (*Pecten maximus*) deployed in Strangford Loch in February 2010. The reef was then seeded with translocated *Modiolus modiolus* in March 2010. Among other species, *Flustra foliacea* had colonized the reef within 6 months of the reef construction. *Flustra foliacea* was also recorded locally prior to construction of the reef, and therefore recruitment may have a local source. An example of where recruitment was longer term, includes that of the *MV Robert* (Hiscock, 1981). Four years after sinking, the wreck of a small coaster, the *MV Robert*, off Lundy was found to be colonized by erect bryozoans and hydroids, including occasional *Flustra foliacea* (Hiscock, 1981). The wreck was several hundreds of metres from any significant hard substrata, and hence a considerable distance from potentially parent colonies (Hiscock, 1981 and pers comm.).

Spirobranchus triqueter and *Parasmittina trispinosa* are two visually dominant encrusting species within CR.MCR.EcCr.FaAlCr.Sec & CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Adig. *Spirobranchus triqueter* is a species of serpulid worm which forms encrusting tubes, typically 2-3cm long, on rock and shell surfaces. Once settled onto the substratum the worm forms a temporary delicate semi-transparent tube. Mature tubes are formed by a secretion of calcium carbonate. The growth rate has been observed by Dons (1927) to be 1.5 mm per month, although this varies with external conditions. Hayward & Ryland (1995) and Dons (1927) stated that sexual maturity is reached in approximately 4 months. *Spirobranchus triqueter* is also a visually dominant species within mobile and/or disturbed biotopes e.g. SS.SCS.CCS.SpiB (Connor *et al.*, 2004), indicating this species is either highly resilient to physical disturbance or has a rapid recolonization rate. In agreement, 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*. Off Chesil Bank, the epifaunal community dominated by *Spirobranchus triqueter*, *Balanus crenatus* and *Electra pilosa*, decreased in cover in October, was scoured away in winter storms, and was recolonized in May to June (Warner, 1985). Hayward & Ryland (1995) noted that *Spirobranchus triqueter* lived approximately 1.5 years (Hayward & Ryland, 1995). *Spirobranchus triqueter* are broadcast spawners and are therefore likely to have large dispersal capacity. Larvae are pelagic for about 2-3 weeks in the summer, however, in the winter this amount of time increases to about 2 months (Hayward & Ryland, 1995). The time of reproduction is variable, Hayward & Ryland (1995) and Segrove (1941) suggested that *Spirobranchus triqueter* reproduction probably takes place throughout the year, but, peaks in spring and summer. However, Moore (1937) noted *Spirobranchus triqueter* breeding only took place in April in Port Erin, Isle of Man. Castric-Fey (1983) studied variations in settlement rate and concluded that, although the species settled all year round, a very rare settlement was observed during winter and maximum settlement occurred in April, June, August and Sept-Oct. Studies in Bantry Bay revealed a single peak in recruitment during summer (especially July and August) with very little recruitment at other times of the year (Cotter *et al.*, 2003).

Caryophyllia smithii is a small (max 3 cm across) solitary coral common within tide swept sites of the UK (Wood, 2005), distributed from Greece (Koukouras, 2010) to the Shetland Islands and southern Norway (NBN, 2015). It was suggested by Fowler & Laffoley (1993) that *Caryophyllia smithii* was a slow growing species (0.5-1mm in horizontal dimension of the corallum per year) which in turn suggests that inter-specific spatial competition with colonial faunal or algae species are important factors in determining local abundance of *Caryophyllia smithii* (Bell & Turner, 2000). *Caryophyllia smithii* reproduces sexually; sessile polyps discharge gametes typically from January-April, gamete release is most likely triggered by seasonal temperature increases, gametes are fertilized in the water column and develop into a swimming planula that then settles onto suitable substrata. The pelagic stage of the larvae may last up to 10 weeks, which provides this species with a good dispersal capability (Tranter *et al.*, 1982).

Whomersley & Picken (2003) documented epifauna colonization of offshore oil platforms in the North Sea from 1989-2000. On all platforms, *Mytilus edulis* dominated the near surface community. For the first 3 years, hydroids and tubeworms dominated the community below the mussel band. However, the hydroid community was later out-competed by other more climax communities. Recruitment of *Alcyonium digitatum* and *Metridium senile* began at 2-5 years (dependent on the oil rig). The community structure and zonation differed between the 4 rigs, however generally after4 years *Metridium senile* had become the dominant organism below the mussel zone to approximately 60-80 m Below Sea Level (BSL). Zonation differed between oil rigs but *Alcyonium digitatum* was the dominant organism from approximately 60-90 m BSL.

The *Scylla* was intentionally sunk on the 27th March 2004 in Whitsand Bay, Cornwall to act as an artificial reef. Hiscock *et al.* (2010) recorded the succession of the biological community on the wreck for 5 years following the sinking of the ship. Initially, the wreck was colonized by opportunistic species /taxa; e.g. filamentous algae, hydroids, serpulid worms and barnacles. *Tubularia* sp. were early colonizers, appearing within a couple of months after the vessel was sunk. *Metridium senile* appeared late in the summer of the first year but didn't become visually dominant until 2007 (3 years after the vessel was sunk). *Sagartia elegans* was recorded within the summer of 2005, and by the end of 2006 was well established. *Corynactis viridis* was first recorded in the summer of the first year and quickly formed colonies via asexual reproduction. *Urticina felina* was first recorded at the end of August 2006 (2 years after the vessel was sunk), and by summer 2008 had increased in abundance. *Alcyonium digitatum* was first recorded in early summer 2005, a year after the vessel was sunk. Within 1 year of growth colonies had grown to nearly full size, however, did not become a visually dominant component of the community until 2009 (5 years after the vessel had been sunk). The authors noted that erect branching Bryozoa (such as *Securiflustra securifrons*) are not a common part of rocky reef communities to the west of Plymouth and at the time of writing had not colonized to any great extent on 'Scylla' by the end of the study, although several species were recorded which included *Chartella papyracea* in 28/08/2006 (2 years after the vessel was sunk). *Caryophyllia smithii* was noted to colonize the wreck a year after the vessel was sunk.

Parasmittina trispinosa is an encrusting bryozoan which is described as having a "cosmopolitan" distribution by Powell (1971), in the North East Atlantic recorded from all coasts of the British Isles (NBN, 2015) to the Iberian Peninsula (Ramos, 2010). *Parasmittina trispinosa* is also recorded from the Panama Cana (Powell (1971) to the Gulf of Alaska (Soule, 2002) in the Pacific ocean. At the time of writing sparse information regarding the life history traits of *Parasmittina trispinosa*. Eggleston (1972) noted In the Isle of Man, a peak in reproductive and vegetative growth was not well marked in *Parasmittina trispinosa*, and the number of embryos present was fairly constant throughout the year (Eggleston, 1972), indicating that *Parasmittina trispinosa* could potentially reproduce annually within the UK. However, due to the lack of available literature regarding *Parasmittina trispinosa*, it's resilience cannot be assessed with sufficient confidence.

Echinus esculentus is a sea urchin found within Northeast Atlantic, recorded from Murmansk Coast, Russia to Portugal (Hansson, 1998). *Echinus esculentus* is estimated to have a lifespan of 8-16 years (Nichols, 1979; Gage, 1992) and reach sexual maturity within 1-3 years (Tyler-Walters, 2008). Maximum spawning occurs in spring although individuals may spawn over a protracted period throughout the year. Gonad weight is at its maximum in February/March in English Channel (Comely & Ansell, 1989) but decreases during spawning in spring and then increases again through summer and winter until the next spawning season. Spawning occurs just before the seasonal rise in temperature in temperate zones but is probably not triggered by rising temperature (Bishop, 1985). *Echinus esculentus* is a broadcast spawner, with a complex larval life history which includes a blastula, gastrula and a characteristic 4 armed echinopluteus stage that forms an important component of the zooplankton. MacBride (1914) observed planktonic larval development could take 45-60 days in captivity. Recruitment is sporadic or variable depending on locality, e.g. Millport populations showed annual recruitment, whereas few recruits were found in Plymouth populations during Nichols studies 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 (Bishop & Earll, 1984). Comely & Ansell (1988) noted that the largest number of *Echinus esculentus* occurred below the kelp forest.

Echinus esculentus is a mobile species and could therefore migrate and re-populate an area quickly if removed. For example, Lewis & Nichols (1979) found that adults were able to colonize an artificial reef in small numbers within 3 months and the population steadily grew over the following year. If completely removed from a site and local populations are naturally sparse then recruitment may be dependent on larval supply which can be highly variable. As suggested by Bishop & Earll (1984) the Skomer, Wales *Echinus esculentus* population had most likely not successfully recruited for 6 years which would suggest the mature population would be highly sensitive to removal and may not return for several years. On 19th November 2002, the *Prestige* oil tanker spilled 63 000t of fuel 130 nautical miles off Galicia, Spain. High wave exposure and strong weather systems increased mixing of the oil to "some" depth within the water column, causing sensitive faunal communities to be effected. Preceding and for nine years following the oil spill, the biological community of Guéthary, France was monitored. Following the oil spill, taxonomic richness decreased significantly from 57 recorded species to 41, which included the loss of *Echinus esculentus* from the site. Spill taxonomic richness had increased to pre-spill levels 2-3 years after the oil and *Echinus esculentus* had returned (Castège *et al.*, 2014).

Resilience assessment. Colonization experiments on artificial reefs and shipwrecks also indicate that *Flustra foliacea* and *Chartella papyracea* can colonize substrata within a period of 6 months-2 years (Hiscock *et al.*, 2010; Fariñas-Franco *et al.*, 2014). *Securiflustra securifrons* is closely related, with a similar life history and (in the absence of other evidence) may recruit at a similar rate. *Spirobranchus triqueter* can reach maturity within approximately 4 months and is often a dominant component of physically disturbed habitats, indicating rapid colonization rates (<1 year). *Echinus esculentus* can reportedly reach sexual maturity within 1-2 years (Tyler-Walters, 2008), however as highlighted by Bishop & Earll (1984) and Castège *et al.*(2014) recovery may take 2-6 years (possibly more if local recruitment is poor). *Alcyonium digitatum* can recruit onto bare surfaces within 2 years, however, may take up to 5 years to become a dominant component of the community (Whomersley & Picken, 2003; Hiscock *et al.*, 2010). *Alcyonium digitatum* is a common characterizing species across CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Sec & CR.MCR.EcCr.FaAlCr.Spi, without which the character of these biotopes would change and maybe un-recognisable. As a result, the resilience assessments within this review are largely based on the recovery of *Alcyonium digitatum*. If the community was completely removed from the habitat (resistance of 'None' or 'Low') resilience would be assessed as '**Medium**'. However where resistance was assessed as 'Medium' or 'High' then resilience would be assessed as **'High**'.

Hydrological Pressures

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

Alcyonium digitatum is described as a northern species by Hiscock *et al.* (2004) but is distributed from Northern Norway (70°N) to Portugal (41°N) (Hartnoll, 1975; Budd, 2008). *Securiflustra securifrons* is recorded from Kongsfjorden, Svalbard (Gontar *et al.*, 2001) to the Iberian peninsula in both Spain and Portugal (Ramos, 2010). Across this latitudinal gradient both species are likely to experience a range of temperatures from approximately 5-18°C (Seatemperature, 2015).

Spirobranchus triqueter is described as a temperate species by Kupriyanova & Badyaev (1998). *Spirobranchus triqueter* is recorded as abundant in sub-tidal habitats of Trondheimsfjord (63°N) (Kukliński & Barnes, 2008), no survey reports could be found further north. The most southerly records are from the Iberian peninsula, Spain (Ramos, 2010) as well from the Alexandria coast of

Egypt, Mediterranean Sea (Dorgham *et al*., 2013). Across this latitudinal gradient, *Spirobranchus triqueter* is likely to experience a range of temperatures from approximately 5-28°C (Seatemperature, 2015).

Bishop (1985) suggested that *Echinus esculentus* cannot tolerate high temperatures for prolonged periods due to increased respiration rate and resultant metabolic stress. Ursin (1960) reported *Echinus esculentus* occurred at temperatures between 0-18°C in Limfjord, Denmark. Bishop (1985) noted that gametogenesis occurred at 11-19°C however, continued exposure to 19°C disrupted gametogenesis. Embryos and larvae developed abnormally after 24hr exposure to 15°C but normally at 4, 7 and 11°C (Tyler & Young 1998).

Tranter *et al.* (1982) suggested *Caryophyllia smithii* reproduction was cued by seasonal increases in temperature. Therefore, unseasonal increases in temperature may disrupt natural reproductive processes and negatively influence recruitment patterns. Mature examples of *Caryophyllia smithii* can be recorded in Greece

CR.MCR.EcCr.FaAlCr.Adig & CR.MCR.EcCr.FaAlCr.Spi are restricted to the north of the British Isles; CR.MCR.EcCr.FaAlCr.Sec is also recorded in the north of the British Isles, however, there are some records from Pembrokeshire, Wales. Sea surface temperature across this distribution ranges from northern to southern Sea Surface Temperature (SST) of 8-16°C in summer and 6-13°C in winter (Beszczynska-Möller & Dye, 2013).

Sensitivity assessment. *Spirobranchus triqueter* records from the Alexandria coast of Egypt, Mediterranean Sea (Dorgham *et al*., 2013) indicate the species is unlikely to be affected at the benchmark level. An increase in sea surface temperature of 2°C for a period of 1 year combined with high temperatures may approach the upper temperature threshold of *Alcyonium digitatum*, *Echinus esculentus*, and/or Securiflustra *securifrons*, and may, therefore, cause minor declines in abundance. Biotopes in the North of the UK are unlikely to be affected at the benchmark level. There is insufficient evidence to assess the effect of a short-term increase in temperature of 5°C on *Alcyonium digitatum* however it may disrupt *Echinus esculentus* spawning in southern examples of this biotope. Resistance has been assessed as '**Medium**', resilience has been assessed as '**High**'. Sensitivity has been assessed as '**Low'.**

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

Alcyonium digitatum is described as a northern species by Hiscock *et al.* (2004) but is distributed from Northern Norway (70°N) to Portugal (41°N) (Hartnoll, 1975; Budd, 2008). Across this latitudinal gradient, both species are likely to experience a range of temperatures from approximately 5-18°C. *Alcyonium digitatum* was also reported to be apparently unaffected by the severe winter of 1962-1963 where air temperature reached -5.8°C (Crisp, 1964). *Securiflustra securifrons* is recorded from Kongsfjorden, Svalbard (Gontar et al., 2001) to the Iberian peninsula in both Spain and Portugal (Ramos, 2010).

Echinus esculentus has been recorded from the Murmansk Coast, Russia. Due to the high latitude at which *Echinus esculentus* can occur it is unlikely to be affected at the pressure benchmark.

Spirobranchus triqueter is described as a temperate species by Kupriyanova & Badyaev (1998). *Spirobranchus triqueter* is recorded as abundant in sub-tidal habitats of Trondheimsfjord (63°N) (Kukliński & Barnes, 2008), no survey reports could be found further north. Averaged across several years the lowest winter temperature within Trondheimsfjord is 4.9°C (Seatemperature, 2015). Below 7°C *Spirobranchus triqueter* is unable to build calcareous tubes (Thomas, 1940). Mature adults may survive a decrease at the pressure benchmark however larvae may not be able to attach to the substate (Riley & Ballerstedt, 2005) if a temperature decrease co-occurred with cold winter temperatures in the UK. However, settlement is reportedly low within winter (See resilience section), and therefore the effects on recruitment are likely to be minor.

CR.MCR.EcCr.FaAlCr.Adig & CR.MCR.EcCr.FaAlCr.Spi core records are restricted to the north of the British Isles; CR.MCR.EcCr.FaAlCr.Sec is also recorded in the north of the British Isles, however, there are some records from Pembrokeshire, Wales. Sea surface temperature across this distribution ranges from northern to southern Sea Surface Temperature (SST) ranges of 8-16°C in summer and 6-13°C in winter (Beszczynska-Möller & Dye, 2013).

Sensitivity assessment. *Alcyonium digitatum*, *Echinus esculentus* & *Securiflustra securifrons* have northern/boreal distributions and are unlikely to be affected at the benchmark level. *Spirobranchus triqueter* is unable to build calcareous tubes at low temperatures, however during winter, this is unlikely to have any significant effects on recruitment. Resistance has been assessed as '**High**', resilience as '**High**'. Sensitivity has been assessed as '**Not sensitive**'.

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

Lyster (1965) tested the tolerance of *Spirobranchus triqueter* larvae to various hyper and hypo salinity treatments. Larvae were placed in cultures ranging from 0-90‰ and notes were made on the time taken for larvae to die or begin displaying abnormal behaviour. *Spirobranchus triqueter* larvae were tolerant of salinities ranging from 20-50‰, above 50‰ caused high mortality. *Spirobranchus triqueter* is, therefore, unlikely to be affected at the pressure benchmark.

Echinoderms are generally stenohaline and possess no osmoregulatory organ (Boolootian, 1966). Therefore, an increase in salinity may cause *Echinus esculentus* mortality. *Alcyonium digitatum*' distribution and the depth at which it occurs also suggest it would not likely experience regular salinity fluctuations and therefore tolerate significant increases in salinity. CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi and CR.MCR.EcCr.FaAlCr.Sec are restricted to full salinity (Connor *et al.*, 2004), it, therefore, seems likely that an increase in salinity to >40‰ may cause a decline in the abundance of *Alcyonium digitatum*, *Echinus esculentus* & *Securiflustra securifrons*.

Sensitivity assessment. Resistance has been assessed as '**Low**', resilience as '**Medium**'. Sensitivity has been assessed as '**Medium**'.

Due to the lack of information regarding salinity effects on *Alcyonium digitatum*, *Echinus esculentus* & *Securiflustra securifrons* confidence in this assessment has been assessed as low.

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

Alcyonium digitatum does inhabit situations such as the entrances to sea lochs (Budd, 2008) or the entrances to estuaries (Braber & Borghouts, 1977) where salinity may vary occasionally. Furthermore, as highlighted the Marine Nature Conservation Review (MNCR) records of 23rd Oct

2014 show *Alcyonium digitatum* is found within a number of variable salinity biotopes, e.g. MCR.BYH.Flu.Hocu. However, its distribution and the depth at which it occurs suggest that *Alcyonium digitatum* would not likely often experience salinity fluctuations and therefore unlikely to survive significant reductions in salinity (Budd, 2008).

Echinoderms are generally unable to tolerate low salinity (stenohaline) and possess no osmoregulatory organ (Boolootian, 1966). At low salinity, urchins gain weight, and the epidermis loses its pigment as patches are destroyed; prolonged exposure is fatal. However, within *Echinus esculentus*, there is some evidence to suggest intracellular regulation of osmotic pressure due to increased amino acid concentrations. Furthermore, as highlighted the Marine Nature Conservation Review (MNCR) records of 23rd Oct 2014 show *Echinus esculentus* is found within a number of variable and reduced salinity biotopes, e.g. IR.LIR.KVS.SlatPsaVS.

Ryland (1970) stated that, with a few exceptions, the Gymnolaemata (the class of Bryozoans which *Securiflustra securifrons* is part of) were fairly stenohaline and restricted to full salinity (35 psu) and noted that reduced salinities result in an impoverished bryozoan fauna. Similarly, Dyrynda (1994) noted that *Flustra foliacea* were probably restricted to the vicinity of the Poole Harbour entrance by their intolerance to reduced salinity. Although protected from extreme changes in salinity due to their subtidal habitat, the introduction of freshwater or hyposaline effluents may adversely affect *Flustra foliacea* colonies.

Lyster (1965) tested the tolerance of *Spirobranchus triqueter* larvae to various hyper and hypo salinity treatments. Larvae were placed in cultures ranging from 0-90‰ and notes were made on the time taken for larvae to die or begin displaying abnormal behaviour. *Spirobranchus triqueter* larvae can survive very well in salinities down to 20‰, and can tolerate salinities down to 10‰. Adults are tolerant of salinities as low as 3‰, and can be found in areas were salinity ranges from 18-23‰ (Alexander *et al.*, 1935).

Sensitivity review. CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are recorded exclusively in full marine conditions (30-40 ‰) (Connor *et al.*, 2004). The lack of records within "Reduced" salinity (18-30‰) suggests the community would not persist/be recognisable if salinity was reduced. *Securiflustra securifrons* is unlikely to tolerate low salinity environments. *Spirobranchus triqueter* is likely to be able to tolerate reduced salinity, Records from the MNCR suggest *Alcyonium digitatum* & *Echinus esculentus* can occur in reduced salinity habitats, however, the general evidence suggests that these species would decrease in abundance. Resistance has been assessed as '**Low**', Resilience as '**Medium**'. Sensitivity has been assessed as '**Medium**'.

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

CR.MCR.EcCr.FaAlCr.Adig is recorded from weak-strong tidal streams (0.5-3 m/sec), CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are recorded from weak-moderately strong tidal streams (<0.5-1.5m/sec) (Connor *et al.*, 2004).

Alcyonium digitatum, *Securiflustra securifrons* & *Spirobranchus triqueter* are suspension feeders relying on water currents to supply food. These taxa therefore thrive in conditions of vigorous water flow e.g. around Orkney and St Abbs, Scotland, where the community may experience tidal currents of 3 and 4 knots during spring tides (Kluijver, 1993).

Flustra foliacea colonies are flexible, robust and reach high abundances in areas subject to strong currents and tidal streams (Stebbing, 1971; Eggleston, 1972; Knight-Jones & Nelson-Smith, 1977; Hiscock, 1983, 1985; Holme & Wilson, 1985). Dyrynda (1994) suggested that mature fronded colonies do not occur on unstable substratum due to the drag caused by their fronds, resulting in rafting of colonies on shells or the rolling of pebbles and cobbles, resulting in destruction of the colony. Dyrynda (1994) reported that the distribution of *Flustra foliacea* in the current swept entrance to Poole Harbour was restricted to circalittoral boulders, on which it dominated as nearly mono-specific stands.

Spirobranchus triqueter has been recorded in areas with very sheltered to exposed water flow rates (Price *et al.*, 1980). Wood (1988) observed *Spirobranchus* sp. in strong tidal streams and Hiscock (1983) found that in strong tidal streams or strong wave action where abrasion occurs, fast growing species such as *Spirobranchus triqueter* occur.

Echinus esculentus occurred in kelp beds on the west coast of Scotland in currents of about 0.5 m/sec. Outside the beds specimens were occasionally seen being rolled by the current (Comely & Ansell, 1988), which may have been up to 1.4 m/sec. Urchins are removed from the stipe of kelps by wave and current action. *Echinus esculentus* are also displaced by storm action. After disturbance *Echinus esculentus* migrates up the shore, an adaptation to being washed to deeper water by wave action (Lewis & Nichols, 1979). Therefore, increased water flow may remove the population from the affected area; probably to deeper water although individuals would probably not be killed in the process and could recolonize the area quickly.

Sensitivity assessment. Due to the range of tidal streams in which CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are recorded (<0.5-3 m/sec) a decrease in tidal velocity of 0.1-0.2 m/s is not likely to have a significant effect on the biological community within these biotopes. *Echinus esculentus* may become dislodged but are unlikely to be killed and may recolonize quickly. Resistance has been assessed as '**High**', resilience has been assessed as '**High**'. Sensitivity has been assessed as '**Not sensitive**'.

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

Changes in emergence are **not relevant** to CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec, which are restricted to fully subtidal/circalittoral conditions-The pressure benchmark is relevant only to littoral and shallow sublittoral fringe biotopes.

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

CR.MCR.EcCr.FaAlCr.Adig is recorded from extremely wave exposed-moderately wave exposed sites. CR.MCR.EcCr.FaAlCr.Spi and CR.MCR.EcCr.FaAlCr.Sec are recorded from exposed to moderately exposed sites (Connor *et al.*, 2004). *Alcyonium digitatum*, *Securiflustra securifrons*, *Spirobranchus triqueter* are suspension feeders relying on water currents to supply food. These taxa therefore thrive in conditions of vigorous water flow.

CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are predominantly circalittoral habitats, CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi are recorded from 5-50 m and CR.MCR.EcCr.FaAlCr.Sec 5-30 m (Connor *et al.*, 2004). The depth at which these biotopes are recorded may therefore also negate the direct physical effects of a localised change in wave height; wave attenuation is directly related to water depth (Hiscock, 1983).

Echinus esculentus occurred in kelp beds on the west coast of Scotland in currents of about 0.5 m/sec. Outside the beds specimens were occasionally seen being rolled by the current (Comely & Ansell, 1988), which may have been up to 1.4 m/sec. Urchins are removed from the stipe of kelps by wave and current action. *Echinus esculentus* are also displaced by storm action. After disturbance *Echinus esculentus* migrates up the shore, an adaptation to being washed to deeper water by wave action (Lewis & Nichols, 1979). Keith Hiscock (pers. comm.) reported *Echinus esculentus* occurred in significant numbers as shallow as 15m below low water at the extremely wave exposed site of Rockall, Scotland. Therefore, localised increases in wave height may remove the population from the affected area; probably to deeper water although individuals would probably not be killed in the process and could recolonize the area quickly.

Sensitivity assessment. Wave action is a fundamental environmental variable controlling the biological community of sub-littoral biotopes. A large and significant change in wave height may fundamentally alter the character of CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec. However a change in near shore significant wave height of 3-5% is not likely to have a significant effect on the biological community. Resistance has been assessed as '**High**', resilience has been assessed as '**High**'. Sensitivity has been assessed as '**Not sensitive**'.

Chemical Pressures

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

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

No information on the direct biological effects of heavy metal contamination on *Alcyonium digitatum*. Possible sub-lethal effects of exposure to heavy metals may result in a change in morphology, growth rate or disruption of the reproductive cycle. The vulnerability of this species to concentrations of pollutants may also depend on variations in other factors e.g. temperature and salinity conditions outside the normal range.

Based on the available evidence for several species Bryan (1984) suggested that polychaetes are fairly resistant to heavy metals.

Bryozoans are common members of the fouling community and amongst those organisms most resistant to antifouling measures, such as copper containing anti-fouling paints (Soule & Soule, 1977; Holt et al., 1995). Bryozoans were shown to bio accumulate heavy metals to a certain extent (Holt *et al*., 1995). For example, *Bowerbankia gracialis* and *Nolella pusilla* accumulated Cd, exhibiting sublethal effects (reduced sexual reproduction and inhibited resting spore formation) between 10-100 µg Cd /l and fatality above 500 µg Cd/l (Kayser, 1990).

Little is known about the effects of heavy metals on echinoderms. Bryan (1984) reported that early work had shown that echinoderm larvae were sensitive to heavy metals contamination, for example, Migliaccio *et al.* (2014) reported exposure of *Paracentrotus lividis* larvae to increased levels of cadmium and manganese caused abnormal larval development and skeletal malformations. Kinne (1984) reported developmental disturbances in *Echinus esculentus* exposed to waters containing 25 µg / l of copper (Cu).

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

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

CR.MCR.EcCr.FaAlCr, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are sub-tidal biotopes (Connor *et al.*, 2004). Oil pollution is mainly a surface phenomenon its impact upon circalittoral turf communities is likely to be limited. However, as in the case of the *Prestige* oil spill off the coast of France, high swell and winds can cause oil pollutants to mix with the seawater and potentially negatively affect sublittoral habitats (Castège *et al.*, 2014). Smith (1968) reported dead colonies of *Alcyonium digitatum* at a depth of 16m in the locality of Sennen Cove, Cornwall which was likely a result of toxic detergents sprayed along the shoreline to disperse oil from the Torrey Cannon tanker spill (Budd, 2008).

At the time of writing little information on the effects of hydrocarbons on bryozoans was found. Ryland & Putron (1998) did not detect adverse effects of oil contamination on the bryozoan *Alcyonidium spp.* in Milford Haven or St. Catherine's Island, south Pembrokeshire although it did alter the breeding period.

Large numbers of dead polychaetes and other fauna were washed up at Rulosquet marsh near Isle de Grand following the Amoco Cadiz oil spill in 1978 (Cross *et al.*, 1978). However, no information was found relating to *Spirobranchus triqueter* in particular.

Echinus esculentus is subtidal and unlikely to be directly exposed to oil spills. However, as with the '*Prestige'* oil spill rough seas can cause mixing with the oil and the seawater, and therefore, sub-tidal habitats can be affected by the oil spill. Castège *et al.*, (2014) recorded the recovery of rocky shore communities following the *Prestige* oil spill which impacted the French Atlantic coast. Rough weather at the time of the spill increased mixing between the oil and seawater, causing sub-tidal communities/habitats to be affected. The urchin *Echinus esculentus* was reported absent after the oil spill, however, returned after 2-5 years. Large numbers of dead *Echinus esculentus* were found between 5.5 and 14.5 m in the vicinity of Sennen cove, presumably due to a combination of wave exposure and heavy spraying of dispersants following the '*Torrey canyon'* oil spill (Smith 1968). Smith (1968) also demonstrated that 0.5 -1ppm of the detergent BP1002 resulted in developmental abnormalities in its echinopluteus larvae. *Echinus esculentus* populations in the vicinity of an oil terminal in A Coruna Bay, Spain, showed developmental abnormalities in the skeleton. The tissues contained high levels of aliphatic hydrocarbons, naphthalenes, pesticides and heavy metals (Zn, Hg, Cd, Pb, and Cu) (Gomez & Miguez-Rodriguez 1999).

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

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

Smith (1968) reported dead colonies of *Alcyonium digitatum* at a depth of 16 m in the locality of

Sennen Cove, Cornwall resulting from the offshore spread and toxic effect of detergents (a mixture of a surfactant and an organic solvent) e.g. BP 1002 sprayed along the shoreline to disperse oil from the Torrey Canyon tanker spill. Possible sub-lethal effects of exposure to synthetic chemicals may result in a change in morphology, growth rate or disruption of the reproductive cycle. The vulnerability of this species to concentrations of pollutants may also depend on variations in other factors e.g. temperature and salinity conditions outside the normal range (Budd, 2008).

Bryozoans are common members of the fouling community and amongst those organisms most resistant to antifouling measures, such as copper containing anti-fouling paints (Soule & Soule, 1979; Holt et al., 1995). Bryan & Gibbs (1991) reported that there was little evidence regarding TBT toxicity in bryozoa with the exception of the encrusting *Schizoporella errata*, which suffered 50% mortality when exposed for 63 days to 100ng/l TBT. Rees *et al.* (2001) reported that the abundance of epifauna (including bryozoans) had increased in the Crouch estuary in the 5 years since TBT was banned from use on small vessels. This last report suggests that bryozoans may be at least inhibited by the presence of TBT. Hoare & Hiscock (1974) suggested that polyzoa (bryozoa) were amongst the most intolerant species to acidified halogenated effluents in Amlwch Bay, Anglesey and reported that *Flustra foliacea* did not occur less than 165m from the effluent source. The evidence, therefore, suggests that *Securiflustra securifrons* would be sensitive to synthetic compounds.

Large numbers of dead *Echinus esculentus* were found between 5.5 and 14.5 m in the vicinity of Sennen, presumably due to a combination of wave exposure and heavy spraying of dispersants in that area following the *Torrey Canyon* oil spill (Smith 1968). Smith (1968) also demonstrated that 0.5 -1ppm of the detergent BP1002 resulted in developmental abnormalities in echinopluteus larvae of *Echinus esculentus*. *Echinus esculentus* populations in the vicinity of an oil terminal in A Coruna Bay, Spain, showed developmental abnormalities in the skeleton. The tissues contained high levels of aliphatic hydrocarbons, naphthalenes, pesticides and heavy metals (Zn, Hg, Cd, Pb, and Cu) (Gomez & Miguez-Rodriguez 1999).

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

No Evidence

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

This pressure is **Not assessed**.

De-oxygenation	Medium Q: Low A: NR C: NR	High Q: High A: High C: High	Low Q: Low A: Low C: Low

There is anecdotal evidence to suggest that *Alcyonium digitatum* is sensitive to hypoxic events. However, because the degree of de-oxygenation wasn't quantified the evidence cannot be compared to the pressure benchmark. There is insufficient evidence to assess the sensitivity of *Securiflustra securifrons* or *Spirobranchus triqueter*.

In general, respiration in most marine invertebrates do not appear to be significantly affected until extremely low concentrations are reached. For many benthic invertebrates, this concentration is about 2 ml l^{-1}, or even less (Herreid, 1980; Rosenberg *et al.*, 1991; Diaz & Rosenberg, 1995).

Alcyonium digitatum mainly inhabits environments in which the oxygen concentration usually exceeds 5 ml l-1 and respiration is aerobic (Budd, 2008). In August 1978 a dense bloom of a dinoflagellate, *Gyrodinium aureolum* occurred surrounding Geer reef in Penzance Bay, Cornwall and persisted until September that year. Observations by local divers indicated a decrease in underwater visibility (<1 m) from below 8 m Below Sea Level. It was also noted that many of the faunal species appeared to be affected, e.g. no live *Echinus esculentus* were observed whereas on surveys prior to August were abundant, *Alcyonium sp.* and bryozoans were also in an impoverished state. During follow up surveys conducted in early September, *Alcyonium sp.* were noted to be much healthier and feeding. It was suggested the decay of *Gyrodinium aureolum* either reduced oxygen levels or physically clogged faunal feeding mechanisms. Adjacent reefs were also surveyed during the same time period and the effects of the *Gyrodinium aureolum* bloom were less apparent. It was suggested that higher water agitation in shallow water on reefs more exposed to wave action were less affected by the phytoplankton bloom (Dennis, 1979).

CR.MCR.EcCr.FaAlCr.Adig is recorded from weak-strong tidal streams (0.5-3 m/sec), CR.MCR.EcCr.FaAlCr.Spi and CR.MCR.EcCr.FaAlCr.Sec are recorded from weak-moderately strong tidal streams (<0.5-1.5m/sec) (Connor *et al.*, 2004). The high water movement which is indicative of these biotopes is likely to increase mixing with surrounding oxygenated water (Dennis, 1979) and may, therefore, decrease the effects of deoxygenation. However, the evidence from Dennis (1979) suggests that grazing echinoderms such as *Echinus* may be affected. Therefore, a resistance of **Medium** is suggested. Resilience is probably **High** so that sensitivity is assessed as **Low**.

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

This biotope is considered to be **'Not sensitive'** at the pressure benchmark that assumes compliance with good status as defined by the WFD.

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

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

It was suggested by Comely & Ansell (1988) that *Echinus esculentus* could absorb dissolved organic material for the purposes of nutrition. Nutrient enrichment may encourage the growth of ephemeral and epiphytic algae and therefore increase sea-urchin food availability. Lawrence (1975) reported that sea urchins had persisted over 13 years on barren grounds near sewage outfalls, presumably feeding on dissolved organic material, detritus, plankton, and microalgae, although individuals died at an early age.

Organic enrichment	Medium Q: Low A: NR C: NR	High Q: High A: High C: High	Low Q: Low A: Low C: Low

Alcyonium digitatum, *Securiflustra securifrons* & *Spirobranchus triqueter* are suspension feeders of phytoplankton and zooplankton. Organic enrichment of coastal waters that enhances the population of phytoplankton may be beneficial to *Alcyonium digitatum*, *Securiflustra securifrons* & *Spirobranchus triqueter* in terms of an increased food supply but the effects are uncertain (Hartnoll, 1998). The survival of *Alcyonium digitatum*, *Securiflustra securifrons* & *Spirobranchus triqueter* may be influenced indirectly. High primary productivity in the water column combined with high summer temperature and the development of thermal stratification (which prevents mixing of the water column) can lead to hypoxia of the bottom waters which faunal species are likely to be highly intolerant of (see deoxygenation pressure).

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Sensitivity assessment. Organic enrichment is not likely to directly negatively affect the characterizing species within this biotope, however, chronic organic enrichment may cause secondary effects such as hypoxia. Resistance has been assessed as '**Medium',** Resilience as '**High**'. Sensitivity has been assessed as '**Low**'.

Physical Pressures

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

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

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

If rock were replaced with sediment, this would represent a fundamental change to the physical character of the biotope and the species would be unlikely to recover. The biotope would be lost.

Sensitivity assessment. Resistance to the pressure is considered '**None**', and resilience '**Very low**'. Sensitivity has been assessed as '**High**'.

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

Not relevant

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

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

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

CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi and CR.MCR.EcCr.FaAlCr.Sec are subtidal habitats (Connor *et al*., 2004). Therefore, abrasion is most likely to be a result of bottom or pot fishing gear, cable laying etc. which may cause localised mobility of the substrata and mortality of the resident community. The effect would be situation dependent however if bottom fishing gear were towed over a site it may mobilise a high proportion of the rock substrata and cause high mortality in the resident community.

Alcyonium digitatum, *Echinus esculentus*, *Securiflustra securifrons* & *Spirobranchus triqueter* are sedentary or slow moving species that might be expected to suffer from the effects of dredging. Boulcott & Howell (2011) conducted experimental Newhaven scallop dredging over a circalittoral rock habitat in the sound of Jura, Scotland and recorded the damage to the resident community. The results indicated that the sponge *Pachymatisma johnstoni* was highly damaged by the experimental trawl. However, only 13% of photographic samples showed visible damage to *Alcyonium digitatum*. Where *Alcyonium digitatum* damage was evident it tended to be small colonies that were ripped off the rock. The authors highlight physical damage to faunal turfs (erect bryozoans and hydroids) was difficult to quantify in the study. However, the faunal turf communities did not show large signs of damage and were only damaged by the scallop dredge teeth which was often limited in extent (approximately. 2cm wide tracts). The authors indicated that species such as *Alcyonium digitatum* and faunal turf communities were not as vulnerable to damage through trawling as sedimentary fauna and whilst damage to circalittoral rock fauna did occur it was of an incremental nature, with the loss of species such as *Alcyonium digitatum* and faunal turf communities increasing with repeated trawls.

Species with fragile tests, such as *Echinus esculentus* were reported to suffer badly as a result of scallop or queen scallop dredging (Bradshaw et al., 2000; Hall-Spencer & Moore, 2000). Kaiser et al. (2000) reported that *Echinus esculentus* were less abundant in areas subject to high trawling disturbance in the Irish Sea. Jenkins *et al.* (2001) conducted experimental scallop trawling in the North Irish sea and recorded the damage caused to several conspicuous megafauna species, both when caught as bi-catch and when left on the seabed. The authors predicted 16.4% of *Echinus esculentus* were crushed/dead, 29.3% would have >50% spine loss/minor cracks, 1.1% would have <50% spine loss and the remaining 53.3% would be in good condition. Sea urchins can rapidly regenerate spines, e.g. *Psammechinus miliaris* were found to re-grow all spines within a period of 2 months (Hobson, 1930). The trawling examples mentioned above were conducted on sedimentary habitats and thus the evidence is not directly relevant to the rock based biotopes-CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec, however, does indicate the likely effects of abrasion on *Echinus esculentus*.

Sensitivity assessment. Resistance has been assessed '**Medium**', resilience has been assessed as '**High**'. Sensitivity has been assessed as '**Low**'

Please note Boulcott & Howell (2011) did not mention the abrasion caused by fully loaded collection bags on the new haven dredges. A fully loaded Newhaven dredge may cause higher damage to the community as indicated in their study.

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

The species characterizing this biotope group are epifauna or epiflora occurring on rock which is resistant to subsurface penetration. The assessment for abrasion at the surface only is therefore considered to equally represent sensitivity to this pressure. This pressure is not thought relevant to hard rock biotopes.

Changes in suspended solids (water clarity)	High Q: High A: High C: High	High Q: High A: High C: High	Not sensitive Q: High A: High C: High

Alcyonium digitatum, *Securiflustra securifrons* & *Spirobranchus triqueter* are not thought highly susceptible to changes in water clarity due to the fact they are suspension feeding organisms and are not directly dependent on sunlight for nutrition. *Alcyonium digitatum* has been shown to be tolerant of high levels of suspended sediment. Hill *et al.* (1997) demonstrated that *Alcyonium digitatum* sloughed off settled particles with a large amount of mucous. *Alcyonium digitatum* is also known to inhabit the entrances to sea lochs (Budd, 2008) or the entrances to estuaries (Braber & Borghouts, 1977) where water clarity is likely to be highly variable.

Moore (1977) suggested that *Echinus esculentus* was unaffected by turbid conditions. *Echinus esculentus* is an important grazer of red macro-algae within CR.MCR.EcCr. Increased turbidity and resultant reduced light penetration is likely to negatively affect algal growth. However, *Echinus esculentus* can feed on alternative prey, detritus or dissolved organic material (Lawrence, 1975, Comely & Ansell, 1988).

Increased turbidity will reduce light penetration and hence phytoplankton productivity. Small phytoplankton are probably an important food source in the shallow subtidal, although, *Flustra* *foliacea* is also found at greater depths, where organic particulates (detritus) are probably more important.

According to Bacescu (1972), sabellids are accustomed to turbidity and silt. *Spirobranchus triqueter* has also recently been recorded by De Kluijver (1993) from Scotland in the aphotic zone, indicating that the species would not be sensitive to an increase in turbidity.

Sensitivity assessment. Resistance has been assessed as '**High**', Resilience as '**High**'. Sensitivity has been assessed as '**Not Sensitive**'.

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

Alcyonium digitatum, *Securiflustra securifrons* & *Spirobranchus triqueter* are sessile and thus, would be unable to avoid the deposition of a smothering layer of sediment. Some *Alcyonium digitatum* colonies can attain a height of up to 20 cm (Edwards, 2008), *Securiflustra securifrons colonies* can attain a height of 10 cm (Porter, 2012) so would still be able to feed in the event of sediment deposition. However, *Spirobranchus triqueter* are an encrusting species and would thus likely be smothered, and depending on sediment retention could block larval settlement.

Holme & Wilson (1985) examined the bottom fauna in a tide-swept region of the central English Channel. *Flustra foliacea* dominated communities were reported to form in areas subject to sediment transport (mainly sand) and periodic, temporary, submergence by thin layers of sand (ca <5 cm).

Comely & Ansell (1988) recorded large *Echinus esculentus* from kelp beds on the west coast of Scotland in which the substratum was seasonally covered with "high levels" of silt. This suggests that *Echinus esculentus* is unlikely to be killed by smothering, however, smaller specimens and juveniles may be less resistant. A layer of sediment may interfere with larval settlement. If retained within the host biotope for extended periods a layer of 5cm of the sediment may negatively affect successive recruitment events.

CR.MCR.EcCr.FaAlCr.Adig is recorded from weak-strong tidal streams (0.5-3 m/sec), CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are recorded from weak-moderately strong tidal streams (<0.5-1.5 m/sec) (Connor *et al*., 2004). Due to the high tidal energy within these biotopes, 5 cm of deposited sediment is likely to be removed from the biotope within a few tidal cycles.

Sensitivity assessment. Resistance has been assessed as '**High**', resilience as '**High**'. Sensitivity has therefore been assessed as '**Not Sensitive**'.

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

Alcyonium digitatum, *Securiflustra securifrons* & *Spirobranchus triqueter* are sessile and thus, would be unable to avoid the deposition of a smothering layer of sediment. *Alcyonium digitatum* colonies can attain a height of up to 20 cm (Edwards, 2008), *Securiflustra securifrons colonies* can attain a height of 10 cm (Porter, 2012) and *Spirobranchus triqueter* are encrusting species. *Echinus esculentus* are large globular urchins which can reach a diameter of 17 cm (Tyler-Walters, 2000). Therefore, it is likely that all characterizing species within CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec would be totally inundated.

Holme & Wilson (1985) examined the bottom fauna in a tide-swept region of the central English Channel. *Flustra foliacea* dominated communities were reported to form in areas subject to sediment transport (mainly sand) and periodic, temporary, submergence by thin layers of sand (ca <5 cm). If inundated by 30cm of sediment respiration and larval settlement are likely to be blocked until the deposited sediment is removed.

Comely & Ansell (1988) recorded large *Echinus esculentus* from kelp beds on the west coast of Scotland in which the substratum was seasonally covered with "high levels" of silt. This suggests that *Echinus esculentus* is unlikely to be killed by smothering, however, smaller specimens and juveniles may be less resistant. A layer of sediment may interfere with larval settlement. If retained within the host biotope for extended periods a layer of 5cm of the sediment may negatively affect successive recruitment events.

CR.MCR.EcCr.FaAlCr.Adig is recorded from weak-strong tidal streams (0.5-3 m/sec), CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are recorded from weak-moderately strong tidal streams (<0.5-1.5 m/sec) (Connor *et al*., 2004). Due to the high tidal energy within these biotopes, 30 cm of deposited sediment is likely to be removed from the biotope within a year.

Sensitivity assessment. Resistance has been assessed as '**Medium**', resilience as '**High**'. Sensitivity has therefore been assessed as '**Low**'.

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

Not assessed. CR.MCR.EcCr.FaAlCr.Adig is recorded from weak-strong tidal streams (0.5-3 m/sec), CR.MCR.EcCr.FaAlCr.Spi and CR.MCR.EcCr.FaAlCr.Sec are recorded from weak-moderately strong tidal streams (<0.5-1.5m/sec) (Connor *et al*., 2004). Therefore, if anthropogenic litter was deposited it would likely be removed within a few tidal cycles.

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

There was **no evidence** on which to assess this pressure.

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

Alcyonium digitatum, *Echinus esculentus*, *Securiflustra securifrons* & *Spirobranchus triqueter* have no hearing perception but vibrations may cause an impact, however, no studies exist to support an assessment (where relevant).

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

There is no evidence to suggest that If exposed to anthropogenic light sources algal species would benefit. CR.MCR.EcCr.FaAlCr, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are also circalittoral biotopes and are thus by definition naturally shaded environments with low light levels. Increased shading (e.g. by the construction of a pontoon, pier etc) could be beneficial to the characterizing species within these biotopes.

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

Barrier to species movement	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Not relevant: barriers and changes in tidal excursion are not relevant to biotopes restricted to open waters.

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

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

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

Not relevant

Biological Pressures

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

Alcyonium digitatum, *Securiflustra securifrons* & *Spirobranchus triqueter* are not cultivated or translocated. *Echinus esculentus* was identified by Kelly & Pantazis (2001) as a species suitable for culture for the urchin roe industry. However, at the time of writing no evidence could be found to suggest that significant *Echinus esculentus* mariculture was present in the UK. If industrially cultivated it is feasible that *Echinus esculentus* individuals could be translocated.

Translocation also has the potential to transport pathogens to uninfected areas (see pressure ‘introduction of microbial pathogens’). The sensitivity of the ‘donor’ population to harvesting to supply stock for translocation is assessed for the pressure ‘removal of target species’.

Introduction or spread of invasive non-indigenous species	No evidence (NEv) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

There was no evidence regarding known invasive species which may pose a threat to

CR.MCR.EcCr.FaAlCr, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec.

Didemnum vexillum is an invasive colonial sea squirt native to Asia which was first recorded in the UK in Darthaven Marina, Dartmouth in 2005. *Didemnum vexillum* can form extensive mats over the substrata it colonizes; binding boulders, cobbles and altering the host habitat (Griffith *et al.*, 2009). *Didemnum vexillum* can also grow over and smother the resident biological community. Recent surveys within Holyhead Marina, North Wales have found *Didemnum vexillum* growing on and smother native tunicate communities (Griffith *et al.*, 2009). Due to the rapid-re-colonization of *Didemnum vexillum* eradication attempts have to date failed.

Presently *Didemnum vexillum* is isolated to several sheltered locations in the UK (NBN, 2015), however, *Didemnum vexillum* has successfully colonized the offshore location of the Georges Bank, USA (Lengyel *et al.*, 2009) which is more exposed than the locations which *Didemnum vexillum* have colonized in the UK. It is, therefore, possible that *Didemnum vexillum* could colonize more exposed locations within the UK and could, therefore, pose a threat to CR.MCR.EcCr.FaAlCr, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec.

Introduction of microbial pathogens	No evidence (NEv) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

There was '**no evidence'** to suggest that any of the characterizing species within CR.MCR.EcCr.FaAlCr, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are sensitive to current/known microbial pathogens.

Alcyonium digitatum acts as the host for the endoparasitic species *Enalcyonium forbesiand* and *Enalcyonium rubicundum* (Stock, 1988). Parasitisation may reduce the viability of a colony but not to the extent of killing them but no further evidence was found to substantiate this suggestion.

Thomas (1940) recorded parasites of *Spirobranchus triqueter*. *Trichodina pediculus* (a ciliate) was observed in high numbers moving over the branchial crown. However, this relationship is symbiotic, not parasitic. Parasites found in the worm include gregarines & ciliated protozoa and parasites that had the appearance of sporozoan cysts. However, no information was found about the effects of microbial pathogens on *Spirobranchus triqueter*.

Stebbing (1971) reported that encrusting epizoites reduced the growth rate of *Flustra foliacea* by ca 50%. The bryozoan *Bugula flabellata* produces stolons that grow in and through the zooids of *Flustra foliacea*, causing "irreversible degeneration of the enclosed polypide" (Stebbing, 1971). There is, however, no evidence of disease which can cause significant mortality at a population or biotope level within *Flustra foliacea* or *Securiflustra securifrons*.

Echinus esculentus is susceptible to 'Bald-sea-urchin disease', which causes lesions, loss of spines, tube feet, pedicellariae, destruction of the upper layer of skeletal tissue and death. It is thought to be caused by the bacteria Vibrio anguillarum and *Aeromonas salmonicida*. Bald sea-urchin disease was recorded from *Echinus esculentus* on the Brittany Coast. Although associated with mass mortalities of *Strongylocentrotus franciscanus* in California and *Paracentrotus lividus* in the French Mediterranean it is not known if the disease induces mass mortality (Bower, 1996).

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

At the time of writing none of the characterizing species within CR.MCR.EcCr.FaAlCr, CR.MCR.EcCr.FaAlCr.Spi & CR.MCR.EcCr.FaAlCr.Sec are commercially exploited. This pressure is considered ‘**Not Relevant**’.

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

Alcyonium digitatum and faunal turf communities (which include bryozoans such as *Securiflustra securifrons*) are probably resistant to abrasion through bottom fishing (see abrasion pressure). *Alcyonium digitatum* goes through an annual cycle, From February to July all *Alcyonium digitatum* colonies are feeding, from July to November an increasing number of colonies stop feeding. During this period, a large number of polyps can retract and a variety of filamentous algae, hydroids and amphipods can colonize the surface of colonies epiphytically. From December to February, the epiphytic community is however sloughed off (Hartnoll, 1975). If *Alcyonium digitatum* were removed the epiphytic species would likely colonize rock surfaces and are therefore not dependent on *Alcyonium digitatum*.

Within CR.MCR.EcCr *Alcyonium digitatum*, *Securiflustra securifrons* & *Spirobranchus triqueter* spatially compete, however at the time of writing there isn’t any evidence to suggest other interspecific relationships or dependencies between these species. Therefore, removal of one or a number of these species would provide colonization space and most likely benefit the species with rapid colonization rates (e.g. *Spirobranchus triqueter*). *Echinus esculentus* is an important red algae grazer within CR.MCR.EcCr (Connor *et al*., 2004), without which the abundance of red algae may increase and possibly displace some of the faunal turf species. If *Alcyonium digitatum*, *Securiflustra securifrons* & *Spirobranchus triqueter* were removed this would alter the character of the biotope.

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

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