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Information on the species and habitats around the coasts and sea of the British Isles

Alcyonium digitatum with *Securiflustra securifrons* on tide-swept moderately wave-exposed circalittoral rock

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

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Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [https://www.marlin.ac.uk/habitats/detail/15]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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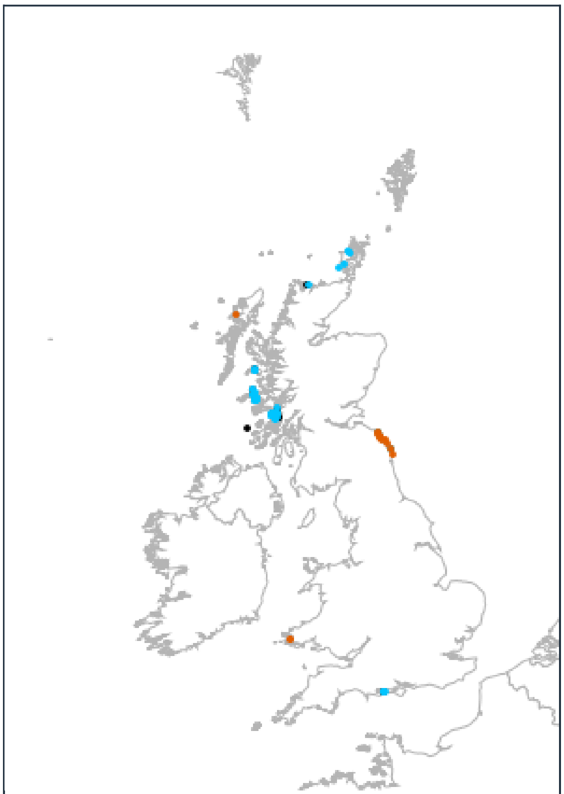
Alcyonium digitatum **with** ***Securiflustra securifrons*** **on tide-swept moderately wave-exposed circalittoral rock**
Photographer: Rohan Holt



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

Researched by Thomas Stamp **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A4.2143	*Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed circalittoral rock
JNCC 2015	CR.MCR.EcCr.FaAlCr.Sec	*Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed circalittoral rock
JNCC 2004	CR.MCR.EcCr.FaAlCr.Sec	*Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed circalittoral rock
1997 Biotope	CR.ECR.Alc.AlcSec	*Alcyonium digitatum* with *Securiflustra securifrons* on weakly tide-swept or scoured moderately exposed circalittoral rock

Description

Found on generally moderately exposed bedrock and boulders with *Alcyonium digitatum*, often appearing fairly clean and grazed but with more erect species than FaAlC, including *Securiflustra securifrons* and *Flustra foliacea*. *Spirobranchus* is abundant at some sites, and other species include *Parasmittina trispinosa*, coralline crusts, *Sagartia elegans*, *Abietinaria abietina*, *Leptasterias muelleri*, *Antedon bifida*, *Filograna/Salmacina* and sometimes *Tubularia*. This biotope tends to occur in areas which are less turbid/silty than Flu.Flu and is found mainly in south-east Scotland and just across the border as well as in some sealochs. ECR.AlcC has fewer species with less *Alcyonium*.

Depth range

10-20 m, 20-30 m

Additional information

-

Listed By

- none -

Further information sources

Search on:

G G G JNCC

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 RV Robert (Hiscock, 1981). Four years after sinking, the wreck of a small coaster, the M.V. 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. 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, 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 is 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 ship wrecks 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 and CR.MCR.EcCr.FaAlCr.Spi, without which the character of these biotopes would change and may be 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 24 hr 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.Pom 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 was 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.Pom 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	Medium	Medium
	Q: Low A: NR C: NR	Q: High A: High C: High	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.Pom 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	Medium	Medium
	Q: Low A: NR C: NR	Q: High A: High C: High	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.Pom & 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.Pom & 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 the 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.Pom and 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.Pom & 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.Pom & 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.Pom & CR.MCR.EcCr.FaAlCr.Sec are predominantly circalittoral habitats, CR.MCR.EcCr.FaAlCr.Adig, CR.MCR.EcCr.FaAlCr.Pom 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.Aug, CR.MCR.EcCr.FaAlCr.Pom & 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.Pom & 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 Canyon* 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, subtidal 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 subtidal 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 165 m 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.Pom 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 de-oxygenation 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.Pom & 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.Pom & 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 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.Pom & 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.Pom & 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.Pom & 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.Pom & 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 were 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

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

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

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.Pom and 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. This pressure is therefore considered 'Not relevant' at the time of writing.

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.Pom & 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.Pom & 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.Pom and 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.Pom and 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, there wasn't any evidence to suggest other interspecific relationships or dependencies between these species. Therefore, removal of 1 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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