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Marine Information Network

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

Caryophyllia (Caryophyllia) smithii and *Swiftia pallida* on 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/386]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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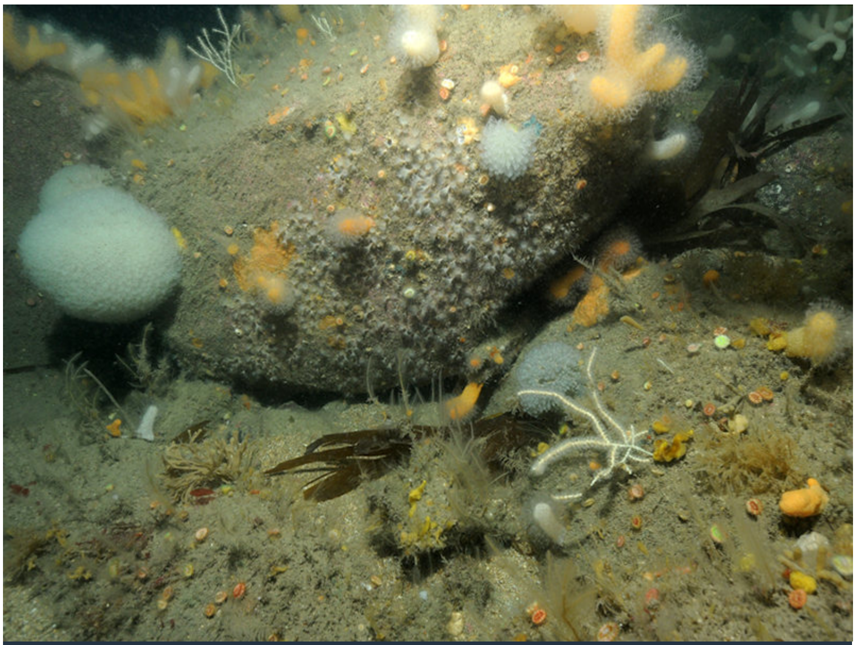
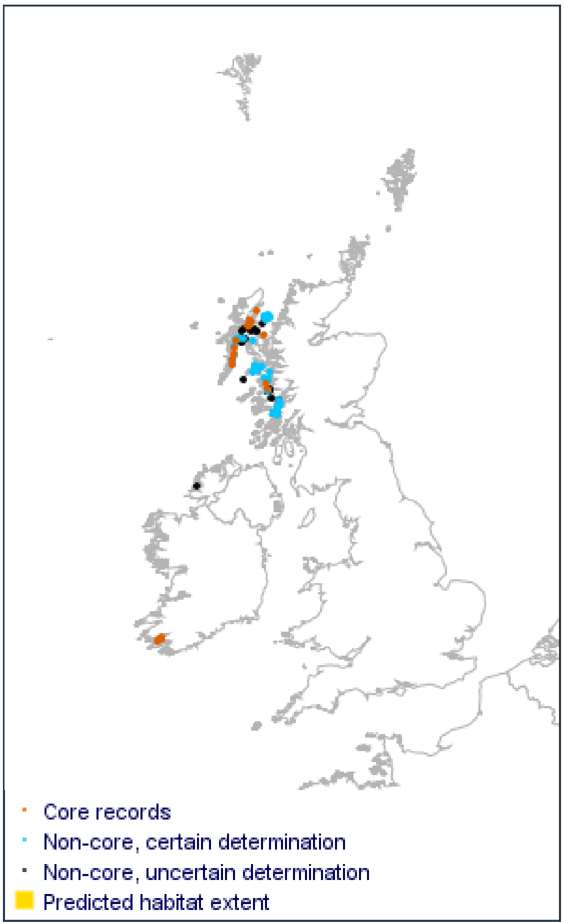


Caryophyllia smithii **and** ***Swiftia pallida*** **on circalittoral rock**
Photographer: Keith Hiscock



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

Researched by John Readman & Olivia Durkin **Refereed by** Dr Rohan Holt

Summary

UK and Ireland classification

EUNIS 2008	A4.211	*Caryophyllia smithii* and *Swiftia pallida* on circalittoral rock
JNCC 2015	CR.MCR.EcCr.CarSwi	*Caryophyllia (Caryophyllia) smithii* and *Swiftia pallida* on circalittoral rock
JNCC 2004	CR.MCR.EcCr.CarSwi	*Caryophyllia smithii* and *Swiftia pallida* on circalittoral rock
1997 Biotope	CR.MCR.XFa.ErSSwi	Erect sponges and *Swiftia pallida* on slightly tide-swept moderately exposed circalittoral rock

Description

Typically found on the upper and vertical faces of very exposed through to wave-sheltered circalittoral bedrock and boulders, favouring weak tidal streams. It is characterized by dense aggregations of the cup coral *Caryophyllia smithii* and the northern sea fan, *Swiftia pallida*, on the silty substratum. Under the silt, bryozoan crusts such as *Parasmittina trispinosa* and encrusting red algae may be present. This biotope may have a grazed appearance, perhaps attributable to the frequently occurring edible sea urchin, *Echinus esculentus*. There may be a sparse hydroid turf present, with species such as *Nemertesia antennina*, *Nemertesia ramosa* and *Halecium halecinum*. The soft corals *Alcyonium glomeratum* and *Alcyonium digitatum* may be present on the tops of boulders along with the crinoids *Antedon petasus* and *Antedon bifida*. Other echinoderms occasionally observed include the starfish *Marthasterias glacialis*, *Asterias rubens* and *Luidia ciliaris*. Sponges feature only occasionally in this biotope, including species such as *Cliona celata*. The bryozoan *Porella compressa* may also be recorded. Ascidians occasionally present include *Ascidia mentula*, *Clavelina lepadiformis* and *Ciona intestinalis*. Under-boulder fauna typically consists of the crustacean *Munida rugosa*. The polychaete *Spirobranchus triqueter* may be seen encrusting the rocky surface. (Information from Connor *et al*., 2004).

Depth range

10-20 m, 20-30 m, 30-50 m

Additional information

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Listed By

- none -

Further information sources

Search on:

JNCC

Habitat review

Ecology

Ecological and functional relationships

1. *Caryophyllia smithii* reduce competition with encrusting organisms (e.g. the sponge *Cliona celata*) by growing taller, keeping the coral cup above sediment. As juveniles, *Caryophyllia smithii* are more able to morphologically adapt to their surrounding conditions, for example, an increased growth rate will be exhibited to reduce competition or to remain above the sediment. The size of *Caryophyllia smithii* is significantly greater in wave sheltered environments as the risk of detachment due to strong water flow is lower. Height of the cup coral also increases with increasing depth in wave sheltered conditions (Bell, 2002).
2. Competition with algae is likely to be an important factor in the distribution of *Caryophyllia smithii*, as algae (foliacous and coralline) interfere with settlement and feeding . Therefore, algal grazing by fish may be beneficial to coral growth by creating suitable colonization space for coral settlement (Miller & Hay, 1998). Algal populations decrease with increasing depth, due to reduced light penetration, and as a result there is a greater availability of space for *Caryophyllia smithii* below the photic zone (Bell, 2002).
3. Edible sea urchins, *Echinus esculentus* are a relatively important species in this habitat and have an important structuring effect on epifaunal communities and succession. Sea urchins are generalist grazers and contribute to the diversity of epiflora/fauna and habitat diversity through grazing; removing seaweeds, bryozoans, hydroids, ascidians and other encrusting invertebrates potentially leaving only encrusting corallines and bedrock (Sebens, 1985; 1986). This biotope, therefore, may have a grazed appearance. The presence of high densities of grazing sea urchins result in urchin barrens allowing for higher coverage of crustose coralline algae (Corallinaceae) habitat as opposed to macroalgal dominated habitat (Shears *et al*., 2002; Connell, 2003).
4. Hydroids and soft corals (e.g. *Alcyonium digitatum*) are passive predators of zooplankton and other small animals, while larger prey are taken by anemones (*Isozoanthus sulcatus*) and cup corals (*Caryophyllia smithii*) (Hartnoll, 1998). The most common prey of hydroids, *Nemertesia antennina*, *Nemertesia ramosa* and *Halecium halecinum*, includes Nauplii, copepods, and other small crustaceans and zooplankton.
5. The nationally rare sea fan anemone, *Amphianthus dohrnii* grows on *Swiftia pallida* and is found growing almost exclusively on seafans.
6. Ascidians, *Ascidia mentula*, *Clavelina lepadiformis* and *Ciona intestinalis*, are fed on by generalist predators, including starfish (e.g. *Marthasterias glacialis*, *Luidia ciliaris*), crabs and squat lobster (*Munida rogusa*).
7. Encrusting coralline algae are present on the bedrock surface and may support epiphytes or be overgrown by epiphytes (e.g. Large anemones, soft corals and colonial ascidians).
8. Mobile fish predators include gobies (e.g. *Thorogobius ephippiatus*) wrasse (e.g. *Ctenolabrus rupestris* and *Labrus bergylta*) feed mainly on small crustaceans.
9. Deposit feeding sea cucumbers, *Thyone roscovita*, may be important in removing silt and enabling settlement of other benthic species.

Seasonal and longer term change

Sea urchins (e.g. *Echinus esculentus*) have a significant effect on community structure and succession, their grazing trails can often be seen through the bryozoan turf, leaving bare rock or encrusting corallines behind.

Species such as *Alcyonium digitatum* have seasonal stages, retracting their polyps and cease feeding from July to November, during which time the surface of the colony becomes colonized by encrusting algae and hydroids (Fish & Fish, 1996). When the colony recommences feeding in December, the surface film together with the surface epithelium is shed. *Alcyonium digitatum* may take advantage of available space for colonization during winter spawning events.

In temperate waters, most bryozoan species tend to grow rapidly in spring and optimal reproduction occurs in late summer, depending on temperature, day length and the availability of phytoplankton (Ryland, 1970). Some species of bryozoans and hydroids demonstrate seasonal cycles of growth in spring/summer and die off in late autumn/winter, overwintering as dormant stages or juvenile stages (see Ryland, 1976; Gili & Hughes, 1995; Hayward & Ryland, 1998). The biotope is likely to demonstrate seasonal changes in the abundance or cover of the dominant bryozoans and hydroids.

Habitat structure and complexity

The biotope occurs on bedrock and boulders which may provide overhangs, crevices and shelter where crevice dwelling species such as sea cucumbers (*Aslia lefevrei*), squat lobsters (*Munida rugosa*) and wrasse (e.g. *Ctenolabrus rupestris*) may live. *Swiftia pallida* colonies are present on the silty substratum and are important habitats for the sea fan anemone *Amphianthus dohrnii*. Small invertebrates, such as crabs, seek refuge within the complexity of sea fan (*Swiftia pallida*) structures and may also protect their host from fouling algae or other invertebrates. Dense aggregations of *Caryophyllia smithii* colonise boulders and bedrock surfaces, Bedrock surfaces are colonized by encrusting invertebrates, such as the bryozoan *Parasmittina trispinosa*, and algae. The fan shape of *Swiftia pallida* enhances the feeding efficiency of the colony with respect to current flow, as it changes water flow pattern through the colony (Chamberlain & Graus, 1975).

Productivity

The main trophic group in this biotope is suspension feeders although there may be several species of predatory fish and grazing echinoderms present. 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).

Recruitment processes

Caryophyllia smithii reproduces between January and March, spawning occurs from March to June (Tranter *et al*., 1982). However, asexual reproduction and division is commonly observed (Hiscock & Howlett, 1976). Hydroids are often the first organisms to colonize available space in settlement experiments (Gili & Hughes, 1995). 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 *Alcyonium digitatum* are highly susceptible to being smothered or eaten, however, can survive intense sea urchin predation when larger (Sebens, 1985, 1986). Maximum spawning of *Echinus esculentus* occurs in spring. Hydroids are capable of asexual reproduction and many species produce dormant, resting stages, which are very resistant of environmental perturbation (Gili & Hughes, 1995). Echinoderms are highly fecund; producing planktonic larvae with high dispersal potential. 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. Spawning for *Antedon bifida* is stated as May to July. *Cerianthus lloydii* has pelagic larvae and have been recorded in the plankton from January to August having a planktonic life of about 3 months (Fish & Fish, 1996).

Time for community to reach maturity

Caryophyllia smithii is slow growing, with a reported growth rate of 0.5 1mm horizontal growth per year (Fowler & Lafferty, 1993). Bryozoans, hydroids, and ascidians are opportunistic, grow and colonize space rapidly and will probably develop a faunal turf within 1-2 years. *Swiftia pallida* is likely to have a similar growth rate to that of *Eunicella verrucosa*, at 1 cm per year (see species reviews). *Swiftia pallida* colonies are generally 7 - 20 cm, (i.e. 7 - 20 years old). Taking growth rates of key species into consideration, it could take approximately 15 years for this community to reach maturity.

Additional information

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Preferences & Distribution

Habitat preferences

Depth Range	10-20 m, 20-30 m, 30-50 m
Water clarity preferences	No information found
Limiting Nutrients	No information found
Salinity preferences	Full (30-40 psu)
Physiographic preferences	Open coast, Sea loch / Sea lough
Biological zone preferences	Circalittoral
Substratum/habitat preferences	Bedrock, Large to very large boulders, Small boulders
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Exposed, Extremely exposed, Moderately exposed, Sheltered, Very exposed
Other preferences	Vertical and upper faces of bedrock and boulders.

Additional Information

Sea temperature around Scotland ranges from 4 - 15°C. It is thought that colonization of the Shetland Islands by *Swiftia pallida*, and as such this biotope, has been prevented by geographical barriers (Hiscock *et al.*, 2001).

Species composition

Species found especially in this biotope

- *Amphianthus dohrnii*

Rare or scarce species associated with this biotope

- *Caryophyllia smithii*

Additional information

Swiftia pallida is host to the sea fan anemone *Amphianthus dohrnii*, which is found exclusively on sea fans.

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

The CR.MCR.EcCr.CarSwi biotope complex is characterized by dense aggregations of the cup coral *Caryophyllia smithii* and the northern sea fan *Swiftia pallida* on rock or boulders with a thin layer of silt. CarSwi.Aglo is a more silted variant of this biotope complex found off south-west Ireland that includes *Alcyonium glomeratum* and may have a more diverse sponge component. CarSwi.LgAs is a more impoverished variant, which occurs across a wide range of wave exposures, up to extremely exposed off the western coast of Scotland. The biotope CR.HCR.XFa.SwiLgAs is very similar to the CR.MCR.EcCr.CarSwi complex, but with the addition of a characteristic faunal turf.

This assessment focuses on the characterizing *Caryophyllia smithii* and *Swiftia pallida*. The faunal turf is composed of typically opportunistic species and is considered where appropriate. *Alcyonium glomeratum* is also considered for the biotope CR.MCR.EcCr.CarSwi.Aglo. Given the lack of information on *Swiftia pallida*, evidence for other sea fans, including *Eunicella verrucosa* is presented where applicable. The evidence is also sparse for *Alcyonium glomeratum* and assessments are based on the similar *Alcyonium digitatum*. Other species present are considered opportunistic colonizers, ephemeral or not important characterizing within the biotopes.

Resilience and recovery rates of habitat

Caryophyllia smithii is a small (max 3 cm across) solitary coral, common within tide swept sites of the UK (Wood, 2005), and distributed from Greece (Koukouras, 2010) to the Shetland Islands and Orkney (NBN, 2015; Wilson, 1975). It was suggested by Fowler & Laffoley (1993) that *Caryophyllia smithii* was a slow growing species (0.5-1 mm in horizontal dimension of the corallum per year), which in turn suggested that inter-specific spatial competition with colonial faunal or algae species were important factors in determining local abundance of *Caryophyllia smithii* (Bell & Turner, 2000). *Caryophyllia smithii* reproduces between January and March and spawning occurs from March to June (Tranter *et al.*, 1982). 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) Asexual reproduction and division is also commonly observed (Hiscock & Howlett, 1976). Bell (2002) reported that juvenile *Caryophyllia smithii* has a variable morphology that gives them an advantage in colonizing a wide range of habitats.

Sea fans are sessile colonial cnidarians that grow erect from the substratum, with each colony formed of many small polyps, each with tentacles that may be either extended or retracted. *Swiftia pallida* is a small sea fan that forms slender colonies with infrequent branching, up to 20 cm tall but usually 7- 10 cm. Branches are irregularly orientated and twig-like (Manuel, 1988; Hiscock, 2007). Populations of *Swiftia pallida* are thought to be self-sustaining, with short-lived larvae and limited potential for larval dispersal. It is thought that the colonization of the Shetland Islands has been prevented by geographical barriers (Hiscock *et al.*, 2001). Reproduction is likely to be annual and may be triggered by either summer high or winter low temperatures (Hiscock *et al.*, 2001).

Although *Swiftia pallida* has not been specifically studied, the average number of eggs per polyp in other gorgonians increases with increasing colony size. The number of eggs released from larger colonies can be orders of magnitude higher than for smaller colonies (Beiring & Lasker, 2000). It has been suggested that when a large colony size is attained, more energy is available for reproduction because relative colony growth decreases (Beiring & Lasker, 2000). *Swiftia pallida* abundance may be up to three colonies per square metre (Minchin, 1987c) or 5-10 /m^2 (Holt pers comm.) and typically occurs at ca 1-9 /10m^2 in this biotope (Connor *et al*., 2004). Growth rates for this species are unknown, however, the pink sea fan *Eunicella verrucosa* has highly variable growth. A population of *Eunicella verrucosa* at Lundy Island had growth rates of approximately 1 cm/year, which may be similar to *Swiftia pallida*. The lifespan of *Swiftia pallida* is estimated to be between 10 and 20 years (Hiscock *et al.* 2001; Wilding & Wilson, 2009). Very little information was found on the recovery potential of this species. The ability to recolonize an area following mass mortality is likely to be restricted (Hiscock *et al*., 2001).

Little information was available for *Alcyonium glomeratum* and resilience was assessed based on the similar *Alcyonium digitatum*. *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). 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). Larvae have been reported to survive for up to 35 weeks as non-feeding planulae and may favour the dispersal and eventual discovery of a site suitable for settlement (Hartnoll, 1975). *Alcyonium digitatum* can recruit onto bare surfaces within 2 years but may take up to 5 years to fully recover following significant mortality (Whomersley & Picken, 2003; Hiscock *et al*., 2010).

Resilience assessment. *Caryophyllia smithii* colonized the wreck of the *Scylla* within a year, however, this may be due to the time of the vessel sinking and if removed recovery may take longer. *Alcyonium glomeratum* is likely to recruit fairly rapidly, however full recovery following a significant decline may take longer. *Swiftia pallida* is likely to be the slowest to recover and if a population was completely removed from the habitat (resistance of '**None**') resilience has been assessed as '**Low'** (recovery in 10-25 years) because of the low larvae dispersal, probable importance of self-sustaining communities and slow growth rate of *Swiftia pallida* (Hiscock *et al*., 2001). For resistance assessments of '**Low**' or '**Medium**', resilience has been assessed as '**Medium**' (recovery in 2-10 years).

Hydrological Pressures

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

Mitchell *et al.* (1983) suggested that the Scottish and Irish populations of *Swiftia pallida* were at the southern limit of the species range. It should be noted that there are reports of *Swiftia pallida* in deep waters (518-766 m depth) in the Mediterranean (Mastrototaro *et al*., 2010). However, their distribution in the British Isles appears to be limited to the Atlantic coasts of Scotland and Ireland (NBN, 2015). Hiscock *et al.* (2001) predicted the loss of all populations occurring in the Inner Hebrides and mainland western Scotland with a 2°C increase in summer surface temperatures over a 20 year period.

Caryophyllia smithii is found across the British Isles (NBN, 2015) and has been recorded in Greece

(Koukouras, 2010). It is, therefore, unlikely to be significantly affected by an increase at the benchmark level. However, Tranter *et al.* (1982) suggested *Caryophyllia smithii* reproduction was cued by seasonal increases in seawater temperature. Therefore, unseasonal increases in temperature may disrupt natural reproductive processes and negatively influence recruitment patterns. Holt (pers. comm.) also suggested that long-term increases in temperature due to climate change may allow the parasitic barnacle *Adna anglica* to extend its range northwards and overlap the range of this biotope. *Adna anglica* is a southern species limited to the southwest of Britain where it parasitizes *Caryophillia* and has probably contributed to the decrease in abundance of *Leptopsammia* (Holt pers. comm.). It may impact the abundance of *Caryophyllia* if climate change allowed it to extend its range northwards (Holt pers. comm.).

Alcyonium glomeratum has been recorded from Scotland to the Bay of Biscay (Hayward & Ryland, 1995b) and would probably tolerate an increase at the benchmark level. Other species present in the biotope are widespread across the British Isles or are not important to the classification of this biotope.

Sensitivity assessment. The CR.MCR.EcCr.CarSwi biotope complex generally has a northern distribution within the British Isles, with the characterizing *Swiftia pallida* being intolerant of warmer conditions. Resistance is likely to be '**Low**', therefore, resilience is '**Medium**' and sensitivity is assessed as '**Medium**'.

Temperature decrease (local)	Low Q: Low A: NR C: NR	Medium Q: Medium A: Medium C: Medium	Medium Q: Low A: Low C: Low

Caryophyllia smithii is a southern species (Fish & Fish, 1992) with a northern range limit in the Shetland Isles (NBN, 2015). It is, therefore, likely to be close to its northerly range limit and therefore likely to be negatively affected by a decrease in temperature at the benchmark level. *Swiftia pallida* is classed as a northerly species and is recorded in Scotland, south-west Ireland (e.g. Kenmare Bay) on the west coasts of Norway and Sweden and in deep water from the Bay of Biscay and the Mediterranean (Wilding & Wilson, 2009). *Alcyonium glomeratum* has been recorded from Scotland to Biscay (Hayward & Ryland, 1995b) and, being close to it northerly distribution limit, is likely to experience a significant decline due to a decrease in temperature.

Sensitivity assessment. *Caryophyllia smithii* and *Alcyonium glomeratum* are already close to their northern range limit and a decrease would likely significantly affect the northern populations of the species and hence the biotope. Resistance is assessed as '**Low**', resilience as '**Medium**' and sensitivity as '**Medium**'.

Salinity increase (local)	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

CR.MCR.EcCr.CarSwi is a circalittoral biotope and an increase in salinity at the benchmark would result in a change from 'full' to hypersalinity. No records of the characterizing *Caryophyllia smithii* or *Swiftia pallida* in hypersaline conditions was found. Hence, no assessment was made due to the lack of evidence.

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

This biotope occurs in full salinity. *Caryophyllia smithii* has been recorded in biotopes from Full to Low salinity (Connor *et al*., 2004) and would probably tolerate a change at the benchmark level. *Swiftia pallida* has only been recorded in full salinity biotopes (Connor *et al*., 2004) and is likely to be intolerant of a decrease in salinity. Therefore, resistance has been assessed as '**Low**', resilience as '**Medium**' and sensitivity has been assessed as '**Medium**'.

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

Alcyonium digitatum, *Caryophyllia smithii*, *Spirobranchus triqueter* and sponges are suspension feeders, relying on water currents to supply food (Hiscock, 1983). These taxa, therefore, thrive in conditions of vigorous water flow e.g. around Orkney and St Abbs, Scotland, where *Alcyonium digitatum* dominated biotopes may experience tidal currents of 3 and 4 knots (approximately 1.5 m/sec) during spring tides (De Kluijver, 1993). *Caryophyllia smithii*, in particular, is described as favouring sites with high tidal flow (Bell & Turner, 2000; Wood, 2005). This biotope consists mainly of species firmly attached to the substratum, which would be unlikely to be displaced by an increase in the strength of tidal streams at the benchmark level.

Sea fans are found in strong tidal streams but probably retract their polyps when current velocity gets too high for the polyps to retain food. Tidal streams exert a steady pull on the colonies and are therefore likely to detach only very weakly attached colonies. Colonies rely on high water flow rates to bring food and to remove silt (Hiscock, 2007). *Caryophyllia smithii* has been recorded in biotopes from negligible to strong water flow (0-6 knots) (Connor *et al*., 2004)

No evidence for *Swiftia pallida* was found, however, Bunker (1986) reported that the sea fan *Eunicella verrucosa* was present in areas subject to at least moderate tidal streams but was most abundant in strong tidal streams. There is a tendency for *Eunicella verrucosa* to grow aligned across the direction of the prevailing current (Bunker, 1986).

Sensitivity assessment. The CR.MCR.EcCr.CarSwi biotope complex is found from negligible to moderately strong water flow (0-3 knots) but can be found from extremely exposed to sheltered wave exposure. It is likely that the biotope exists in moderate energy, with either water flow or wave action prevailing. Change in water flow is, therefore, probably only relevant to wave sheltered examples. The characterizing species (including gorgonians, soft corals *and Caryophyllia smithii*) are generally associated with moderate to high energy environments. However, a change at the benchmark level is unlikely to be significant. Resistance is, therefore, assessed as '**High**', resilience as '**High**' and the biotope is '**Not Sensitive'** at the benchmark level.

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

Changes in emergence are **Not Relevant** to this biotope as it is restricted to fully subtidal/circalittoral conditions. The pressure benchmark is relevant only to littoral and shallow sublittoral fringe biotopes.

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

Dead sea fans have been recorded washed up along Chesil Beach (UK) following winter storms (Hatcher & Trewhella, 2006). However, Bunker (1986) reported that *Eunicella verrucosa* was most abundant in moderately exposed locations. *Caryophyllia smithii* has been recorded in very sheltered to extremely exposed biotopes (Connor *et al*., 2004). Bell (2002) reported that *Caryophyllia smithii* near Lough Hyne (Ireland) exposed to strong wave action on open coasts were relatively small, possibly due to juvenile morphological variability, as *Caryophyllia smithii* found deeper and in sediment were thinner and taller.

Sensitivity assessment. The CR.MCR.EcCr.CarSwi biotope complex is extremely exposed to sheltered from wave action, but can be found from negligible to moderately strong water flow (0-3 knots). It is likely that the biotope exists in moderate to high energy, with either water flow or wave action prevailing. Change in wave exposure is therefore probably only relevant to habitats that experience weak water flow. The characterizing species (including gorgonians and *Caryophyllia smithii*) are generally associated with moderate to high energy environments. However, a change at the benchmark level is unlikely to be significant. Resistance is therefore assessed as '**High**', resilience as '**High**' and the biotope is '**Not Sensitive'** at the benchmark level.

Chemical Pressures

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

Chan *et al.* (2012) studied the response of the gorgonian *Subergorgia suberosa* to heavy metal-contaminated seawater from a former coastal mining site in Taiwan. Cu, Zn, and Cd each showed characteristic bioaccumulation. Metallic Zn accumulated but rapidly dissipated. In contrast, Cu easily accumulated but was slow to dissipate, and Cd was only slowly absorbed and dissipated. Associated polyp necrosis, mucus secretion, tissue expansion, and increased mortality were reported in *Subergorgia suberosa* exposed to water polluted with heavy metals. However, this pressure is **Not assessed**

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.CarSwi is a sub-tidal biotope complex (Connor *et al*., 2004). Oil pollution is mainly a surface phenomenon and its impact on 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 could potentially negatively affect sub-littoral habitats (Castège *et al*., 2014).

Filter feeders are highly sensitive to oil pollution, particularly those inhabiting the tidal zones which experience high exposure and show correspondingly high mortality, as are bottom-dwelling organisms in areas where oil components are deposited by sedimentation (Zahn *et al*., 1981). White *et al.* (2012) reported on deep-water gorgonian communities, including *Swiftia pallida* six months after the *Deep Water Horizon* oil spill. Stress in the gorgonians was observed including excessive mucous production, retracted polyps and smothering of brown flocculent material (floc) which contained oil from the Macondo well. Hsing *et al.* (2013) reported that, following smothering by floc associated with the *Deep Water Horizon* spill, recovery of corals and gorgonians was inversely correlated with floc presence.

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.

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	Low Q: Low A: NR C: NR	Medium Q: Low A: NR C: NR	Medium Q: Low A: Low C: Low

In general, respiration in most marine invertebrates does not appear to be significantly affected until extremely low concentrations are reached. For many benthic invertebrates this concentration is about 2 ml/l (ca 2.66 mg/l) (Herreid, 1980; Rosenberg *et al.*, 1991; Diaz & Rosenberg, 1995). Cole *et al.* (1999) suggest possible adverse effects on marine species below 4 mg/l and probable adverse effects below 2 mg/l.

Little information on the effects of oxygenation on bryozoans was found. No evidence was found concerning the effects of hypoxia for *Swiftia pallida*. However, as a species that lives in fully oxygenated waters in conditions of flowing waters, it is expected that it would be intolerant to decreased oxygen levels. Bell (2002) reported that an oxycline at Lough Hyne (<5 % surface concentration) limited vertical colonization by *Caryophillia smithii*.

Sensitivity assessment

Despite limited evidence, *Swiftia pallida* and *Caryophyllia smithii* are unlikely to tolerate hypoxic events given their preference for moderate water movement. Resistance is '**Low**', resilience is '**Medium**' and sensitivity is '**Medium**'. It should be noted that, as these biotopes occur in high energy habitats and low oxygen events are likely to be short-lived.

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

Echavarri-Erasun *et al.* (2007) described the effects of deepwater sewage outfall discharges on the relative abundance of rocky reef communities. Species typical of hard substrata (including *Caryophyllia smithii* and bryozoans) increased in total richness and abundance near the outfall.

Whilst *Swifita pallida* could be at risk of competition from algae in shallow waters due to nutrient enrichment, this biotope occurs in the circalittoral below the depth suitable for most macroalgae. If nutrient enrichment resulted in algal blooms, then their subsequent death could result in deposition of dead algae on the sea bed and resultant localised hypoxia (see above).

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

Organic enrichment	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

Echavarri-Erasun *et al.* (2007) described the effects of deepwater sewage outfall discharges on the relative abundance of rocky reef communities. Species typical of hard substrata (including *Caryophyllia smithii* and bryozoans) increased in total richness and abundance near the outfall.

Sensitivity assessment. Evidence for some of the characterizing species suggests some tolerance or even increased abundance when exposed to organic enrichment in the circalittoral. However, **'No evidence'** for the important characterizing *Swiftia pallida* could be found.

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' to biotopes occurring on bedrock.

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	Low Q: Low A: NR C: NR	Medium Q: Low A: NR C: NR	Medium Q: Low A: Low C: Low

Physical disturbance by fishing gear has been shown to adversely affect emergent epifaunal communities with hydroid and bryozoan matrices reported to be greatly reduced in fished areas (Jennings & Kaiser, 1998). Heavy mobile gears could also result in movement of boulders (Bullimore, 1985; Jennings & Kaiser, 1998). Whilst no evidence for *Swiftia pallida* was found, reviews have considered the sea fan *Eunicella verrucosa* to be sensitive to abrasion (MacDonald *et al.*, 1996; Hall *et al.*, 2008; Tillin *et al.*, 2010). *Swiftia pallida* has been observed tangled in lobster pot netting and detached in the vicinity of lobster pots (Holt, pers comm.). Other studies suggest that *Eunicella verrucosa* may be more resistant to abrasion pressures. Eno *et al.* (2001) conducted experimental potting on areas containing fragile epifaunal species in Lyme Bay, south-west England. Divers observed that pink sea fan 'flexed and bent before returning to an upright position under the weight of pots'. Although relatively resistant to a single event it was not clear whether repeated exposure could cause further damage or whether injuries had been inflicted that could lead to deterioration (Eno *et al.*, 2001). Observation of pots suggested that these were dragged along the bottom when wind and tidal streams were strong, however little damage to epifauna was observed. *Eunicella verrucosa* were patchily distributed in areas subject to potting damage, but the study could not determine whether this was due to damage from potting (Eno *et al.*, 2001). A further four-year study on potting in the Lundy Marine Protected Area detected no significant differences in *Eunicella verrucosa* between areas subject to commercial potting and those where this activity was excluded (Sheehan *et al.*, 2013).

However, Tinsley (2006) observed flattened sea fans, that had continued growing, with new growth being aligned perpendicular to the current, so clearly even colonies of *Eunicella verrucosa* that are damaged can continue to survive. Healthy *Eunicella verrucosa* are able to recover from minor damage and scratches to the coenenchyme (Tinsley, 2006), and the coenenchyme covering the axial skeleton will regrow over scrapes on one side of the skeleton in about one week (Hiscock, pers. comm.) Hinz *et al.* (2011) reported that *Eunicella verrucosa* did not show a significant negative response with respect to abundance and average body size to the intensity of scallop dredging.

A study by Boulcott & Howell (2011) on the effects of scallop dredging in rocky substrata suggested that associated epifaunal communities, such as bryozoans, hydroids, soft corals and sponges were removed by a passing scallop dredge. However, on hard, uneven rock damage, damage to more resistant epifauna, whilst in evidence, was restricted. The study also recorded that the mobile substrata present were likely to be moved and turned by the passing dredge, leading to further damage to the epifaunal communities.

This biotope is also characterized by the bryozoan *Porella compressa*. *Porella compressa* is a delicate, 'stony' and brittle, erect bryozoan that is likely to be damaged by abrasion (Holt pers. comm.). However, its loss from the biotope would not result in loss of the biotope.

Sensitivity assessment. *Swiftia pallida* is sessile and epifaunal and, based on evidence for *Eunicella verrucosa*, is likely to be severely damaged by heavy gears, such as scallop dredging (MacDonald *et al*., 1996). However, some studies suggest the sea fan *Eunicella verrucosa* may be more resistant, particularly to low intensity lighter abrasion pressures, such as pots and associated anchor damage (Eno *et al*. 2001; Sheehan *et al*., 2013), and this could be the case for *Swiftia pallida*. Therefore, a resistance of '**Low**' is recorded. Resilience is assessed as '**Medium**' and sensitivity as '**Medium'.**

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 thought '**Not Relevant'** to hard rock biotopes

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

Bell & Turner (2000) studied populations of *Caryophyllia smithii* at three sites of differing sedimentation regime in Lough Hyne, Ireland. Calyx size was largest at the site of least sedimentation and smallest at the site of most sedimentation. In contrast, the height of individuals was greatest at the site of most sedimentation and smallest at the site of least sedimentation. The height of individuals correlated with the level of surrounding sediment. High density correlated with high sedimentation and depth (Bell & Turner, 2000).

While siltation may inhibit feeding, colonies of the sea fan *Eunicella verrucosa* produce mucus to clear themselves of silt (Hiscock, 2007) and sea fans are probably tolerant of increases in suspended sediment (Hiscock *et al*., 2004). Bunker (1986) reported that *Eunicella verrucosa* were mostly observed on bedrock or boulders, but did occur at sites up to 'moderately silted'.

Sensitivity assessment. CR.MCR.EcCr.CarSwi occurs on bedrock in the circalittoral and is unlikely to experience highly turbid conditions. From the evidence presented above, the characterizing species tolerate some siltation and a change at the benchmark level is unlikely to cause mortality. Resistance is recorded as '**High**', resilience as '**High**' and the biotope is '**Not sensitive**' at the benchmark level.

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

Caryophyllia smithii is small (approx. <3 cm height from the seabed) and would therefore likely be inundated in a 'light' sedimentation event. However, Bell & Turner (2000) reported *Caryophyllia smithii* was abundant at sites of 'moderate' sedimentation (7 mm ± 0.5 mm) in Lough Hyne. It is therefore likely that *Caryophyllia smithii* would be resistant to periodic sedimentation. If 5 cm of sediment were removed rapidly, via tidal currents, *Caryophyllia smithii* would likely remain within the biotope. Burton *et al.* (2005) partly attributed fluctuations in *Caryophyllia smithii* abundance at Skomer Island to surface sediment cover. Bell (2002) reported that juvenile *Caryophyllia smithii* are morphologically variable and initially undergo rapid growth with tall and thin forms in deeper, sheltered, relatively sedimented conditions near Lough Hyne, Ireland. It was concluded that this was to escape the thin layer of sediment present.

Swiftia pallida generally grows to a height of about 7-10 cm (Wilson, 2007). It is found on rocks covered with a fine layer of silt (Mitchell *et al.*, 1983). While siltation may inhibit feeding, colonies of the sea fan *Eunicella verrucosa* produce mucus to clear themselves of silt (Hiscock, 2007). It is however thought that smothering causes mortality (Hiscock *et al.*, 2004). Bunker (1986) reported that *Eunicella verrucosa* were mostly observed on bedrock or boulders, but did occur at sites up to 'moderately silted'.

Sensitivity assessment. Smothering by 5 cm would cover the majority of *Caryophyllia smithii* and the smallest examples of the other characterizing species and could result in limited mortality. *Caryophyllia smithii* has been reported as quite tolerant of temporary burial and the biotope occurs in moderate water flow and the sediment would likely be removed rapidly. Resistance was assessed as '**High**', resilience as '**High**' and the biotope is '**Not sensitive**' at the benchmark level.

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

Caryophyllia smithii is small (approx. <3 cm height from the seabed) and would therefore likely be inundated in a "light" sedimentation event. However, Bell & Turner (2000) reported *Caryophyllia smithii* was abundant at sites of "moderate" sedimentation (7 mm ± 0.5 mm) in Lough Hyne. It is therefore likely that *Caryophyllia smithii* would be resistant to periodic sedimentation. If the sediment was removed rapidly, via tidal currents, *Caryophyllia smithii* would likely remain within the biotope. Burton *et al.* (2005) partly attributed fluctuations in *Caryophyllia smithii* abundance at Skomer Island to surface sediment cover. Bell (2002) reported that juvenile *Caryophyllia smithii* are morphologically variable and initially undergo rapid growth with tall and thin forms in deeper, sheltered, relatively sedimented conditions near Lough Hyne, Ireland. It was concluded that this was to escape the thin layer of sediment present.

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Sensitivity assessment. Smothering by 30 cm of sediment would likely bury the majority of characterizing species, with only those individuals on boulders and vertical surfaces escaping burial. The biotope occurs in moderate water flow and it is likely that the sediment would probably be removed rapidly. Resistance was assessed as **'Medium'**, resilience as **'Medium'** and sensitivity as **'Medium'**.

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

Not assessed.

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

'No evidence' was found

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

Whilst no evidence could be found on the effects of noise or vibrations on the characterizing species, it is unlikely that these species would be adversely affected by noise. This pressure **'Not relevant'**.

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

Whilst no evidence could be found for the effect of light on the characterizing species of these biotopes, it is unlikely that these species would be impacted. The biotope is circalittoral, occurs below 10 m and is dependent on secondary rather than primary production. Resistance to this pressure is assessed as '**High**' and resilience as '**High**'. This biotope is therefore considered to be '**Not sensitive**' at the benchmark level.

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

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

No evidence of translocation or genetic modification of populations of the characterizing species was found. Therefore, there is currently **'No evidence'** on which to assess this pressure.

Introduction or spread of invasive non-indigenous species	Medium Q: Low A: NR C: NR	Medium Q: Low A: NR C: NR	Medium Q: Low A: Low C: Low

This biotope is classed as circalittoral and, therefore, no invasive algal species have been considered. *Solidobalanus fallax* barnacles are an invasive southern species only recently recorded in south-west England (Southward *et al.*, 2004) and have been observed fouling (primarily damaged or diseased) gorgonians (Hall-Spencer *et al.*, 2007). Resistance is, therefore, assessed as '**Medium**', resilience as '**Medium**' and sensitivity as '**Medium**'. Due to the constant risk of new invasive species, the literature for this pressure should be revisited.

Introduction of microbial pathogens	Medium Q: Low A: NR C: NR	Medium Q: Low A: NR C: NR	Medium Q: Low A: Low C: Low

Whilst no evidence of disease in *Swiftia pallida* could be found, the first recorded incidence of cold-water coral disease was noted in the sea fan *Eunicella verrucosa*, in south-west England in 2002 (Hall-Spencer *et al.*, 2007). Video surveys of 634 separate colonies at 13 sites revealed that disease outbreaks were widespread in south-west England from 2003 to 2006. Coenenchyme became necrotic in diseased specimens, leading to tissue sloughing and exposing skeletal gorgonin to settlement by fouling organisms. Sites, where necrosis was found, had significantly higher incidences of fouling. No fungi were isolated from diseased or healthy tissue, but significantly higher concentrations of bacteria occurred in diseased specimens. *Vibrio*s isolated from *Eunicella verrucosa* did not induce disease at 15°C, but at 20°C controls remained healthy and test gorgonians became diseased. Bacteria associated with diseased tissue produced proteolytic and cytolytic enzymes that damaged *Eunicella verrucosa* tissue and may be responsible for the necrosis observed. Monitoring at the site where the disease was first noted showed new gorgonian recruitment from 2003 to 2006; some individuals had died and become completely overgrown, whereas others had continued to grow around a dead central area (Hall-Spencer *et al.*, 2007). No evidence for disease in the characterizing bryozoans was found.

Sensitivity assessment. Based on reports of mortality linked to disease in the sea fan *Eunicella verrucosa*, a disease may result in mortality of *Swiftia pallida*. It should be noted that the colder temperatures in which *Swiftia pallida* occurs may confer some resistance. Resistance is assessed as '**Medium**', resilience as '**Medium**' and sensitivity as '**Medium**'.

Removal of target species	None Q: Low A: NR C: NR	Low Q: Low A: NR C: NR	High Q: Low A: Low C: Low

Eunicella verrucosa was collected historically as a curio by divers and was collected until recently in the British Isles (Wells *et al.*, 1983; Bunker, 1986). It is now protected under schedule 5 of the Wildlife and Countryside Act 1981, no evidence of harvesting of the sea fan *Swifita pallida* or any of the other characterizing species was found.

As there is historical evidence of harvesting of other sea fans, the sessile, epifaunal *Swifita pallida* would have no resistance to harvesting by divers. Resistance has been assessed as '**None**', resilience as '**Low'** and sensitivity is, therefore '**High**'.

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

The characteristic species probably compete for space within the biotope, so that loss of one species would probably have little if any effect on the other members of the community. However, removal of the characteristic epifauna due to by-catch is likely to remove a proportion of the biotope and change the biological character of the biotope. As sessile epifauna, the characterizing species and likely to be severely damaged by heavy gears, such as scallop dredging (MacDonald *et al*., 1996). However, some studies suggest that sea fans may be more resistant, particularly to low intensity, lighter abrasion pressures, such as pots and associated anchor damage (Eno *et al.* 1996; Sheehan *et al*., 2013) Taking all the evidence into account, a resistance of '**Low**' is recorded, albeit with a low confidence value owing to the lack of consensus in the literature. Resilience is assessed as '**Medium**' and sensitivity as '**Medium'.**

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