Deep sponge communities

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

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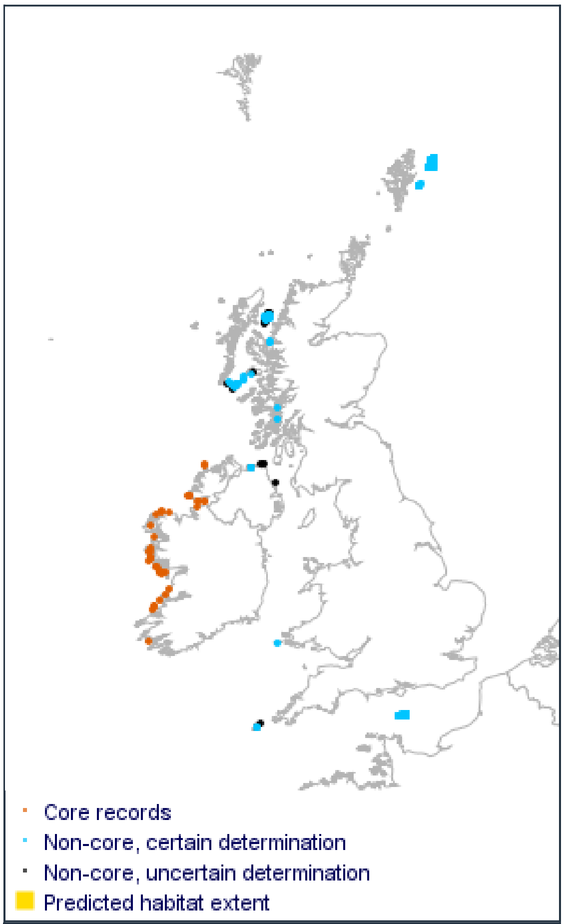

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by John Readman **Refereed by** Dr Claire Goodwin

Summary

UK and Ireland classification

EUNIS 2008	A4.12	Sponge communities on deep circalittoral rock
JNCC 2015	CR.HCR.DpSp	Deep sponge communities
JNCC 2004	CR.HCR.DpSp	Deep sponge communities
1997 Biotope		

Description

This biotope complex typically occurs on deep (commonly below 30m depth), wave-exposed circalittoral rock subject to negligible tidal streams. The sponge component of this biotope is the most striking feature, with similar species to the bryozoan and erect sponge biotope complex (BrErSp) although in this case, the sponges *Phakellia ventilabrum*, *Axinella infundibuliformis*, *Axinella dissimilis* and *Stelligera stuposa* dominate. Other sponge species frequently found on exposed rocky coasts are also present in low to moderate abundance. These include *Cliona celata*, *Polymastia* *boletiformis*, *Haliclona viscosa*, *Pachymatisma johnstonia*, *Dysidea fragilis*, *Suberites carnosus*, *Stelligera rigida*, *Hemimycale columella* and *Tethya citrina*. The cup coral *Caryophyllia smithii* and the anemone *Corynactis virdis* may be locally abundant in some areas, along with the holothurian *Holothuria forskali*. The soft corals *Alcyonium digitatum* and *Alcyonium glomeratum* are frequently observed. The bryozoans *Pentapora foliacea* and *Porella compressa* are also more frequently found in this deep-water biotope complex. Bryozoan crusts such as *Parasmittina trispinosa* are also occasionally recorded. Isolated clumps of large hydroids such as *Nemertesia antennina*, *Nemertesia ramosa* and*Sertularella gayi* may be seen on the tops of boulders and rocky outcrops. Large echinoderms such as *Echinus esculentus*, *Luidia ciliaris*, *Marthasterias glacialis*, *Strichastrella rosea*, *Henricia oculata* and *Aslia lefevrei* may also be present. The sea fan *Eunicella verrucosa* may be locally common but to a lesser extent than in ByErSp.Eun. The top shell *Calliostoma zizyphinum* is often recorded as present. (Information from Connor *et al.*, 2004; JNCC, 2015).

The sponge community varies with latitude. *Phakellia ventilabrum*, *Axinella infundibuliformis* are presernt in northern examples, while southern examples lack *Phakellia ventilabrum* and have a greater diversity of axinellids (*Axinella dissimilis* and *Axinella damicornis*) and *Eunicella verrucosa* (Claire Goodwin, pers comm.).

Depth range

20-30 m, 30-50 m

Additional information

None entered

Listed By

- none -

Further information sources

Search on:

G G G JNCC

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

These biotopes are defined by the dominance of erect sponge species with *Axinella dissimilis, Axinella infundibuliformis, Phakellia ventilabrum and Stelligera stuposa* as characterizing species; although other species of sponges are frequently found and appropriate evidence is presented where applicable (Connor *et al*., 2004). Other smaller cushion and erect sponges are common members of sponge communities. Faunal turf species (e.g. *Caryophyllia smithii*) and bryozoans are also common in circalittoral faunal dominant biotopes. The echinoderms (e.g. *Echinus esculentus* and *Luidia ciliaris*) are mobile and probably found in the surrounding area. Therefore, the sensitivity assessment is focused on the sensitivity of the erect sponges. Literature detailing the sensitivity of the characterizing erect sponges is sparse and, given the range of sponge species present, most assessments for this group are quite general, and provided with 'Low' confidence.

Resilience and recovery rates of habitat

Little is known about the longevity and recruitment prospects for the sponges that characterize CR.HCR.DpSp. Fowler & Laffoley (1993) studied the sessile epifauna near Lundy and found that the growth rates for branching sponges were irregular, but generally very slow, with apparent shrinkage in some years (notably between 1985 and 1986). Monitoring studies at Lundy (Hiscock, 1994; Hiscock, 2003; Hiscock, pers comm) suggested that growth the of *Axinella dissimilis* (as *Axinella polypoides*) and *Homaxinella subdola* was no more than about 2 mm a year (up to a height of ca 30 cm) and that all branching sponges included in photographic monitoring over a period of four years exhibited very little or no growth over the study. In addition, no recruitment of *Axinellia dissimilis* or *Axinellia infundibuliformis* was observed. Hiscock & Jones (2004) concluded that the predominance of erect sponges in CR.HCR.DpSp was likely to result in no recovery following a loss with any decline in the occurrence of these biotopes likely to be permanent.

Resilience assessment. Given their slow growth rate and the lack of observed recovery or recruitment in some axinellids, any perturbation resulting in mortality is likely to result in negligible recovery within 25 years. Resilience is, therefore, classed as **Very low** (recovery >25 years) for resistance values of None, Low or Medium. Confidence is assessed as ‘Medium’.

Hydrological Pressures

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

There is no information available about the tolerance of *Axinella dissimilis* to changes in temperature. In the British Isles, it has a mainly southern and western distribution. The species is found in warmer waters as far south as Spain. It is replaced in the Mediterranean by the very similar species, *Axinella polypoides* (Howson & Picton, 1997). *Phakellia ventilabrum* is distributed from the Arctic to the coast of North Africa (Van Soest, 2004).

Long-term increases in temperature may cause extension of the British Isles populations and decreases in temperature may result in population shrinkage. Goodwin *et al.* (2013) noted increases in the abundance of *Axinella damicornis* and *Axinella dissimilis* in Northern Ireland over a twenty year period and suggested the increase was due to sea temperature warming. Berman *et al.* (2013) monitored sponge communities off Skomer Island, UK over three years with all characterizing sponges for this biotope assessed. Seawater temperature, turbidity, photosynthetically active radiation and wind speed were all recorded during the study. It was concluded that, despite changes in species composition, primarily driven by the non-characterizing *Hymeraphia stellifera* and *Halicnemia patera*, no significant difference in sponge density was recorded in all sites studied. Morphological changes correlated with seasonal changes in water visibility and water temperature (Berman *et al.*, 2013). Cebrian *et al.* (2011) conducted four-year surveys of two shallow-water sponge species, *Ircinia fasciculata* and *Sarcotragus spinosulum* in the western Mediterranean Sea. Two severe sponge die-offs (total mortality ranging from 80 to 95% of specimens) occurred in the summers of 2008 and 2009. These events primarily affected *Ircinia fasciculata*, and a significant positive correlation was observed between elevated temperature and injured specimens. It was suggested, following *in vitro* studies of the associated cyanobacteria in increasing temperatures up to those experienced in 'extreme summer' of 27°C, that heat-related disappearance of the cyanobacteria in *Ircinia fasciculata* (a bacteriosponge) was important when considering sponge mortality.

Research by Webster *et al.* (2008, 2011), Webster & Taylor (2012) and Preston & Burton (2015) suggested that many sponges relied on a holobiont of synergistic microbes. Webster *et al.* (2011) described a much higher thermal tolerance to sponge larval holobiont when compared with adult sponges. Adult *Rhopaloeides odorabile* from the Great Barrier Reef has been shown to have a strict thermal threshold of between 31-33°C (Webster *et al.*, 2008) whereas the larvae could tolerate temperatures of up to 36°C with no adverse effects (Webster *et al.*, 2011). Whalan *et al.* (2008) noted that while the larvae of *Rhopaloeides odorabile* survived elevated temperatures, the planktonic duration of the larvae was reduced markedly. Whalan *et al.* (2008) suggested that the increases in temperature predicted under climate change on the Great Barrier Reef may reduced planktonic duration but result in reduced dispersal and increased population sub-division. However, little research has been undertaken on the larvae of temperate species (Goodwin pers comm.).

Sensitivity assessment: No evidence could be found for characterizing sponge mortality due to increases in temperature, however, it is possible that short-term acute changes in temperature could result in mortality. Therefore, a cautious resistance assessment of '**Medium**' is applied, albeit with a 'Low' confidence due to the lack of evidence. In the event of any mortality, a resilience of '**Very Low**' is recorded. Therefore, sensitivity is assessed as '**Medium**'.

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

The British Isles is at the northern distribution limit of *Axinella dissimilis* (Ackers *et al.*, 1992). Apparent shrinkage of individual sponges (negative growth rate) observed in Lundy in some years was attributed to particularly cold winters, notably between 1985 and 1986 (Hiscock, 1993). *Phakellia ventilabrum* is distributed from the Arctic to the coast of North Africa (Van Soest, 2004). However, it occurs only in deeper, colder waters at the Southern part of its range and has a northern / deeper distribution, only occurring in diving depths commonly off Scotland, with scattered records on the west coast of Ireland (Goodwin pers. comm.).

Berman *et al.* (2013) monitored sponge communities off Skomer Island, UK over three years, with all characterizing sponges for this biotope assessed. Seawater temperature, turbidity, photosynthetically active radiation and wind speed were all recorded during the study. It was concluded that, despite changes in species composition, primarily driven by the non-characterizing *Hymeraphia stellifera* and *Halicnemia patera*, no significant difference in sponge density was recorded in all sites studied.

Some sponges do exhibit morphological strategies to cope with winter temperatures e.g. *Halichondria bowerbanki* goes into a dormant state below 4°C, characterized by major disintegration and loss of choanocyte chambers with many sponges surviving mild winters in more protected areas from where it can recolonize (Vethaak *et al*., 1992). Crisp (1964a) studied the effects of an unusually cold winter (1962-3) on the marine life in Britain, including *Porifera* in North Wales. Whilst difficulty distinguishing between mortality and delayed development was noted, Crisp (1964a) found that *Pachymastia johnstonia* and *Halichondria panicea* were wholly or partly killed by frost and several species appeared to be missing including *Amphilectus fucorum*. Others, including *Hymeniacidon perleve*, were unusually rare and a few species, including *Polymastia boletiformis*, were not seriously affected. No mention was made of the characterizing sponges assessed in this review. It should be noted that Crisp's general comments on all marine life state that damage decreased the deeper the habitat. In addition, the extremely cold temperatures recorded in 1962/63 (sea temperatures between 4-6°C colder than the 5 year mean over a period of 2 months) are more extreme than the benchmark level for assessment.

Sensitivity assessment: There is evidence of sponge mortality at extremely low temperatures in the British Isles and shrinkage (negative growth rate in individuals) of *Axinella dissimilis* has been attributed to particularly cold winters. It is possible that rapid cooling of 5°C would affect the characterizing sponges. However, this biotope is protected from the effects of acute temperature change due to its depth. Therefore, a cautious resistance assessment of '**Medium**' is applied, albeit with a 'Low' confidence due to the lack of evidence. In the event of any mortality, a resilience of '**Very Low**' is recorded. Sensitivity is therefore assessed as '**Medium**'.

Salinity increase (local)	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

Marin (1997) describes the presence of *Dysidea fragilis* in a hypersaline coastal lagoon (42-47 g/l) in La Mar Menor, Spain. As a subtidal full salinity biotope (Connor *et al*., 2004), change to hypersaline conditions may affect some of the community, but **'No evidence'** was found to support an assessment.

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

CR.HCR.DpSp is a deep circalittoral biotope, and given that *Axinella dissimilis* is recorded as having a preference for full salinity of 30-40 psu (Jackson, 2008c), it is likely that the characterizing species are intolerant of a decrease in salinity.

Castric-Fey & Chassé (1991) conducted a factorial analysis of the subtidal rocky ecology near Brest, France and rated the distribution of species from estuarine to offshore conditions. *Dysidea fragilis* and *Raspailia ramosa* were rated as indifferent to this range. *Cliona celata* and *Pachymatisma johnstonia* had a slight preference for more estuarine conditions while *Polymastia mamillaris* and *Tethya citrina* had a slight preference for offshore conditions. *Stelligera rigida* and *Polymastia boletiformis* (as *Polymastia robusta*) were intolerant of the more estuarine conditions. Mean salinity difference was low (35.1 and 33.8‰ respectively) but with a greater range being experienced in the Inner Rade (±2.4‰ compared with ±0.1‰). It should be noted that the range of salinities identified in this study do not reach the lower benchmark level.

Sensitivity Assessment: CR.HCR.DpSp is a deep circalittoral group biotope and, combined with evidence of low salinity intolerance in some sponge species, it is likely that the characterizing sponges would be intolerant of a salinity decrease at the benchmark level. Therefore, resistance is assessed as '**Low**'. In the event of any mortality, a resilience of '**Very Low**' is recorded. Sensitivity is, therefore, assessed as '**High**'.

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

Riisgard *et al.* (1993) discussed the low energy cost of filtration for sponges and concluded that passive current-induced filtration may be of insignificant importance for sponges. However, water movement is probably required to ensure supply of food (particulates and dissolved organic matter) as well as oxygen.The sponges *Axinella* spp. and *Phakellia ventilabrum* were recorded in biotopes that experienced moderate-very weak flow (0-1.5 m/s) whereas *Stelligera stuposa* was recorded in biotopes from strong to very weak (0-3 m/s) (Connor *et al.*, 2004).

Sensitivity assessment: The biotope is recorded from sites that experience very weak to moderately strong water flow (0-1.5 m/s). It is unlikely that a change at the benchmark level (increase or decrease) would cause mortality in the characterizing sponges. Resistance is therefore assessed as '**High**', resilience as '**High**' and Sensitivity 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 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: Medium A: Medium C: Medium

Roberts *et al.* (2006) studied deep sponge reef communities (18-20 m) in sheltered and exposed locations in Australia. They reported greater diversity and cover (>40% cover) of sponges in wave-sheltered areas compared with a sparser and more temporal cover in exposed sites (25% cover). Erect sponges dominated the sheltered sites, while encrusting sponges dominated in exposed locations. Erect or massive forms possessing a relatively small basal area relative to volume do poorly in high energy environments (Wulff, 1995; Bell & Barnes, 2000).

Whilst little evidence for the characterizing sponges could be found, Connor *et al*. (2004) noted that in shallower conditions with increased wave action, water mixing is more prevalent and the CarSp.PenPor biotope occurs. CR.HCR.DpSp is exposed to the highest levels of wave exposure (exposed to extremely exposed) (Connor *et al.* 2004), but the effects of wave action decrease with depth (Hiscock, 1983). Hiscock (2003) suggested that 'prolonged Easterly gales in 1985' might account for the loss of *Axinella dissimilis* specimens at Lundy.

Sensitivity Assessment: CR.HCR.DpSp is a deep circalittoral biotope complex recorded in extremely wave exposed to wave exposed conditions. Wave action is probably an important source of water movement energy in the biotope. However, the effects of wave action decrease with depth.

A decrease in wave action may reduce water movement further. It is uncertain what effect, if any, would result. Connor *et al*., (2004) note that an increase in mixing would probably replace the biotope with a CaSp.PenPor biotope. Hiscock (2001) also noted mortality of axinellids after storms at Lundy. However, an increase in wave action above extremely exposed unlikely. In addition, a change in wave action at the benchmark level is not significant compared with the biotope's natural range. Mortality at the benchmark level (3-5% change in significant wave height), is unlikely and 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

Whilst some sponges, such as *Cliona* spp. have been used to monitor heavy metals by looking at the associated bacterial community (Marques *et al*., 2006; Bauvis *et al*., 2015), no literature on the effects of transition element or organo-metal pollutants on the characterizing sponges could be found. Nevertheless, 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.HCR.DpSp is a sub-tidal biotope complex (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 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). Zahn *et al*. (1981) found that *Tethya lyncurium* concentrated BaP (benzo[a]pyrene) to 40 times the external concentration and no significant repair of DNA was observed in the sponges, which, in higher animals, would likely lead to cancers. As sponge cells are not organized into organs the long-term effects are uncertain (Zahn *et al*., 1981).

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

'No evidence'.

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

This pressure is **Not assessed.**

De-oxygenation	Low Q: Medium A: Low C: Low	Very Low Q: Medium A: Medium C: Medium	High 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 (Herreid, 1980; Rosenberg *et al.*, 1991; Diaz & Rosenberg, 1995). Cole *et al.* (1999) suggested possible adverse effects on marine species below 4 mg/l and probable adverse effects below 2 mg/l.

Hiscock & Hoare (1975) reported an oxycline forming in the summer months (Jun-Sep) in a quarry lake (Abereiddy, Pembrokeshire) from close to full oxygen saturation at the surface to <5% saturation below ca 10 m. No *Tethya citrina Kirchenpaueria pinnata*, *Hymeniacidon pereleve*, *Polymastia boletiformis* or *Ascidia mentula* were recorded at depths below 10 - 11 m. Demosponges maintained under laboratory conditions can tolerate hypoxic conditions for brief periods. Gunda & Janapala (2009) investigated the effects of variable oxygen levels on the survival of the marine sponge, *Haliclona pigmentifera*. Under hypoxic conditions (1.5-2.0 ppm O_2), *Haliclona pigmentifera* with intact ectodermal layers and subtle oscula survived for 42 ± 3 days. Sponges with prominent oscula, foreign material, and damaged pinacoderm exhibited poor survival (of 1-9 days) under similar conditions. Complete mortality of the sponges occurred within 2 days under anoxic conditions (<0.3 ppm O_2).

Sensitivity assessment: Whilst some sponges have demonstrated tolerance to short-term hypoxic events, others were excluded below the oxycline at Abereiddy Quarry (Hiscock & Hoare, 1975). Therefore, some members of the community may be lost and a precautionary resistance assessment of '**Medium**' is justified, albeit with 'Low' confidence. Resilience is '**Very Low**' and sensitivity is, therefore '**Medium**'.

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

Gochfeld *et al.* (2012) studied the effect of nutrient enrichment (≤0.05 to 0.07 μM for nitrate and ≤0.5 μM for phosphate) as a potential stressor in the sponge *Aplysina caulifornis* and its bacterial symbionts and found that nutrient enrichment had no effects on sponge or symbiont physiology when compared to control conditions. This study contradicts findings in Gochfeld *et al.* (2007) in which *Aplysina spp*. sponges were virtually absent from a site of anthropogenic stress in Bocas del Toro, Panama which experienced high rainfall and terrestrial runoff. The author suggested that whilst this site did include elevated nutrient concentrations, other pressures and stresses could be contributing.

Rose & Risk (1985) described an increase in abundance of *Cliona delitrix* in an organically polluted section of Grand Cayman fringing reef affected by the discharge of untreated faecal sewage and reported a positive correlation between the two. Ward-Paige *et al.* (2005) noted that greatest size and biomass of Clionids corresponded with areas with the highest nitrogen, ammonia and ▯^{15}N levels.

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

Rose & Risk (1985) described an increase in abundance of the sponge *Cliona delitrix* in an organically polluted section of Grand Cayman fringing reef affected by the discharge of untreated faecal sewage.

De Goeij *et al.* (2008) used ^{13}C to trace the fate of dissolved organic matter in the coral reef sponge *Halisarca caerulea*. Biomarkers revealed that the sponge incorporated dissolved organic matter through both bacteria-mediated and direct pathways, suggesting that it feeds, directly and indirectly, on the dissolved organic matter.

Sensitivity assessment: Resistance to this pressure is assessed as '**High**'. Therefore, resilience is assessed as '**High**' and the biotope is therefore considered to be **'Not sensitive'** at the benchmark level.

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 characteristics of the biotope and the species would be unlikely to recover. The biotope would be lost. Therefore, resistance to the pressure is considered '**None**', resilience '**Very low'**, and sensitivity is 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)	Low Q: High A: Medium C: Medium	Very Low Q: Low A: NR C: NR	High Q: Low A: Low C: Low

The species characterizing this biotope are epifauna or epiflora occurring on rock and would be sensitive to the removal of the habitat. Extraction of bedrock substratum is considered unlikely and this pressure is considered to be ‘**Not relevant’** to hard substratum habitats. However, Picton & Goodwin (2007) noted that an area of boulders with a rich fauna of sponges and hydroids on the east coast of Rathlin Island, Northern Ireland was significantly altered since the 1980s. Scallop dredging had begun in 1989 and boulders were observed to have been turned and the gravel harrowed. In addition, many of the boulders had disappeared and rare hydroid communities were greatly reduced (Picton & Goodwin, 2007). Prior records indicated the presence of large sponges, mainly *Axinella infundibuliformis* (Picton & Goodwin, 2007). Freese *et al.* (1999) also noted that trawling could remove important substratum such as boulders. Therefore, where this biotope occurs on boulders that could be subject to removal or extraction, resistance is likely to be **'Low'.** Hence, as resilience is probably '**Very low'**, sensitivity is assessed as **'High'.**

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

All characterizing sponges for this biotope are sessile epifauna, being either branching or cup-like. *Phakellia ventilabrum* is firm, quite elastic, fairly tough, but becomes softer in older specimens, when it can become easily torn (Ackers *et al.*, 1992). *Stelligera stuposa* is branching, moderately firm, elastic with a soft outer layer (Ackers *et al.*, 1992). *Axinella infundibuliformis* is moderately firm and resilient but pieces break off if bent through 90° (Ackers *et al.*, 1992). *Axinella dissimilis* is quite elastic and flexible (Moss & Ackers, 1982). However, if the sponge is bent through more than 90°, the surface will crack (Ackers *et al.*, 1992). Picton & Goodwin (2007) noted that an area of boulders with a rich fauna of sponges and hydroids on the east coast of Rathlin Island, Northern Ireland was significantly altered since the 1980s. Scallop dredging had begun in 1989 and boulders were observed to have been turned and the gravel harrowed. In addition, many of the boulders had disappeared and rare hydroid communities were greatly reduced (Picton & Goodwin, 2007). Prior records indicated the presence of large sponges, mainly *Axinella infundibuliformis* (Picton & Goodwin, 2007). Hiscock (2014) identified *Axinella dissimilis* as being very susceptible to towed fishing gear. Hinz *et al.* (2011) studied the effects of scallop dredging in Lyme Bay, UK and found that the presence of the erect sponge *Axinella dissimilis* was significantly higher at non-fished sites (33% occurrence) compared to fished sites (15% occurrence).

Freese *et al.* (1999) studied the effects of trawling on seafloor habitats and associated invertebrates in the Gulf of Alaska. They found that a transect following a single trawling event showed a significant reduction in ‘vase’ sponges (67% expressed damage) and ‘morel’ sponges, although total damage could not be quantified as their brittle nature meant that these sponges were completely torn apart and scattered. The ‘finger’ sponges, the smallest and least damaged (only 14%) of the sponges assessed, were damaged by being knocked over. Van Dolah *et al.* (1987) studied the effects on sponges and corals of one trawl event over a low-relief hard bottom habitat off Georgia, the USA. The densities of individuals taller than 10 cm of three species of sponges in the trawl path and in adjacent control area were assessed by divers and were compared before, immediately after and 12 months after trawling. Of the total number of sponges remaining in in the trawled area, 32% were damaged. Most of the affected sponges were the barrel sponges *Cliona* spp., whereas *Haliclona oculta* and *Ircina campana* were not significantly affected. Freese (2001) studied deep cold-water sponges in Alaska a year after a trawl event; 46.8% of sponges exhibited damage with 32.1% having been torn loose. None of the damaged sponges displayed signs of regrowth or recovery. This was in stark contrast to early work by Freese *et al.* (1999) on shallow sponge communities, with impacts of trawling activity being much more persistent due to the slower growth/regeneration rates of deep, cold-water sponges. Given the slow growth rates and long lifespans of the rich, diverse fauna, it is likely to take many years for deep sponge communities to recover if adversely affected by physical damage.

Tilmant (1979) found that, following a shrimp trawl in Florida, the USA, over 50% of sponges, including *Neopetrosia*, *Spheciospongia*, *Spongia* and *Hippiospongia*, were torn loose from the bottom. The highest damage incidence occurred to the finger sponge *Neopetrosia longleyi*. Size did not appear to be important in determining whether a sponge was affected by the trawl. Recovery was ongoing, but not complete 11 months after the trawl, although no specific data relating to the sponges was provided. 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 epifaunal species, including the sponge *Pachymatisma johnstoni*, were highly damaged by the experimental trawl. Coleman *et al.* (2013) described a four year study on the differences between a commercially potted area in Lundy with a no-take zone. No significant difference in *Axinellid* populations was observed. The authors concluded that the study indicated that lighter abrasion pressures, such as potting, were far less damaging than heavier gears, such as trawls.

Sensitivity assessment: Whilst some of the characterizing sponges can be quite elastic, abrasion pressures, especially by heavy gears, have been shown to cause significant damage to the sessile epifaunal sponges. Therefore, resistance is assessed as **'Low'.** Hence, resilience is assessed as **'Very Low'** and sensitivity as **'High'.**

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

Schönberg (2015) reviewed and observed the interactions between sediments and marine sponges in Australia and described the lack of research on Porifera. Bell *et al.* (2015) reviewed the effects and interactions of sponges with sediment in suspension and after deposition. Whilst many sponges are disadvantaged by sedimentation (as would be expected, being sessile filter feeders), many examples exist of sponges adapting to sediment presence (Bell *et al.*, 2015; Schönberg, 2015). Adaptations included sediment incorporation, sediment encrusting, structural modification (such as reduction in numbers of oscula, or repositioning of inhalant and exhalant openings), soft sediment anchoring using spicules, modification of spicules to shield the body from sediment, backwashing, mucus production, morphology (e.g. upright forms intercept less settling sediment) and living, at least partially, embedded within the sediment (Bell *et al.*, 2015; Schönberg, 2015). Despite sediment being considered to have a negative impact on suspension feeders (Gerrodette & Flechsig 1979), many encrusting sponges appear to be able to survive in highly sedimented conditions, and, in fact, many species prefer such habitats (Bell & Barnes 2001; Bell & Smith 2004).

Among the characterizing species, Schönberg (2015) found that Axinellids frequently formed external crusts and sediment interaction was observed in 5.8 ± 4.8% of observations but required rock substrata under the sediment for attachment. Ackers *et al.* (1992) describe *Axinella dissimilis* as preferring clean oceanic water but tolerating silt. Sanchez *et al.* (2009) described finding communities composed primarily of *Phakellia ventilabrum* and *Dendrophyllia cornigera* in circalittoral rocky habitats in the Cantabrian Sea, northern Spain. *Phakellia ventilabrum* showed greater tolerance to sedimentation pressures than the coral. The authors concluded that *Phakellia ventilabrum* preferred a mixed rock–sand habitat where deposition processes predominate, and hence sedimentation, together with hard substrata where it settles (Sanchez *et al.*, 2009). *Axinella dissimilis* is mainly found on upward facing clean or silty rock and whilst it tends to prefer clean oceanic water, it is tolerant of silt (Ackers *et al.*, 1992).

Castric-Fey & Chassé (1991) conducted a factorial analysis of the subtidal rocky ecology near Brest, France and rated the distribution of species in varying turbidity (corroborated by the depth at which laminarians disappeared). *Cliona celata* and *Stelligera rigida* were classed as indifferent to turbidity, *Tethya citrina*, *Pachymatisma johnstonia* and *Polymastia boletiformis* (as *Polymastia robusta*) had a slight preference for clearer water, while *Dysidea fragilis*, *Polymastia mamillaris*, and *Raspailia ramosa* had a strong preference for turbid water. None of the important characterizing sponges in this biotope were assessed. Bell *et al.* (2015) noted that upright forms intercepted a smaller amount of settling sediment than encrusting forms. For example, Bell & Barnes (2002; cited in Bell *et al.*, 2015) reported considerable variation in the branching characteristics of *Raspaillia ramosa* and *Stelligera stuposa* across a sediment gradient in Lough Hyne, Northern Ireland, although the patterns were due to the interaction between sedimentation and water flow. *Raspailia ramosa* and *Stelligera stuposa* have a reduced maximum size in areas of high sedimentation (Bell *et al.*, 2002).

Storr (1976) observed the sponge *Sphecispongia vesparium* backwashing to eject sediment and noted that other sponges (such as *Condrilla nucula*) use secretions to remove settled material. Tjensvoll *et al.* (2013) found that *Geodia barretti* physiologically shuts down when exposed to sediment concentrations of 100 mg /l (86% reduction in respiration). Rapid recovery to initial respiration levels directly after the exposure indicated that *Geodia barretti* can cope with a single short exposure to elevated sediment concentrations. However, it should be noted that a laboratory study on the impact of elevated sedimentation rates on deep-water sponges found that sediment load of 30 mg sed./l resulted in significantly higher sponge mortality compared with sponges exposed to 5 and 10 mg sed./l, although no additional information was provided (Hoffman & Tore Rapp, pers comm. cited in Lancaster *et al.*, 2014). Pineda *et al.* (2017a) examined the effect of suspended sediments in three species of sponge from New Zealand; two phototrophic (due to symbiotic algae) (*Cliona orientalis* and *Carteriospongia foliascens*) and one heterotrophic (*Ianthella basta*) under laboratory conditions. All sponges exhibited a short-term response to suspended sediment, e.g. closed ocsula, mucus production, and tissue regression. Most survived low to medium turbidity (≤33 mg/l) for up to 28 days but at high turbidity (≤76 mg/l) *Cliona orientalis* and *Carteriospongia foliascens* experienced 20-90% mortality and *Ianthella basta* showed tissue regression. Pineda *et al.* (2017a) suggested that suspended sediment combined with low light due to turbidity increased mortality in the phototrophic species but noted that there was considerable interspecies variation in their response.

Sensitivity assessment: Despite reports that demonstrated increased sponge mortality at the benchmark level (see Lancaster *et al*., 2014, Pineda *et al*., 2017), the majority of the literature reviewed suggests that a change at the benchmark level is unlikely to cause significant mortality of the species considered characteristic of this biotope. Therefore, resistance at the benchmark has been assessed as '**High**', resilience as '**High**' and the biotope is '**Not sensitive**' at the benchmark level.

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

Schönberg (2015) reviewed and observed the interactions between sediments and marine sponges in Australia and described the lack of research on Porifera. Bell *et al.* (2015) reviewed the effects and interactions of sponges with sediment in suspension and after deposition. Whilst many sponges are disadvantaged by sedimentation (as would be expected, being sessile filter feeders), many examples exist of sponges adapting to sediment presence (Bell *et al*., 2015; Schönberg, 2015). Adaptations included sediment incorporation, sediment encrusting, structural modification (such as reduction in numbers of oscula, or repositioning of inhalant and exhalant openings), soft sediment anchoring using spicules, modification of spicules to shield the body from sediment, backwashing, mucus production, morphology (e.g. upright forms intercept less settling sediment) and living, at least partially, embedded within the sediment (Bell *et al*., 2015; Schönberg, 2015). Despite sediment being considered to have a negative impact on suspension feeders (Gerrodette & Flechsig 1979), many encrusting sponges appear to be able to survive in highly sedimented conditions, and, in fact, many species prefer such habitats (Bell & Barnes 2001; Bell & Smith 2004). Pineda *et al.* (2017b) exposed three phototrophic (due to symbiotic algae) and two heterotrophic sponges from New Zealand to repeated deposition events and sediment cover over 80-100% of sponge surface to a depth of ca 0.5 mm for up to 30 days in laboratory conditions. All five species survived with minimal physiological effects. However, Wulff (2006) described mortality in three sponge groups following four weeks of complete burial under sediment; 16% of *Amphimedon* biomass died compared with 40% and 47% in *Iotrochota* and *Aplysina* respectively.

Among the characterizing species, Schönberg (2015) found that Axinellids frequently formed external crusts and sediment interaction was observed in 5.8 ± 4.8% of observations but required rock substrata under the sediment for attachment. Ackers *et al.* (1992) describe *Axinella dissimilis* as preferring clean oceanic water but tolerating silt. Sanchez *et al.* (2009) described finding communities composed primarily of *Phakellia ventilabrum* and *Dendrophyllia cornigera* in circalittoral rocky habitats in the Cantabrian Sea, northern Spain. *Phakellia ventilabrum* showed greater tolerance to sedimentation pressures than the coral. The authors concluded that *Phakellia ventilabrum* preferred a mixed rock–sand habitat where deposition processes predominate, and hence sedimentation, together with hard substrata where it settles (Sanchez *et al*., 2009). *Axinella dissimilis* is mainly found on upward facing clean or silty rock and whilst it tends to prefer clean oceanic water, it is tolerant of silt (Ackers *et al*., 1992).

Castric-Fey & Chassé (1991) conducted a factorial analysis of the subtidal rocky ecology near Brest, France and rated the distribution of species in varying turbidity (corroborated by the depth at which laminarians disappeared). *Cliona celata* and *Stelligera rigida* were classed as indifferent to turbidity, *Tethya citrina*, *Pachymatisma johnstonia* and *Polymastia boletiformis* (as *Polymastia robusta*) had a slight preference for clearer water, while *Dysidea fragilis*, *Polymastia mamillaris*, and *Raspailia ramosa* had a strong preference for turbid water. None of the important characterizing sponges in this biotope were assessed. Bell *et al.* (2015) noted that upright forms intercepted a smaller amount of settling sediment than encrusting forms. For example, Bell & Barnes (2002; cited in Bell *et al.*, 2015) reported considerable variation in the branching characteristics of *Raspaillia ramosa* and *Stelligera stuposa* across a sediment gradient in Lough Hyne, Northern Ireland, although the patterns were due to the interaction between sedimentation and water flow. However, *Raspailia ramosa* and *Stelligera stuposa* have a reduced maximum size in areas of high sedimentation (Bell *et al.*, 2002). Storr (1976) observed the sponge *Sphecispongia vesparium* backwashing to eject sediment and noted that other sponges (such as *Condrilla nucula*) use secretions to remove settled material. The complete disappearance of the sea squirt *Ascidiella aspera* biocoenosis and 'associated sponges' in the Black Sea near the Kerch Strait was attributed to siltation (Terent'ev, 2008 cited in Tillin & Tyler-Walters, 2014).

Sensitivity assessment: The characterizing sponges are all large, erect sponges, while some of the characterizing sponges have been reported to cope with sediment occurring on rock (Sanchez *et al.*, 2009). It should also be noted that some of the characterizing sponges are likely to be buried in 5 cm of sediment deposition and, in this low energy biotope, sediment is unlikely to be removed rapidly. Therefore, resistance (at the benchmark level) has been assessed as '**Medium**', resilience as '**Very Low**' and sensitivity assessed as '**Medium'**.

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

Schönberg (2015) reviewed and observed the interactions between sediments and marine sponges in Australia and described the lack of research on Porifera. Bell *et al.* (2015) reviewed the effects and interactions of sponges with sediment in suspension and after deposition. Whilst many sponges are disadvantaged by sedimentation (as would be expected, being sessile filter feeders), many examples exist of sponges adapting to sediment presence (Bell *et al.*, 2015; Schönberg, 2015). Adaptations included sediment incorporation, sediment encrusting, structural modification (such as reduction in numbers of oscula, or repositioning of inhalant and exhalant openings), soft sediment anchoring using spicules, modification of spicules to shield the body from sediment, backwashing, mucus production, morphology (e.g. upright forms intercept less settling sediment) and living, at least partially, embedded within the sediment (Bell *et al.*, 2015; Schönberg, 2015). Despite sediment being considered to have a negative impact on suspension feeders (Gerrodette & Flechsig 1979), many encrusting sponges appear to be able to survive in highly sedimented conditions, and, in fact, many species prefer such habitats (Bell & Barnes 2001; Bell & Smith 2004). Pineda *et al.* (2017b) exposed three phototrophic (due to symbiotic algae) and two heterotrophic sponges from New Zealand to repeated deposition events and sediment cover over 80-100% of sponge surface to a depth of ca 0.5 mm for up to 30 days in laboratory conditions. All five species survived with minimal physiological effects. However, Wulff (2006) described mortality in three sponge groups following four weeks of complete burial under sediment; 16% of *Amphimedon* biomass died compared with 40% and 47% in *Iotrochota* and *Aplysina* respectively.

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Sensitivity assessment: In 30 cm of deposition, the majority of sponges (whose growth is up to ca 30 cm) are likely to be buried, unless the topography of the biotope includes many vertical surfaces. Hiscock & Jones (2004) reported that *Axinella dissimilis* (as *Axinella polypoides*) and *Homaxinella subdola* grew up to a height of ca 30 cm. The benchmark level is, therefore, at the upper limit of the growth of the characterizing sponges. As this biotope experiences negligible water flow, it is unlikely that this sediment would be removed rapidly. Therefore, resistance at the benchmark has been assessed as ‘**Low**’, resilience as ‘**Very Low**’ and sensitivity assessed as ‘**High**’.

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

Not assessed.

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

'No evidence' 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 was found on the effect of noise or vibrations on the characterizing species of these biotopes, it is unlikely that these species have the facility for detecting or noise vibrations.

Sensitivity assessment: The characterizing sponges are unlikely to respond to noise or vibrations and resistance is, therefore assessed as '**High**', Resilience as '**High**' and Sensitivity as '**Not Sensitive**'.

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

Jones *et al.* (2012) reported on the monitoring of sponges around Skomer Island and found that many sponges, particularly encrusting species, preferred vertical or shaded bedrock to open, light surfaces. Bell & Barnes (2000; cited in Bell et al., 2015) noted higher sponge diversity and abundance at areas subject to sedimentation in Lough Hyne, Northern Ireland and suggested reduced competition with macroalgae was a factor. However, Cárdenas *et al.* (2016) reported high sponge diversity associated with canopy-forming macroalgae in the Antarctic. Nevertheless, 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, as light is unlikely to be important at the depths that this biotope is found.

Sensitivity assessment: The characterizing sponges are unlikely to be affected by light and resistance is, therefore, assessed as '**High**', resilience as '**High**' and sensitivity as '**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

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

'No evidence' for the characterizing sponges could be found.

Introduction or spread of invasive non-indigenous species	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

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). However, it is unknown if this species would be a threat to a deep water sponge community. Another non-native sponge, the cauliflower sponge *Celtodoryx ciocalyptoides* is thought to have been introduced to the North East Atlantic from Japan via *Crassostrea gigas* aquaculture. It has not been recorded in UK waters to date but has become a major space occupier in the Oosterschelde, Netherlands and Gulf of Morbihan, France (Van Soest *et al.*, 2007; Henkel & Janussen, 2011; GBNNSIP, 2017). However, there is '**No evidence**' regarding known invasive species posing a threat to this biotope.

Introduction of microbial pathogens	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

Gochfeld *et al.* (2012) found that diseased sponges hosted significantly different bacterial assemblages compared to healthy sponges, with diseased sponges also exhibiting a significant decline in sponge mass and protein content. Sponge disease epidemics can have serious long-term effects on sponge populations, especially in long-lived, slow-growing species (Webster, 2007). Numerous sponge populations have been brought to the brink of extinction including cases in the Caribbean with 70-95% disappearance of sponge specimens (Galstoff, 1942), the Mediterranean (Vacelet, 1994; Gaino *et al.*,1992). Decaying patches and white bacterial film were reported in *Haliclona oculata* and *Halichondria panicea* in North Wales, 1988-89, (Webster, 2007). Specimens of *Cliona* spp. have exhibited blackened damage since 2013 in Skomer. Preliminary results have shown that clean, fouled and blackened *Cliona* all have very different bacterial communities. The blackened *Cliona* are effectively dead and have a bacterial community similar to marine sediments. The fouled Cliona have a very distinct bacterial community which may suggest a specific pathogen caused the effect (Burton, pers comm; Preston & Burton, 2015).

Sensitivity assessment: 'No evidence' of diseases affecting the important characterizing sponges has been recorded. Sponge diseases have caused limited mortality in some species in the British Isles, although mass mortality and even extinction have been reported further afield.

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

Hiscock (2003) stated that the greatest loss of *Axinella dissimilis* at Lundy might have been due to collecting during scientific studies in the 1970s. No indication of recovery was evident. *Axinella damicornis* was harvested in Lough Hyne during the 1980s (for molecular investigations) and the populations were reduced to very low densities, which subsequently recovered very slowly, although they are now considered to be back to their original densities (Bell, 2007).

Sensitivity assessment: Based on the above observations, resistance is assessed as **'None'** and resilience as **'Very Low'** with a resultant sensitivity of **'High'**.

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

This biotope may be removed or damaged by static or mobile gears that are targeting other species. These direct, physical impacts are assessed through the abrasion and penetration of the seabed pressures. The sensitivity assessment for this pressure considers any biological/ecological effects resulting from the removal of non-target species in this biotope. The unintentional removal of the important characterizing species will result in loss of the biotope. Therefore, resistance is recorded as '**Low**', resilience as **'Very Low'** and sensitivity as **'High'**.

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