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Saccharina latissima, Gracilaria gracilis and brown seaweeds on full salinity infralittoral sediment

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

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2015-10-12

A report from:

The Marine Life Information Network, Marine Biological Association of the United Kingdom.

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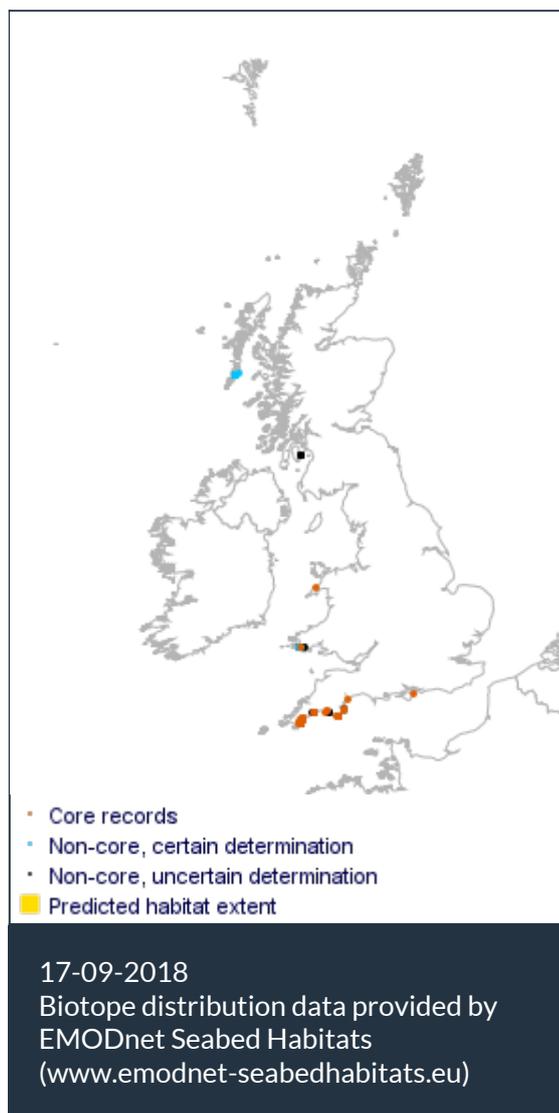
This review can be cited as:

Stamp, T.E., 2015. *Saccharina latissima*, *Gracilaria gracilis* and brown seaweeds on full salinity infralittoral sediment. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. DOI <https://dx.doi.org/10.17031/marlinhab.1035.1>



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Researched by Thomas Stamp Refereed by Admin

Summary

☰ UK and Ireland classification

EUNIS 2008 A5.524

Laminaria saccharina, *Gracilaria gracilis* and brown seaweeds on full salinity infralittoral sediment

JNCC 2015 SS.SMp.KSwSS.SlatGraFS

Saccharina latissima, *Gracilaria gracilis* and brown seaweeds on full salinity infralittoral sediment

JNCC 2004 SS.SMp.KSwSS.LsacGraFS

Laminaria saccharina, *Gracilaria gracilis* and brown seaweeds on full salinity infralittoral sediment

1997 Biotope

🔍 Description

Shallow kelp community found on muddy sand, in moderately exposed or sheltered, fully marine conditions, with weak tidal currents. The community is characterized by a reasonable covering of *Saccharina latissima*. Frequent *Chorda filum* may also form part of the canopy although not at the

abundance in SlatCho. Beneath the canopy the community is characterized by the red algae *Gracilaria gracilis*, and various brown algal species particularly *Dictyota dichotoma*. Other members of the understory may include a variety of other filamentous and foliose red algae in particular *Ceramium nodulosum* and the green alga *Ulva*. The muddy sand substrate supports a variety of faunal species including polychaetes (*Lanice conchilega*) and gastropods (*Hinia reticulata*).

↓ Depth range

-

🏛️ Additional information

-

✓ Listed By

- none -

🔗 Further information sources

Search on:



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 latissima* 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 latissima* 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 latissima 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 latissima* 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 lattissima 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 lattissima* 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 $\leq 23^\circ\text{C}$ (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 $\geq 20^\circ\text{C}$ could tolerate these temperatures, whereas sporophytes from other populations which rarely experience $\geq 17^\circ\text{C}$ 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 $\leq 26^\circ\text{C}$. 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 latissima* have been shown to have different temperature optimums (Dubois, 1988). Acute 5°C increases in temperature for a period of 1 month combined with high summer temperatures could cause large scale mortality of *Saccharina latissima* and inhibit *Chorda filum* reproduction. *Gracilaria gracilis* is unlikely to be significantly affected. A 2°C increase in temperature for a period of 1 year when combined with high summer temperatures could similarly result in large scale mortality of *Saccharina latissima* 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 latissima and *Chorda filum* are widespread throughout the arctic. *Saccharina latissima* 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 Resilience assessed as 'High'). However due to the proximity of the 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 ($\geq 40\%$) 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 ($\geq 40\%$). An increase in salinity to $\geq 40\%$ 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 may be able to acclimate to salinity changes more effectively.

Chorda filum is tolerant of low salinities (Wilce, 1959; Hayren, 1940; Norton & South, 1969), and has been recorded at Björnholm, Finland at a salinity as low as 5.15‰ (Hayren, 1940). Norton & South (1969) observed that *Chorda filum* could develop sporophytes at $\geq 5\%$ 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‰ 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 ($\geq 40\%$) 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 recorded 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 0-10 m 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) reported that *Gracilaria gracilis* was 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

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.

This pressure is **Not assessed**