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Saccharina latissima and *Gracilaria gracilis* with sponges and ascidians on variable salinity infralittoral sediment

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

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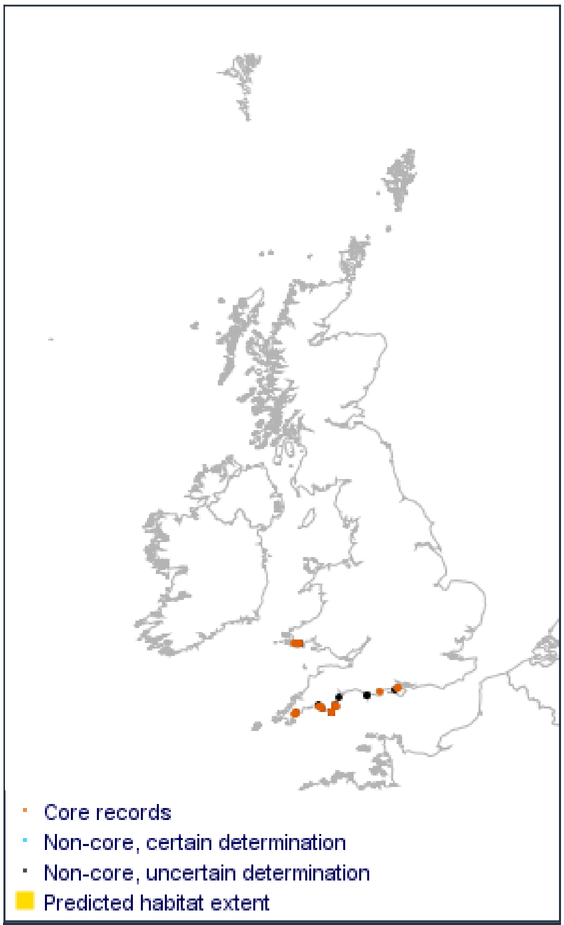

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by Thomas Stamp **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A5.525	*Laminaria saccharina* and *Gracilaria gracilis* with sponges and ascidians on variable salinity infralittoral sediment
JNCC 2015	SS.SMp.KSwSS.SlatGraVS	*Saccharina latissima* and *Gracilaria gracilis* with sponges and ascidians on variable salinity infralittoral sediment
JNCC 2004	SS.SMp.KSwSS.LsacGraVS	*Laminaria saccharina* and *Gracilaria gracilis* with sponges and ascidians on variable salinity infralittoral sediment
1997 Biotope		

Description

Shallow kelp community found on stony sediment, in extremely sheltered, variable salinity conditions, with moderately strong tidal currents. The community is characterized by a more sparse covering of *Saccharina latissima*, particularly when compared to the fully marine version of this sub biotope (SMP.SlatGraFS). Beneath the canopy, the community is characterized by the red algae *Gracilaria gracilis*, and a variety of faunal species in particular sponges (*Suberites ficus* and *Halichondria panacea*) and ascidians (*Ascidiella aspersa* and *Dendrodoa grossularia*). The stony substratum provides a surface for attachment for these and many other filter and suspension feeding species, particularly barnacles (*Balanus crenatus*), hydroids (*Urticina felina* and *Hydractinia echinata*) and anemones. Other members of the understory may include a variety of filamentous and foliose red algae in particular *Pterothamnion plumula*, and the green alga *Ulva*. (Information from Connor *et al*., 2004; JNCC, 2015).

Depth range

-

Additional information

-

Listed By

- none -

Further information sources

Search on:

G G G JNCC

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

SS.SMp.KSwSS.SlatGraFS & SS.SMp.KSwSS.SlatGraVS typically occur on a mixture of shallow sediments and rock fractions. The generally sheltered nature of the biotopes allows *Saccharina latissima* (syn *Laminaria saccharina*), *Chorda filum*, *Gracilaria gracilis* and other red and brown seaweeds to grow on small stones and shells. *Saccharina latissima* and *Chorda filum* are important canopy forming species and *Gracilaria gracilis* can characterize the understory community. The associated community depend on the salinity, with red algae characterizing the full salinity example, while sponges and ascidians characterize the variable salinity example.

In undertaking this assessment of sensitivity, account is taken of knowledge of the biology of all characterizing species in the biotope. For this sensitivity assessment *Saccharina latissima*, *Chorda filum* and *Gracilaria gracilis* are the primary foci of research, however it is recognized that the red seaweed species and the abundance of sponges and ascidians also define these biotopes. Examples of important species groups are mentioned where appropriate.

Resilience and recovery rates of habitat

Saccharina latissima (formerly *Laminaria saccharina*) and *Chorda filum* are opportunistic seaweeds which have relatively fast growth rates. *Saccharina lattisma* is a perennial kelp which can reach maturity in 15-20 months ((Sjøtun, 1993) and has a life expectancy of 2-4 years (Parke, 1948). *Saccharina lattisma* is widely distributed in the north Atlantic from Svalbard to Portugal (Birket *et al.*, 1998; Conor *et al.*, 2004; Bekby & Moy 2011; Moy & Christie 2012). *Chorda filum* is widely distributed across the northern hemisphere (Algae Base, 2015). In the North Atlantic, *Chorda filum* is recorded from Svalbard (Fredriksen *et al.*, 2014) to Northern Portugal (Araújo *et al*, 2009). *Chorda filum* is an annual seaweed, completing its life cycle in a single season (Novaczek *et al.*, 1986). *Gracilaria gracilis* is widely distributed however in the North Atlantic is found from south west Norway (Rueness, 1977) and extends to South Africa (Anderson *et al.*, 1999). *Gracilaria gracilis* is widely distributed, in the North Atlantic specifically is found from south west Norway (Rueness, 2005) and extends to South Africa (Anderson *et al.*, 1999). *Gracilaria gracilis* is a perennial red seaweed, individuals are composed of an annual erect thalli which grow from a perennial holdfast (Martín *et al.*, 2011).

Saccharina lattisma and *Chorda filum* have heteromorphic life strategies (Edwards, 1998). Mature sporophytes broadcast spawn zoospores from reproductive structures known as sori (South & Burrows, 1967; Birket et al., 1998). Zoospores settle onto rock and develop into gametophytes, which following fertilization germinate into juvenile sporophytes. *Laminarian* zoospores are expected to have a large dispersal range, however zoospore density and the rate of successful fertilization decreases exponentially with distance from the parental source (Fredriksen *et al.*, 1995). Hence, recruitment can be influenced by the proximity of mature kelp beds producing viable zoospores (Kain, 1979; Fredriksen *et al.*, 1995). *Saccharina lattisma* recruits appear in late winter early spring beyond which is a period of rapid growth, during which sporophytes can reach a total length of 3 m (Werner & Kraan, 2004), in late summer and autumn growth rates slow and spores are released from autumn to winter (Parke, 1948; Lüning, 1979; Birket *et al.*, 1998). The overall length of the sporophyte may not change during the growing season due to marginal erosion but growth of the blade has been measured at 1.1 cm/day, with a total length addition of ≥2.25 m per year (Birkett *et al.*, 1998). *Chorda filum* recruits appear from February (South & Burrows, 1967), beyond which is a period of rapid growth during which sporophytes can reach a length of ≤6 m (South & Burrows, 1967). In culture *Chorda filum* can reach reproductive maturity and produce zoospores within 186 days (ca 6 months) of settlement, however the time taken to reach maturity may be locally variable (South & Burrows, 1967). In nature, sporophytes growth slows/stops from October and sporophytes may begin to die off (South & Burrows, 1967; Novaczek *et al.*, 1986).

Saccharina lattisma is a rapid colonizing species and appear early in algal succession. For example, Lienaas & Christie (1996) removed *Strongylocentrotus droebachiensis* from “Urchin Barrens” and observed a succession effect. Initially the substrate was colonized by filamentous algae, after a couple of weeks these were out-competed and the habitat dominated by *Saccharina latissima* however this was subsequently out-competed by *Laminaria hyperborea*. In the Isle of Man, Kain (1975) cleared sublittoral blocks of Laminaria hyperborea at different times of the year for several years. The first colonizers and succession community differed between blocks and at what time of year the blocks were cleared. *Saccharina lattisima* was an early colonizer, however within 2 years of clearance the blocks were dominated by Laminaria hyperborea.

In 2002, a 50.7-83% decline of *Saccharina latissima* was discovered in the Skaggerak region, South Norway (Moy *et al.*, 2006; Moy & Christie, 2012). Survey results indicated a sustained shift from *Saccharina latissima* communities to those of ephemeral filamentous algal communities. The reason for the community shift was unknown, but low water movement in wave and tidally sheltered areas combined with the impacts of dense human populations, e.g. increased land run-off, was suggested to be responsible for the dominance of ephemeral turf macro-algae. Multiple stressors such as eutrophication, increasing regional temperature, increased siltation and overfishing may also be acting synergistically to cause the observed habitat shift.

Gracilaria gracilis has a complex life history; reproducing sexually through haploid and diploid spores (Martín *et al.*, 2011) and through vegetative fragmentation (Rueness *et al.*, 1987). Mature individuals consist of erect annual thalli growing from a perennial holdfast (Martín *et al.*, 2011). Vegetative growth is limited to approximately 6 months each year (Kain & Destcombe, 1995) during which thalli can reach 60cm (Bunker *et al.*, 2012). Thalli become reproductively active within 2 and half months from March-September (Engel & Destombe, 2002). *Gracilaria gracilis* is recorded throughout the British Isles (AlgaeBase, 2015; NBN, 2015), but SS.SMp.KSwSS.SlatGraFS & SS.SMp.KSwSS.SlatGraVS core records are restricted to wave and tidally sheltered sites of south west UK (Connor *et al.*, 2004).

Resilience assessment. *Saccharina latissima*, *Chorda filum* and *Gracilaria gracilis* have the potential to rapidly recover following disturbance. *Saccharina latissima* has been shown to be an early colonizer within algal succession, appearing within 2 weeks of clearance, and can reach sexual maturity within 15-20 months. *Chorda filum* and *Gracilaria gracilis* have rapid growth rates, and are capable of reaching sexual maturity within one year. Resilience has therefore been assessed as ‘**High**’.

Hydrological Pressures

	Resistance	Resilience	Sensitivity
Temperature increase (local)	None Q: High A: High C: High	High Q: High A: High C: High	Medium Q: High A: High C: High

The temperature isotherm of 19-20°C has been reported as limiting *Saccharina latissima* geographic distribution (Müller *et al.*, 2009). Gametophytes can develop in ≤23°C (Lüning, 1990) but the optimal temperature range for sporophyte growth is 10-15°C (Bolton & Lüning, 1982).

Bolton & Lüning (1982) experimentally observed that sporophyte growth was inhibited by 50-70% at 20°C and following 7 days at 23°C all specimens completely disintegrated. In the field *Saccharina latissima* has shown significant regional variation in its acclimation to temperature changes, for example Gerard & Dubois (1988) observed sporophytes of *Saccharina latissima* which were regularly exposed to ≥20°C could tolerate these temperatures, whereas sporophytes from other populations which rarely experience ≥17°C showed 100% mortality after 3 weeks of exposure to 20°C. Therefore the response of *Saccharina latissima* to a change in temperatures is likely to be locally variable.

Lüning (1980) observed that *Chorda filum* could not reproduce at 15-20°C but found that sporophytes could tolerate ≤26°C. The optimal temperature for *Gracilaria gracilis* growth was found to be 18°C, but high growth was recorded up to 25.5°C (Rebello *et al.*, 1996). *Gracilaria gracilis* northern range edge is south western Norway where it exclusively occurs in shallow bays in which summer temperatures exceed 20°C (Rueness, 1977).

Northern to southern Sea Surface Temperature (SST) ranges from 8-16°C in summer and 6-13°C in winter (Beszczynska-Möller & Dye, 2013). The effect of this pressure is likely to be regionally variable

Sensitivity assessment. Ecotypes of *Saccharina lattisma* have been shown to have different temperature optimums (Dubois, 1988). Acute 5°C increases in temperature for a period of one month combined with high summer temperatures could cause large scale mortality of *Saccharina lattisma* and inhibit *Chorda filum* reproduction. *Gracilaria gracilis* is unlikely to be significantly affected. A 2°C increase in temperature for a period of one year when combined with high summer temperatures could similarly result in large scale mortality of *Saccharina lattisima* ecotypes. Resistance has been assessed as '**None**', Resilience as '**High**'. Sensitivity has been assessed as '**Medium**'.

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

Saccharina lattissima and *Chorda filum* are widespread throughout the arctic. *Saccharina lattissima* has a lower temperature threshold for sporophyte growth at 0°C (Lüning, 1990). *Chorda filum* sporophytes can also tolerate 0°C, however at this temperature 99% of zoospores perish (Novaczek *et al.*, (1986). Subtidal red algae can survive at -2°C (Lüning, 1990; Kain & Norton, 1990). The distribution and temperature tolerances of these species suggests they likely be unaffected by temperature decreases assessed within this pressure

Gracilaria gracilis is widespread throughout the UK (Bunker *et al.*, 2012) however has its northern range edge within south west Norway, where it is restricted to shallow bays in which summer temperatures exceed 20°C. Furthermore SS.SMp.KSwSS.SlatGraFS & SS.SMp.KSwSS.SlatGraVS core records are restricted to the south west UK (Connor *et al.*, 2004), where the average summer Sea Temperature ranges from 12-16°C, and winter 8-13°C (Plymouth: 1981-2010, Beszczynska-Möller & Dye, 2013).

Sensitivity assessment. Considering all the characterizing species are recorded throughout the UK, the reason for the restricted distribution of SS.SMp.KSwSS.SlatGraFS & SS.SMp.KSwSS.SlatGraVS in the south west UK is unclear however is unlikely due to temperature. SS.SMp.KSwSS.SlatGraFS & SS.SMp.KSwSS.SlatGraVS has been assessed as '**Not sensitive'** (Resistance and Resiliance assessed as **'High**'). However due to the proximity of UK the northern range limit of *Gracilaria gracilis* and the restricted distribution of SS.SMp.KSwSS.SlatGraFS & SS.SMp.KSwSS.SlatGraVS in the south west UK confidence has been assessed as 'Low'.

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

Karsten (2007) tested the photosynthetic ability of *Saccharina latissima* under acute 2 and 5 day exposure to salinity treatments ranging from 5-60 psu. A control experiment was also carried at 34 psu . *Saccharina latissima* showed high photosynthetic ability at >80% of the control levels between 25-55 psu.

Optimal salinities for *Gracilaria gracilis* growth have been recorded at 30‰ (Rebello *et al.*, 1996), however *Gracilaria gracilis* can reportedly tolerate wide salinity fluctuations (Bunker *et al.*, 2012). Furthermore, *Chorda filum* and *Gracilaria gracilis* can be found in rock pools where salinity is likely to be highly variable (South & Burrows, 1967; Engel & Destombe, 2002). High air temperatures and direct sunlight can cause high surface water evaporation, and resultant increases in salinity within the rock pool. The extent of temperature and salinity change is affected by the frequency and time of day at which tidal inundation occurs, and the size of the pool (Pyefinch, 1943). It should be noted however that local populations may be acclimated to the prevailing salinity regime and may therefore exhibit different tolerances to other populations subject to different salinity conditions and therefore caution should be used when inferring tolerances. It is therefore likely that *Chorda filum* and *Gracilaria gracilis* may be tolerant of short-term hyper (≥40‰) and hypo saline conditions. Other members of the community, e.g *Ceramium* sp. and *Ulva* are found widely across the intertidal, while the sponges and ascidians probably vary in hypersaline tolerance, although no evidence was available. The effects of long-term exposure to hypersaline conditions are unknown.

Sensitivity assessment. The evidence suggests that *Saccharina latissima*, *Chorda filum* and *Gracilaria gracilis* may tolerate short-term exposure to hypersaline conditions (≥40‰). An increase in salinity to ≥40‰ may however be above the optima for a proportion of the characterizing species and cause a decline in growth. Resistance has been assessed as '**Medium**', resilience as '**High**'. The sensitivity of this biotope to an increase in salinity has been assessed as '**Low**'.

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

Karsten (2007) tested the photosynthetic ability of *Saccharina latissima* under acute 2 and 5 day exposure to salinity treatments ranging from 5-60 psu. A control experiment was also carried at 34 psu. *Saccharina latissima* showed high photosynthetic ability at >80% of the control levels between 25-55 psu. Hyposaline treatment of 10-20 psu led to a gradual decline of photosynthetic ability. After 2 days at 5 psu *Saccharina latissima* showed a significant decline in photosynthetic ability at approx. 30% of control. After 5 days at 5 psu *Saccharina latissima* specimens became bleached and showed signs of severe damage. The experiment was conducted on *Saccharina latissima* from the Arctic, and the authors suggest that at extremely low water temperatures (1-5°C) macroalgae acclimation to rapid salinity changes could be slower than at temperate latitudes. It is therefore possible that resident *Saccharina latissima* of the UK maybe be able to acclimate to salinity changes more effectively.

Chorda filum is tolerant of low salinities (Wilce, 1959; Hayren, I940; Norton & South, 1969), and has been recorded at Björnholm, Finland at a salinity as low as 5.15‰ (Hayren, I940). Norton & South (1969) observed that *Chorda filum* could develop sporophytes at ≥5‰ under laboratory conditions, however at low salinities the time taken to develop into sporophytes took 65 days at 5‰, or 16 days at 35‰. It was also noted that below 9%o sporophytes did not grow above 2 mm in length.

Optimal salinities for *Gracilaria gracilis* growth have been recorded at 30‰ (Rebello *et al.*, 1996), however *Gracilaria gracilis* can reportedly tolerate wide salinity fluctuations (Bunker *et al.*, 2012). Furthermore, *Chorda filum* and *Gracilaria gracilis* can be found in rock pools where salinity is likely to be highly variable (South & Burrows, 1967; Engel & Destombe, 2002). High air temperatures and direct sunlight can cause high surface water evaporation, and resultant increases in salinity within the rock pool. The extent of temperature and salinity change is affected by the frequency and time of day at which tidal inundation occurs, and the size of the pool (Pyefinch, 1943). It should be noted however that local populations may be acclimated to the prevailing salinity regime and may therefore exhibit different tolerances to other populations subject to different salinity conditions and therefore caution should be used when inferring tolerances. It is therefore likely that *Chorda filum* and *Gracilaria gracilis* may be tolerant of short-term hyper (≥40‰) and hypo saline conditions. Other members of the community, e.g. *Ceramium* sp. and *Ulva* are found widely across the intertidal, while the sponges and ascidians probably vary in hypersaline tolerance, although no evidence was available. The effects of long-term exposure to hypersaline conditions are unknown.

Sensitivity assessment. SlatGraFS is record at 'Full' salinity while SlatGraVS occur at Full and Variable (18-40 psu). A decrease in one MNCR category (i.e. from Full to Variable) would probably result in a change in SlatGraFS to SlatGraVS, although SlatGRaVS would not be affected. However, in variable salinity examples of the SlatGraVS biotope, a reduction on one MNCR category from variable to reduced (18 -30 psu) would probably remain within the tolerance range of the characteristic species, most of which are found in the intertidal exposed to short-term freshwater runoff or occur in estuaries. However, there may be a loss of species richness. Resistance has been assessed as '**Medium**' resilience as '**High**'. Sensitivity of this biotope to a decrease in salinity has been assessed as '**Low**'.

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

Peteiro & Freire (2013) measured *Saccharina latissima* growth from 2 sites, the 1st had maximal water velocities of 0.3 m/sec and the 2nd 0.1 m/sec. At site 1 *Saccharina latissima* had significantly larger biomass than at site 2 (16 kg/m to 12 kg/m respectively). Peteiro & Freire (2013) suggested that faster water velocities were beneficial to *Saccharina latissima* growth. However, Gerard & Mann (1979) measured *Saccharina latissima* productivity at greater water velocities and found *Saccharina latissima* productivity is reduced in moderately strong tidal streams (≤1 m/sec) when compared to weak tidal streams (<0.5 m/sec).

Chorda filum sporophytes often grow on unstable objects, such as pebbles and shell. Owing to the typically unstable substratum which *Chorda filum* grows on, whole populations can be moved during storms and deposited in more sheltered locations where development will continue (South & Burrows, 1967). The survival of *Chorda filum* sporophytes following transport of their attached substrata indicates the species is relatively tolerant to changes in water flow or wave action.

SS.SMp.KSwSS.SlatGraFS and SS.SMp.KSwSS.SlatGraVS are found in a range of tidal streams (<0.5-1.5m/sec-weak) (Connor *et al*., 2004) indicating that *Gracilaria gracilis* is tolerant to high water movement. The mobile nature of the sediment within this biotope allows opportunistic Laminarians to dominate the canopy, and inhibits significant colonisation by other kelps. The range of tidal streams in which these biotopes are found suggests that an increase in tidal streams of 0.1-0.2m/sec would not have a significant effect on the biotope

Sensitivity assessment. A change of 0.1 m/s to 0.2 m/s is not likely to dramatically affect biotope structure. Resistance has been assessed as '**High**', resilience as '**High**'. Sensitivity has been assessed as '**Not Sensitive**'.

Emergence regime changes	Low Q: Medium A: High C: High	High Q: High A: Low C: High	Low Q: Medium A: Low C: High

The biotopes (SlatGraFS and SlatGraVS) are shallow sublittoral biotopes recorded from 0-10m BCD, and as such could likely be exposed during some extreme low tides. *Saccharina latissima*, *Chorda filum* and *Gracilaria gracilis* can grow in the sub-littoral fringe and/or intertidal (South & Burrows, 1967; Engel & Destombe, 2002; White & Marshall, 2007).

An increase in emergence will result in an increased risk of desiccation and mortality of *Saccharina latissima*, *Chorda filum* and *Gracilaria gracilis*. Removal of macro-algae canopy may also increase desiccation and mortality of the undergrowth red seaweed community (Hawkins & Harkin, 1985). Providing that suitable substrata are present, the biotope is likely to re-establish further down the shore within a similar emergence regime to that which existed previously. Similarly, a decrease in emergence could allow the biotope to extend up the shore (depending on substratum availability) although the its lower extent may be lost.

Sensitivity assessment. Resistance has been assessed as '**Low**'. Resilience as '**High**'. The sensitivity of this biotope to a change in emergence is considered as '**Low**'.

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

Birkett *et al*. (1998) suggested that *Saccharina latissima* is rarely present in areas of wave exposure, where it is out-competed by *Laminaria hyperborea*. However The mobile nature of the sediment within this biotope allows opportunistic Laminarians, such as *Saccharina latissima*, to dominate the canopy, and inhibits significant colonisation by other kelps. *Chorda filum* sporophytes often grow on unstable objects, such as pebbles and shell. Owing to the typically unstable substratum which *Chorda filum* grows on, whole populations can be moved during storms and deposited in more sheltered locations where development will continue (South & Burrows, 1967). The survival of *Chorda filum* sporophytes following transport of their attached substrata indicates the species is relatively tolerant to changes in water flow or wave action.

Bunker *et al*. (2012) reports that *Gracilaria gracilis* is most common in wave sheltered sites. However, SS.SMp.KSwSS.SlatGraFS and SS.SMp.KSwSS.SlatGraVS are recorded from moderately exposed to extremely sheltered sites(Connor *et al*., 2004).

Sensitivity assessment. An increase in local wave height (e.g. to strong or moderately strong exposure) may increase local sediment mobility, potentially increase dislodgment or relocation of the characterizing species (South & Burrows, 1967; Birkett *et al.*, 1998). An increase in wave exposure, may therefore result in significant change to or loss of the biotope. However, an increase in nearshore significant wave height of 3-5% is not likely to have a significant effect on biotope structure. Resistance has been assessed as '**High'**, Resilience as '**High**'. Sensitivity has been assessed as '**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

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

Bryan (1984) suggested that the general order for heavy metal toxicity in seaweeds is: Organic Hg > inorganic Hg > Cu > Ag > Zn > Cd > Pb. Cole *et al.*, (1999) reported that Hg was very toxic to macrophytes. Similarly, Hopkin & Kain (1978) demonstrated sub-lethal effects of heavy metals on kelp gametophytes and sporophytes, including reduced growth and respiration. Sheppard *et al.* (1980) noted that increasing levels of heavy metal contamination along the west coast of Britain reduced species number and richness in holdfast fauna, except for suspension feeders which became increasingly dominant. Gastropods may be relatively tolerant of heavy metal pollution (Bryan, 1984). Although macroalgae species may not be killed, except by high levels of contamination, reduced growth rates may impair the ability of the biotope to recover from other environmental disturbances. Thompson & Burrows (1984) observed the growth of *Saccharina latissima* sporophyte growth was significantly inhibited at 50 μg Cu /l, 1000 μg Zn/l and 50 μg Hg/l. Zoospores were found to be more intolerant and significant reductions in survival rates were observed at 25 μg Cu/l, 1000 μg Zn/l and 5 μg/l.

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.

The mucilaginous slime layer coating of *Laminarians* may protect them from smothering by oil. Hydrocarbons in solution reduce photosynthesis and may be algicidal. However, Holt *et al.* (1995) reported that oil spills in the USA and from the *Torrey Canyon* had little effect on kelps. Similarly, surveys of subtidal communities at a number sites between 1-22.5 m below chart datum showed no noticeable impacts of the Sea Empress oil spill and clean up (Rostron & Bunker, 1997) or during experimental release of untreated oil in Baffin Island, Canada (Cross *et al.*, 1987). Laboratory studies of the effects of oil and dispersants on several red algae species (Grandy 1984) concluded that they were all sensitive to oil/ dispersant mixtures, with little differences between adults, sporelings, diploid or haploid life stages.

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.

O'Brian & Dixon (1976) suggested that red algae were the most sensitive group of macrophytes to oil and dispersant contamination (see Smith, 1968). *Saccharina latissima* has also been found to be sensitive to antifouling compounds. Johansson (2009) exposed samples of *Saccharina latissima* to several antifouing compounds, observing chlorothalonil, DCOIT, dichlofluanid and tolylfluanid inhibited photosynthesis. Exposure to Chlorothalonil and tolylfluanid, was also found to continue inhibiting oxygen evolution after exposure had finished, and may cause irreversible damage.

Smith (1968) observed that epiphytic and benthic red algae were intolerant of dispersant or oil contamination during the Torrey Canyon oil spill; only the epiphytes *Crytopleura ramosa* and *Spermothamnion repens* and some tufts of *Jania rubens* survived together with *Osmundea pinnatifida*, *Gigartina pistillata* and *Phyllophora crispa* from the sublittoral fringe.

Radionuclide contamination	Not relevant (NR) 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	High Q: Medium A: High C: High	High Q: Medium A: High C: High	Not sensitive Q: Medium A: High C: High

Reduced oxygen concentrations can inhibit both photosynthesis and respiration in macroalgae (Kinne, 1977). Despite this, macroalgae are thought to buffer the environmental conditions of low oxygen, thereby acting as a refuge for organisms in oxygen depleted regions especially if the oxygen depletion is short-term (Frieder *et al.*, 2012). A rapid recovery from a state of low oxygen is expected if the environmental conditions are transient. If levels do drop below 4 mg/l negative effects on these organisms can be expected with adverse effects occurring below 2mg/l (Cole *et al.*, 1999).

Sensitivity Assessment. Reduced oxygen levels are likely to inhibit photosynthesis and respiration but not cause a loss of the macroalgae population directly. Resistance has been assessed as '**High**', Resilience as '**High**'. Sensitivity has been assessed as '**Not sensitive**' at the benchmark level.

Nutrient enrichment	Medium Q: Medium A: High C: High	High Q: High A: Medium C: High	Low Q: Medium A: Medium C: High

Conolly & Drew (1985) found *Saccharina latissima* sporophytes had relatively higher growth rates when in close proximity to a sewage outlet in St Andrews, UK, compared to other sites along the east coast of Scotland. At St Andrews nitrate levels were 20.22µM, which represents an approx. 25% increase compared to other sites (approx. 15.87 µM). Handå *et al.* (2013) also reported *Saccharina latissima* sporophytes grew approx. 1% faster per day when in close proximity to Norwegian salmon farms, where elevated ammonium could be readily absorbed by sporophytes. Read *et al.* (1983) reported after the installation of a new sewage treatment works, which reduced the suspended solid content of liquid effluent by 60% in the Firth of Forth, *Saccharina* *latissima* became abundant where previously it had been absent. Bokn *et al.* (2003) conducted a nutrient loading experiment on intertidal fucoids. Within 3 years of the experiment no significant effect was observed in the communities, however 4-5 years into the experiment a shift occurred from perennials to ephemeral algae. Although Bokn *et al.* (2003) focussed on fucoids the results could indicate that long-term (>4 years) nutrient loading can result in community shift to ephemeral algae species. Disparities between the findings of the aforementioned studies are likely to be related to the level of organic enrichment.

Johnston & Roberts (2009) conducted a meta-analysis, which reviewed 216 papers to assess how a variety of contaminants (including sewage and nutrient loading) affected 6 marine habitats (including subtidal reefs). A 30-50% reduction in species diversity and richness was identified from all habitats exposed to the contaminant types. Johnston & Roberts (2009) however also highlighted that macroalgal communities are relative tolerant to contamination, but that contaminated communities can have low diversity assemblages which are dominated by opportunistic and fast growing species (Johnston & Roberts, 2009 and references therein).

Sensitivity assessment. Although short-term exposure (<4 years) to nutrient enrichment may not affect seaweeds directly, indirect effects such as turbidity may significantly affect photosynthesis and result in reduced growth and reproduction and increased competition form fast growing but ephemeral species. However, this biotope is considered to be '**Not sensitive**' at the pressure benchmark, that assumes compliance with good status as defined by the WFD.

Smit (2002) suggested that dissolved inorganic nitrogen from fish factory waste in Saldanha Bay, South Africa could maintain *Gracilaria gracilis* growth when natural nutrient sources were low.

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

Conolly & Drew (1985) found *Saccharina latissima* sporophytes had relatively higher growth rates when in close proximity to a sewage outlet in St Andrews, UK, compared to other sites along the east coast of Scotland. At St Andrews nitrate levels were 20.22µM, which represents an approx. 25% increase compared to other sites (approx. 15.87 µM). Handå *et al.* (2013) also reported *Saccharina latissima* sporophytes grew approx. 1% faster per day when in close proximity to Norwegian salmon farms, where elevated ammonium could be readily absorbed by sporophytes. Read *et al.* (1983) reported after the installation of a new sewage treatment works, which reduced the suspended solid content of liquid effluent by 60% in the Firth of Forth, *Saccharina latissima* became abundant where previously it had been absent. Bokn *et al.* (2003) conducted a nutrient loading experiment on intertidal fucoids. Within 3 years of the experiment no significant effect was observed in the communities, however 4-5 years into the experiment a shift occurred from perennials to ephemeral algae. Although Bokn *et al.* (2003) focussed on fucoids the results could indicate that long-term (>4 years) nutrient loading can result in community shift to ephemeral algae species. Disparities between the findings of the aforementioned studies are likely to be related to the level of organic enrichment.

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Sensitivity assessment. Although short-term exposure (<4 years) to organic enrichment may not affect seaweeds directly, indirect effects such as turbidity may significantly affect photosynthesis and result in reduced growth and reproduction and increased competition from fast growing but ephemeral species. Resistance has been assessed as '**Medium**', resilience as '**High**'. Sensitivity has been assessed as '**Low**'.

Physical Pressures

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

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

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

If sediment were replaced with rock or artificial substrata, this would represent a fundamental change to the biotope (Macleod *et al.*, 2014). All the characterizing species within this biotope can grow in rock biotopes (Birkett *et al.*, 1998; Connor *et al.*, 2004), however SS.SMp.KSwSS are, by definition, sediment biotopes and introduction of rock would change them into a rock based habitat complex.

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)	None Q: Low A: NR C: NR	Very Low Q: High A: High C: High	High Q: Low A: Low C: Low

The benchmark for this pressure refers to a change in one Folk class. The pressure benchmark originally developed by Tillin *et al.*, (2010) used the modified Folk triangle developed by Long (2006) which simplified sediment types into four categories: mud and sandy mud, sand and muddy sand, mixed sediments and coarse sediments. The change referred to is therefore a change in sediment classification rather than a change in the finer-scale original Folk categories (Folk, 1954). The change in one Folk class is considered to relate to a change in classification to adjacent categories in the modified Folk triangle. For mixed sediments and sand and muddy sand habitats a change in one Folk class may refer to a change to any of the sediment categories. Dredging and dumping of sediment, and infrastructure developments, can lead to changes in sediment character.

SS.SMp.KSwSS.SlatGraFS & SS.SMp.KSwSS.SlatGraVS occur on mixed substrata, therefore within this pressure a change in one folk class relates to a change to either “Coarse sediment”, “Mud and sandy Mud” and “Sand and sandy mud”. Macroalgae are likely to successfully recruit onto the larger sediment/small rock fractions within these biotopes (e.g. gravel, pebbles, cobbles).Therefore, if the proportion of stabilised large sediment/small rock fractions increased this may benefit these biotopes. Conversely if the proportion of smaller sediment fractions increased within these biotopes (as with “Mud and sandy Mud” and “Sand and sandy mud”) then macro-algal recruitment would likely be significantly reduced.

Sensitivity assessment. Resistance has been assessed as ‘**None**’, resilience as **Very low** (the pressure is a permanent change), and sensitivity as **High.**

Habitat structure changes - removal of substratum (extraction)	None Q: High A: High C: High	High Q: High A: High C: High	Medium Q: High A: High C: High

SS.SMp.KSwSS.SlatGraFS and SS.SMp.KSwSS.SlatGraVS are found on a varied mixture of sediment and rock fractions. Extraction of substratum to 30 cm is likely to remove small sediment fractions (e.g. gravel, cobbles) and may mobilize the remaining larger rock fractions (e.g. boulders) causing high mortality within the resident community. All characterizing species have rapid growth rates and are likely to recover within 2 years.

Sensitivity assessment. Resistance has been assessed as ‘**None**’, Resilience as ‘**High**’. Sensitivity has been assessed as ‘**Medium**’.

Abrasion/disturbance of the surface of the substratum or seabed	None Q: Low A: NR C: NR	High Q: High A: High C: High	Medium Q: Low A: Low C: Low

Abrasion of the substratum e.g. from bottom or pot fishing gear, cable laying etc. may cause localised mobility of the substrata and mortality of the resident community. The effect would be situation dependent however if bottom fishing gear were towed over a site it may mobilise a high proportion of the substrata and cause high mortality in the resident community.

The effect of trampling on shallow algal communities was examined by a single Mediterranean study (Milazzo et al., 2002). Experimental trampling of 18 transects were carried out at 0, 10, 25, 50, 100 and 150 passes and the community examined immediately after and three months later in the shallow infralittoral (0.3-0.5 m below mean low water). Percentage cover and canopy were significantly affected by trampling, the degree of effect increasing in proportion with trampling intensity. Intermediate trampling treatments (25, 50 and 100 tramples) were similar in effect but significantly different from 0 and 10 tramples. After 150 tramples, percentage cover was significantly lower. Erect macroalgae were particularly susceptible, e.g. the canopy forming Cystoseira brachicarpa v. balearica and Dictyota mediterranea. At low to intermediate trampling intensity, Dictyota mediterranea was strongly damaged while Cystoseira brachicarpa v. balearica lost fronds. At high trampling intensities, D. mediterranea was completely removed while C. brachicarpa v. balearica was reduced to holdfasts. Low to intermediate trampling intensities (10, 25, 50 tramples) resulted in a loss of algal biomass of 50 g/m2 , while 100 or 150 tramples resulted in a loss of ca 150 g/m2 . Recovery was incomplete after three months and significant differences in effect were still apparent between trampling treatments. Overall, trampling reduced percentage algal cover and canopy. However, the study focused on the canopy forming species and lower turf forming species were not mentioned. In summary the above evidence suggests that shallow infralittoral algal communities are susceptible to the effects of trampling by pedestrians. Again the canopy forming, erect species seem to be the most susceptible. Trampling of sublittoral fringe communities could occur as coasteerers haul themselves out of the water at the bottom of the shore. Therefore, sublittoral fringe communities in the UK could be susceptible but there is limited evidence at present (Tyler-Walters 2005).

Sensitivity assessment. Resistance has been assessed as '**None**', Resilience as '**High**'. Sensitivity has been assessed as '**Medium**'.

Penetration or disturbance of the substratum subsurface	None Q: Low A: NR C: NR	High Q: High A: High C: High	Medium Q: Low A: Low C: Low

Penetration and/or disturbance of the substrate below the surface of the seabed, may cause localised mobility of the substrata, remove kelps and bury read algae, remove large rock fractions (e.g. cobble and pebbles), and remove a proportion of the infuana and result in and mortality of the resident community. However, there is no direct evidence of the effects of mobile gear (e.g. scallop dredges) on these habitats.

Sensitivity assessment. Resistance has been assessed as '**None**', Resilience as '**High**'. Sensitivity has been assessed as '**Medium**'.

Changes in suspended solids (water clarity)	None Q: High A: High C: High	High Q: High A: High C: High	Medium Q: High A: High C: High

Suspended Particle Matter (SPM) concentration has a positive linear relationship with sub surface light attenuation (Kd) (Devlin *et al*., 2008). Light availability and water turbidity are principal factors in determining depth range at which macro-algae can be found (Birket *et al*., 1998). Light penetration influences the maximum depth at which *laminarians* can grow and it has been reported that *laminarians* grow at depths at which the light levels are reduced to 1 percent of incident light at the surface. Maximal depth distribution of *Laminarians* therefore varies from 100m in the Mediterranean to only 6-7m in the silt laden German Bight. In Atlantic European waters, the depth limit is typically 35m. In very turbid waters the depth at which kelp is found may be reduced, or in some cases excluded completely (e.g. Severn Estuary), because of the alteration in light attenuation by suspended sediment (Lüning, 1990; Birkett et al. 1998). *Laminarians* show a decrease of 50% photosynthetic activity when turbidity increases by 0.1/m (light attenuation coefficient =0.1-0.2/m; Staehr & Wernberg, 2009).

Sensitivity Assessment. An increase in water clarity from clear to intermediate (10-100mg/l) represent a change in light attenuation of ca 0.67-6.7 Kd/m, and is likely to result in a greater than 50% reduction in photosynthesis of Laminaria spp. Therefore the dominant kelp species will probably suffer a severe decline and resistance to this pressure is assessed as '**None**'. Resilience is probably to this pressure is defined as '**Medium**' at the benchmark. Hence, this biotope is regarded as having a sensitivity of '**Medium** 'to this pressure.

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

Smothering by sediment e.g. 5 cm material during a discrete event, is unlikely to damage mature examples of *Saccharina latissima*, *Chorda filum* or *Gracilaria gracilis* but may provide a physical barrier to zoospore settlement and therefore could negatively impact on recruitment processes (Moy & Christie, 2012). Laboratory studies showed that kelp and gametophytes can survive in darkness for between 6-16 months at 8 deg C and would probably survive smothering by a discrete event and once returned to normal conditions gametophytes resumed growth or maturation within 1 month (Dieck, 1993).

SS.SMp.KSwSS biotopes are all recorded from moderately strong to weak tidal streams (≤0.5-1.5 m/sec) (Connor *et al*., 2004). In tidally exposed biotopes deposited sediment is unlikely to remain for more than a few tidal cycles (due to water flow or wave action). In sheltered biotopes deposited sediment could remain but are unlikely to remain for longer than a year.

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

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

Smothering by sediment e.g. 30 cm material during a discrete event, is unlikely to damage mature examples of *Saccharina latissima*, *Chorda filum* or *Gracilaria gracilis* but may provide a physical barrier to zoospore settlement and therefore could negatively impact on recruitment processes (Moy & Christie, 2012). Laboratory studies showed that kelp and gametophytes can survive in darkness for between 6-16 months at 8deg C and would probably survive smothering by a discrete event and once returned to normal conditions gametophytes resumed growth or maturation within 1 month (Dieck, 1993).

SS.SMp.KSwSS biotopes are all recorded from moderately strong to weak tidal streams (≤0.5-1.5 m/sec) (Connor *et al*., 2004). In tidally exposed biotopes deposited sediment is unlikely to remain for more than a few tidal cycles (due to water flow or wave action). In sheltered biotopes deposited sediment could remain but are unlikely to remain for longer than a year.

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

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

Not assessed.

Electromagnetic changes	Not relevant (NR) 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

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

Not relevant

Introduction of light or shading	Low Q: Low A: NR C: NR	High Q: Low A: NR C: NR	Low Q: Low A: Low C: Low

There is no evidence to suggest that anthropogenic light sources would affect macro-algae. Shading of the biotope (e.g. by construction of a pontoon, pier etc) could adversely affect the biotope in areas where the water clarity is also low, and tip the balance to shade tolerant species, resulting in the loss of the biotope directly within the shaded area, or a reduction in seaweed abundance.

Sensitivity assessment. Resistance is probably '**Low**', with a '**High**' resilience and a sensitivity of '**Low**', albeit with 'low' confidence due to the lack of direct evidence.

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

Not relevant. This pressure is considered applicable to mobile species, e.g. fish and marine mammals rather than seabed habitats. Physical and hydrographic barriers may limit the dispersal of spores. But spore dispersal is not considered under the pressure definition and benchmark.

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. Collision from grounding vessels is addressed under abrasion pressure.

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

There is no evidence for translocation of *Saccharina latissima*, *Chorda filum* or *Gracilaria gracilis* over significant geographic distances. *Gracilaria gracilis* is a commercial species valued for agar production (Marinho-Soriano, 2001). As a result of commercial interest various strains of *Gracilaria spp.* have been developed to produce higher agar yields (Bird, 1988). However, there is '**No evidence**' to suggest that these strains of *Gracilaria spp.* have negatively affected natural populations.

Introduction or spread of invasive non-indigenous species	Low Q: High A: High C: High	Very Low Q: High A: High C: High	High Q: High A: High C: High

Undaria pinnatifida has received a large amount of research attention as a major Invasive Non Indigenous Species (INIS) which could out-compete native UK kelp habitats (see Farrell & Fletcher, 2006; Thompson & Schiel, 2012, Brodie *et al*., 2014; Hieser *et al*., 2014). *Undaria pinnatifida* was first recorded in the UK, Hamble Estuary, in June 1994 (Fletcher & Manfredi, 1995) and has since spread to a number of British ports. *Undaria pinnatifida* is an annual species, sporophytes appear in Autumn and grow rapidly throughout winter and spring during which they can reach a length of 1.65m (Birket *et al*., 1998). Farrell & Fletcher (2006) suggested that native short lived species that occupy similar ecological niches to *Undaria pinnatifida*, such as *Saccharina latissima* or *Chorda filum*, are likely to be worst affected and out-competed by *Undaria pinnatifida*. Where present an abundance of *Undaria pinnatifida* has corresponded to a decline in *Saccharina lattisima* (Farrel & Fletcher, 2006) and *Laminaria hyperborea* (Hieser *et al*., 2014).

In new Zealand, Thompson & Schiel (2012) observed that native fucoids could out-compete *Undaria pinnatifida* and re-dominate the substratum. However, Thompson & Schiel (2012) suggested the fucoid recovery was partially due to an annual *Undaria pinnatifida* die back, which as noted by Heiser *et al*., (2014) does not occur in Plymouth sound, UK. *Undaria pinnatifida* was successfully eradicated on a sunken ship in Clatham Islands, New Zealand, by applying a heat treatment of 70deg C (Wotton *et al*., 2004) however numerous other eradication attempts have failed, and as noted by Fletcher & Farrell, (1999) once established *Undaria pinnatifida* resists most attempts of long-term removal. The biotope is unlikely to fully recover until *Undaria pinnatifida* is fully removed from the habitat, which as stated above is unlikely to occur.

Sensitivity assessment. Resistance to the pressure is considered '**Low**', and resilience '**Very Low**'. The sensitivity of this biotope to introduction of microbial pathogens is assessed as '**High**'.

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

Laminarians may be infected by the microscopic brown alga *Streblonema aecidioides*. Infected algae show symptoms of Streblonema disease, i.e. alterations of the blade and stipe ranging from dark spots to heavy deformations and completely crippled thalli Infection can reduce growth rates of host algae (Peters & Scaffelke, 1996). The marine fungi *Eurychasma spp* can also infect early life stages of *Laminarians* however the effects of infection are unknown (Müller *et al*., 1999).

Gracilaria gracilis is also susceptible to bacterial pathogens. Farmed and natural populations of *Gracilaria gracilis* within Saldanha Bay, South Africa have experienced a number of large die-offs since 1989, in which thalli have become bleached and/or rotten as a result of *Pseudoalteromonas gracilis* B9 infection (Schroeder *et al*., 2003).

Sensitivity assessment. Resistance to the pressure is considered '**Low**' based on the potential susceptibility of *Gracilaria gracilis*and resilience is probably '**High**'. The sensitivity of this biotope to introduction of microbial pathogens is assessed as '**Low**'.

Removal of target species	None Q: High A: High C: High	High Q: High A: High C: High	Medium Q: High A: High C: High

There has been recent commercial interest in *Saccharina lattisma* as a consumable called "sea vegetables" (Birket *et al*., 1998). However, *Saccharina lattissima* sporophytes are typically matured on ropes (Handå et al 2013) and not directly extracted from the seabed, as with *Laminaria hyperborea* (Christie *et al*., 1998). No evidence has been found for commercial extraction of *Chorda filum*. *Gracilaria gracilis* is commercially harvested for the production of agar (Marinho-Soriano, 2001). Over-exploitation of *Gracilaria gracilis* has, in some regions, resulted in depletion of natural stocks. As result, various culture techniques have been developed to increase yields. Natural stocks are still harvested however in some instances has been restricted to gathering beach cast (Martín *et al*., 2011). Furthermore removal of macro-algae canopy may also cause mortality of the understory community (Hawkins & Harkin, 1985).

Sensitivity assessment. As a result of historical exploitation causing mass declines in *Gracilaria gracilis* resistance has been assessed as '**None**', however confidence scores are marked as low. Resilience as '**High**'. Sensitivity has been assessed as '**Medium**'.

Removal of non-target species	None Q: High A: High C: High	Medium Q: High A: High C: High	Medium Q: High A: High C: High

Low level disturbances (e.g. solitary anchors) are unlikely to cause harm to the biotope as a whole, due to the impact's small footprint. Thus evidence to assess the resistance of SS.SMp.KSwSS.SlatGraFS and SS.SMp.KSwSS.SlatGraVS to non-targeted removal is limited. It is assumed that incidental non-targeted catch (e.g. by trawls or dredges) could mobilise sediment, remove large kelp species, overturn boulders and cobbles and bury smaller seaweeds and cause high mortality within the affected area. Furthermore removal of macro-algae canopy may also cause mortality of the understory community (Hawkins & Harkin, 1985).

Sensitivity assessment. Resistance has been assessed as '**None**', Resilience as '**High**'. Sensitivity has been assessed as '**Medium**'.

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