Kelp in variable or reduced salinity

MarLIN – Marine Life Information Network

Marine Evidence–based Sensitivity Assessment (MarESA) Review

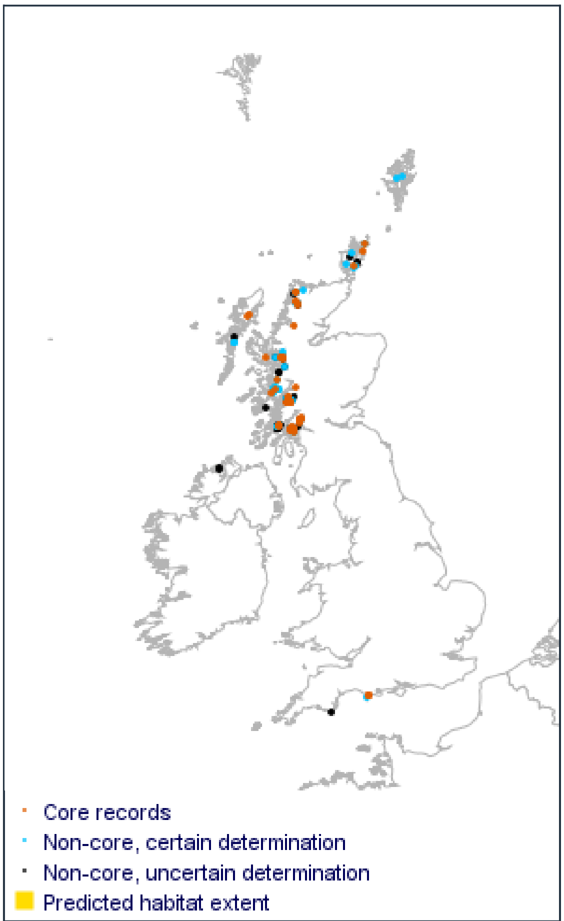
Dr Keith Hiscock

2002-11-21

A report from:
The Marine Life Information Network, Marine Biological Association of the United Kingdom.

Please note. This MarESA report is a dated version of the online review. Please refer to the website for the most up-to-date version [https://www.marlin.ac.uk/habitats/detail/345]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

This review can be cited as:
Hiscock, K. 2002. Kelp in variable or reduced salinity. 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.345.1



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

Researched by Dr Keith Hiscock **Refereed by** This information is not refereed.

Summary

UK and Ireland classification

EUNIS 2008	A3.32	Kelp in variable salinity on low energy infralittoral rock
JNCC 2015	IR.LIR.KVS	Kelp in variable or reduced salinity
JNCC 2004	IR.LIR.KVS	Kelp in variable or reduced salinity
1997 Biotope	IR.SIR.K.LsacRS	*Laminaria saccharina* on reduced or low salinity infralittoral rock

Description

Very wave-sheltered bedrock, boulders and cobbles subject to only weak tidal streams in the sublittoral fringe and infralittoral zone, in areas of variable/reduced salinity. This biotope complex is characterized by the kelp *Saccharina latissima* and coralline crusts such as *Lithothamnion glaciale*. Grazers such as the urchins *Psammechinus miliaris* and *Echinus esculentus*, and the gastropods *Gibbula cineraria* and *Buccinum undatum* may be present. The tube-dwelling polychaete *Spirobranchus triqueter*, the ascidians *Ciona intestinalis*, *Corella* *parallelogramma* and *Ascidiella scabra*, the barnacle *Balanus crenatus*, the starfish *Asterias rubens* and the brittlestar *Ophiothrix fragilis* may also be present. Red algal communities are composed primarily of *Phycodrys rubens*. The crabs *Carcinus maenas* and *Pagurus bernhardus*, and the bivalve *Modiolus modiolus* may also be observed. (Information from Connor *et al*., 2004; JNCC, 2015)

Depth range

-

Additional information

The biotope SIR.SlatRS occurs as SIR.SlatRS.FIR with filamentous algae and sponges particularly characteristic in southwest Britain and as SIR.SlatRS.Phy, with *Phyllophora crispa* and SIR.SlatRS.Psa with *Psammechinus miliaris* especially characteristic in western Scotland.

Listed By

- none -

Further information sources

Search on:

G G G JNCC

Habitat review

Ecology

Ecological and functional relationships

The sub-biotopes of SIR.LsacRS illustrate the importance of ecological relationships in determining the presence of different species assemblages in apparently similar situations with regard to physical and chemical conditions. In some examples of low water movement and reduced salinity, rocks are dominated by algae (SIR.LsacRS.FiR and SIR.LsacRS.Phy) but in others, the sea urchin *Psammechinus miliaris* grazes algae so that few foliose seaweeds are present (SIR.LsacRS.Psa). In the absence of grazing, algae dominate this biotope most likely providing a habitat for a community of small worms, crustaceans and molluscs but making movement difficult for larger species that require attachment to the surface. For instance, brittle stars, *Ophiocomina nigra*, occur extensively in the grazed sub-biotope but not in those dominated by foliose algae. Some other species may have difficulty settling onto bare rock in areas dominated by algae although the richness of communities in the LsacRS.FiR sub-biotope in south-west Britain suggests that algal growth may not be a great impedance to settlement. A significant fauna may also be associated with sponges (Peattie & Hoare, 1981).

Seasonal and longer term change

No specific information has been found in relation to this biotope.*Saccharina latissima* is a short-lived perennial. Sporophytes typically have a lifespan of 2 to 4 years although plants may occur as annuals suggesting the possibility of some seasonal fluctuation in abundance. Where surfaces have been cleared, Kain (1975) recorded that *Saccharina latissima* (studied as *Laminaria saccharina*) was abundant six months after substratum was cleared. Foliose algae are likely to show a seasonal change in condition of the fronds and in abundance (see Hiscock, 1986c). Also, solitary ascidians are short lived and may fluctuate in numbers through the year and from year to year. For instance, Svane (1988) describes *Ascidiella scabra* as "an annual ascidian".

Habitat structure and complexity

There are a wide range of microhabitats within this biotope. They include sediments, sometimes maerl, where infauna will occur, underboulder habitats, the sides and tops of boulder which often have different dominant species, the interstices of massive sponge growths, the holdfasts of kelp plants and the fronds of kelps and other algae.

Productivity

No specific information found has been found but the communities in this biotope are likely to be highly productive. The biotope occurs in shallow depths where high light intensity will result in high primary productivity. Secondary productivity is also be high although due mainly to active suspension feeding by such species as ascidians, barnacles and mussels largely unassisted by external water movement.

Recruitment processes

The characterizing species in this biotope all have planktonic spores or larvae and are fairly short-lived. There is therefore high recruitment and high turnover. In sub-biotopes with significant algal presence (especially SIR.LsacRS.Phy), algae might attract a high abundance of solitary ascidians (see Schmidt, 1983) relative to the erect tubes of the hydroid *Tubularia indivisa*).

Time for community to reach maturity

The community would probably reach maturity within 2-3 years although recruitment of additional species to the biotope would continue for some further time.

Additional information

Examples of this biotope are notably rich for areas subject to low or variable salinity. It might be that, in areas not subject to grazing, the stability of physical conditions allows for settlement and survival of progressively more species with time.

Preferences & Distribution

Habitat preferences

Depth Range	
Water clarity preferences	
Limiting Nutrients	No information found
Salinity preferences	
Physiographic preferences	
Biological zone preferences	
Substratum/habitat preferences	
Tidal strength preferences	
Wave exposure preferences	
Other preferences	None

Additional Information

The biotope occurs attached to bedrock and stable boulders and cobbles in wave and tidal stream sheltered areas.

Species composition

Species found especially in this biotope

Rare or scarce species associated with this biotope

- *Akera bullata*

Additional information

The nationally scarce mollusc *Akera bullata* has been recorded in two examples of SIR.LsacRS.Phy.

Sensitivity review

Explanation

The biotope SIR.LsacRS occurs as SIR.LsacRS.FiR with filamentous algae and sponges particularly characteristic in southwest Britain and as SIR.LsacRS.Phy, with *Phyllophora crispa* especially characteristic and SIR.LsacRS.Psa with *Psammechinus miliaris* especially characteristic in western Scotland. The importance of *Psammechinus miliaris* in the biotope is, however, as a key functional species that affects the biotope through grazing. The range of species in the sub-biotopes is large but the species selected as indicative of sensitivity are or represent species that may be common in at least some examples of the biotope.

Species indicative of sensitivity

Community Importance	Species name	Common Name
Important structural	*Ascidiella scabra*	A sea squirt
Key structural	*Asterias rubens*	Common starfish
Key structural	*Balanus crenatus*	An acorn barnacle
Important other	*Ceramium virgatum*	A red seaweed
Important other	*Clavelina lepadiformis*	Light bulb sea squirt
Important other	*Halichondria panicea*	Breadcrumb sponge
Important other	*Mytilus edulis*	Common mussel
Important other	*Pomatoceros triqueter*	Keel worm
Key functional	*Psammechinus miliaris*	Green sea urchin
Key structural	*Saccharina latissima*	Sugar kelp
Important other	*Ulva lactuca*	Sea lettuce

Physical Pressures

	Intolerance	Recoverability	Sensitivity	Richness	Confidence
Substratum Loss	High	High	Moderate	Major decline	High

Most of the species characteristic of this biotope are permanently or firmly attached to the substratum so would be removed upon substratum loss. Intolerance is therefore high. Recovery would be likely within a few years and by five years the biotope is likely to appear as before the impact (see additional information below).

	Intolerance	Recoverability	Sensitivity	Richness	Confidence
Smothering	Intermediate	High	Low	Decline	Moderate

Some species, especially *Saccharina latissima*, are likely to protrude above smothering material. Others such as the active suspension feeders and foliose algae are likely to be killed by smothering. An intolerance of intermediate is suggested as some individuals might die but the biotope will persist and recoverability will be high (see additional information below). However, if smothering is in the form of impermeable material, intolerance will be high.

	Intolerance	Recoverability	Sensitivity	Richness	Confidence
Increase in suspended sediment	Low	Very high	Very Low	No change	Moderate

Increased suspended sediment levels will reduce the amount of light reaching the seabed and may therefore inhibit photosynthesis of the algal component of the biotope (see increase in turbidity below). However, the biotope occurs in very shallow depths and algae are likely to survive. Suspended silt may clog respiratory and feeding organs (especially of sea squirts). However, since many of the species in this biotope live in areas of high silt content (turbid water) it is expected that they would survive increased levels of silt in the water. Both algae and animals would suffer some decrease in viability. On return to lower suspended sediment levels it is expected that recovery of condition will be rapid. Therefore an intolerance of low and recoverability of very high is indicated.

Decrease in suspended sediment	Low	High	Moderate	Major decline	High

Decreased suspended sediment levels will increase the amount of light reaching the seabed and may therefore increase competitiveness of the algal component of the biotope (see decrease in turbidity below). Suspended sediment may include organic matter and a decrease may reduce the amount of food available to suspension feeding animals. Both algae and animals would suffer some decrease in viability. On return to higher suspended sediment levels it is expected that recovery of condition will be rapid. Therefore an intolerance of low and recoverability of very high is indicated.

Dessication	Low	High	Low	Minor decline	Moderate

The biotope is predominantly sublittoral but does extend onto the shore and therefore has some ability to resist desiccation. On a sunny day at low water of spring tides, damage (bleaching) is likely to occur to the *Saccharina latissima* plants and other foliose algae but not destroy them completely. Species living below the kelp fronds will be protected by them from the worst effects of desiccation. Sponges, such as *Halichondria panicea*, are likely to withstand some desiccation as they hold water. An intolerance of low is suggested as although some individuals of species might die, the biotope will persist. Recoverability will be high or possibly very high (see additional information below).

Increase in emergence regime	High	High	Moderate	Major decline	Moderate

The biotope is predominantly sublittoral and the dominant species (*Saccharina latissima*) and many of the subordinate species, especially foliose algae and solitary sea squirts, are unlikely to survive an increased emergence regime. Several mobile species are likely to move away. However, 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 (see additional information below). An intolerance of high and a recoverability of high is therefore indicated.

Decrease in emergence regime	Tolerant*		Not sensitive	No change	High

The biotope is subtidal and thrives in fully submerged conditions.

Increase in water flow rate	Intermediate	High	Low	No change	Moderate

Increase in tidal flow rates may dislodge substrata (especially where large plants of *Saccharina latissima* subject to drag are attached to cobbles). Also, increased water flow rate may result in certain species being unable to feed when water flow is likely to damage feeding organs (see Hiscock 1983). However, it is unlikely that species attached to non-mobile substrata in the biotope will be killed by an increase in flow rate. Therefore a decline in the abundance of some species that are swept away is suggested with some reduction in viability of others depending on whether the current velocity reaches a high enough level to inhibit feeding. An intolerance of intermediate has been recorded with a recoverability of high (see additional information below).

Decrease in water flow rate Not sensitive* No change High

The biotope occurs in areas of weak or very weak tidal flow and a further decrease may adversely affect the biotope through the onset of stagnation and consequent deoxygenation as well as siltation and smothering. However, some species in the biotope are active suspension feeders (sponges, solitary ascidians) that are known to thrive in extremely sheltered locations (see, for instance, Hiscock & Hoare, 1973) or at least survive in such situations (barnacles). Therefore, there may be some localized mortality but all-in-all, the biotope is likely to survive. An intolerance of low is therefore indicated and a recovery of very high.

Increase in temperature Low Very high Very Low No change Low

The biotope occurs as different sub-biotopes in warmer and colder parts of Britain and Ireland and it might be that northern elements would be adversely affected and, in the long-term, northern version of the biotope may be lost. However, exposure to high temperatures for several days may produce stress in some component species but not mortality and recovery would be expected to be rapid. An intolerance of low is therefore indicated and a recoverability of very high.

Decrease in temperature Low Very high Moderate No change Low

The biotope occurs in warmer and colder parts of Britain and Ireland as different sub-biotopes. Similar assemblages of species are known to occur in Scandinavia so that long-term decrease in temperature is unlikely to cause a significant impact on the northern sub-biotopes but may adversely affect the southern form. However, exposure to low temperatures for several days may produce stress in some component species but recovery would be expected to be rapid. An intolerance of low is therefore indicated and a recoverability of very high.

Increase in turbidity Intermediate High Low No change Moderate

Several of the characteristic species are algae that rely on light for photosynthesis. Reduction in light penetration as a result of higher turbidity is unlikely to be fatal to algae in the short term but in the long term will result in a reduction in downward extent and therefore overall extent of the biotope. Species richness may decline in the long-term as algae are unable to survive high turbidity and low light but reduced extent of the biotope (depth limits) is the most significant likely decline. An intolerance of intermediate will apply and recoverability will be high (see additional information below).

Decrease in turbidity Tolerant* Not sensitive No change High

Decreased turbidity and the subsequent increase in light levels is likely to result in an extension of the downward extent of the biotope. Not sensitive* is therefore indicated.

Increase in wave exposure High High Moderate Major decline Moderate

This is a fundamentally sheltered coast biotope with species that does not appear to occur in wave exposed situations. Increased wave action is likely to dislodge *Saccharina latissima* plants and interfere with feeding in solitary tunicates. Massive growths of *Halichondria panicea* are likely to be displaced. Although 'major decline' is indicated with regard to species richness, the results of increased wave exposure would be replacement of biotope-characteristic species with others and the development of a different biotope. A change of biotope means high intolerance. On return to previous conditions, the 'new' biotope would have to degrade before A3.32 developed. Nevertheless, such a change should occur within five years and a recoverability of high is indicated (see additional information below).

Decrease in wave exposure			Not sensitive*	No change	High

This biotope occurs in locations not subject to any significant wave exposure so that decrease in wave exposure is considered not relevant.

Noise	Tolerant	Not relevant	Not relevant	Not relevant	High

The macroalgae characterizing the biotope have no known sound or vibration sensors and animals such as the sponges, urchins and solitary sea squirts are not known to respond to noise. Therefore 'not sensitive' is indicated.

Visual Presence	Tolerant	Not relevant	Not relevant	Not relevant	High

None of the animals that characterize the biotope respond significantly to visual presence although barnacles, whose cirri are consumed by blennies and probably other fish, are likely to cease feeding briefly as a response to shadowing. Overall, an intolerance of not relevant is suggested.

Abrasion & physical disturbance	High	High	Moderate	Major decline	High

Saccharina latissima, other algae, sponges and the large solitary tunicates are likely to be removed from the substratum by physical disturbance and sea urchins may be crushed. Physical disturbance will also overturn boulders and cobbles so that the epibiota becomes buried. Mortality of species is therefore likely to be high although many, particularly mobile species, will survive. An intolerance of high is therefore indicated. Recoverability is expected to he high (see additional information below).

Displacement	Intermediate	High	Low	Decline	High

Although many of the species in the biotope are sessile and would therefore be killed if removed from their substratum, displacement will often be of the boulders or cobbles on which the community occurs in which case survival will be high. The 'Intermediate' ranking given here supposes that some individual sessile organisms will be removed and die. Mobile organisms such as the prosobranchs and sea urchins in the biotope are likely to survive displacement. Recovery is likely to be high (see additional information below).

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Richness	Confidence
Synthetic compound contamination	Intermediate	High	Low	Decline	Moderate

Several of the species characteristic of the biotope are reported as having high intolerance to synthetic chemicals. For instance, Cole *et al.* (1999) suggested that herbicides such as Simazine and Atrazine were very toxic to macrophytic algae. Hiscock & Hoare (1974) noted that almost all red algal species and many animal species were absent from Amlwch Bay in North Wales adjacent to an acidified halogenated effluent. Red algae have also been found to be sensitive to oil spill dispersants (O'Brien & Dixon 1976; Grundy quoted in Holt *et al.* 1995). However, this biotope typically occurs in enclosed areas including harbours and so some tolerance of contaminants must occur and an intolerance of intermediate is suggested. Recovery is likely to occur fairly rapidly. For recoverability, see additional information below.

Heavy metal contamination	Low	Very high	Very Low	Minor decline	Moderate

Sporophytes of *Saccharina latissima* have a low intolerance to heavy metals, but the early life stages are more intolerant. The effects of copper, zinc and mercury on *Saccharina latissima* (studied as *Laminaria saccharina*) have been investigated by Thompson & Burrows (1984). They observed that the growth of sporophytes 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. The effects of contaminants on *Mytilus* sp. were extensively reviewed by Widdows & Donkin, (1992) and Livingstone & Pipe (1992). Widdows & Donkin (1992) list tolerances of *Mytilus edulis* adults and larvae but note that lethal responses give a false impression of high tolerance, since the adults can close their valves and isolate themselves from the environment for days. They suggested that sublethal effects e.g. shell growth and 'scope for growth' (SFG), are more sensitive indicators of the effects of contaminants. Overall, *Mytilus edulis* is probably relatively tolerant of heavy metal contamination. (For more information see the *MarLIN* review of *Mytilus edulis*. Barnacles accumulate heavy metals and store them as insoluble granules (Rainbow, 1987). Pyefinch & Mott (1948) recorded a median lethal concentration of 0.19 mg/l copper and 1.35 mg/l mercury, for *Balanus crenatus* over 24 hours. Barnacles may tolerate fairly high level of heavy metals in nature, for example they are found in Dulas Bay, Anglesey, where copper reaches concentrations of 24.5 µg/l, due to acid mine waste (Foster et al., 1978). Overall, the biotope is unlikely to be lost although there may be some species mortality so that an intolerance of low is indicated. Recoverability is expected to be very high.

Hydrocarbon contamination	Intermediate	High	Low	Decline	Low

Red algae have been found to be sensitive to oil and oil spill dispersants (O'Brien & Dixon 1976; Grundy quoted in Holt *et al.* 1995). Foliose red algae in the biotope may therefore be subject to bleaching and death. Holt *et al.* (1995) reported that *Saccharina latissima* (studied as *Laminaria saccharina*) had been observed to show no discernible effects from oil spills. Echinoderms seem especially intolerant of the toxic effects of oil, likely because of the large amount of exposed epidermis (Suchanek, 1993). Following the *Torrey Canyon* incident, large numbers of dead *Psammechinus miliaris* were found in the vicinity of Sennen, presumably due to exposure to the oil spill and the heavy spraying of hydrocarbon based dispersants in that area (Smith 1968). However, elements of the biotope, especially sponges and solitary ascidians were abundant on jetty piles adjacent to an oily refinery effluent in Milford Haven (Hiscock *et al.* 1980-83). The shallow nature of this biotope suggests that oil might diffuse in significant quantities to the biota. Overall, because of the equivocal nature of evidence, an intolerance of intermediate is suggested.

Radionuclide contamination				Insufficient information	High

Insufficient information.

Changes in nutrient levels	Low	Very high	Very Low	No change	Low

Evidence is equivocal. For *Saccharina latissima* (studied as *Laminaria saccharina*), Conolly & Drew (1985) found that plants at the most eutrophic site in a study on the east coast of Scotland where nutrient levels were 25% higher than average exhibited a higher growth rate. However, Read *et al.* (1983) reported that, after removal of a major sewage outfall in the Firth of Forth, *Saccharina latissima* (studied as *Laminaria saccharina*) became abundant where previously it had been absent. Increased nutrients may increase the abundance of ephemeral algae and result in smothering or changing the character of the biotope. For a review of potential impacts on algae, see Fletcher (1996) and for impacts of eutrophication on the Swedish west coast, see Lundälv (1990). In relation to the level of nutrient increase in the benchmark, an intolerance of low has been reported. Any recovery is likely to be very high as species are unlikely to be lost and anyway have planktonic propagules and high growth rates. See also additional information below.

Increase in salinity	High	High	Moderate	Rise	Moderate

The biotope is typically found in areas subject to reduced or low salinity. It is most likely that, with an increase in salinity, the biotope will change to another one, possibly A3.3133 or A3.321 and *Saccharina latissima* might be joined by *Laminaria digitata* so that the biotope becomes A3.3131. Change to another biotope means that SIR.LsacRS is lost and so intolerance is high. Species richness might increase as low salinity ceases to be an adverse factor. Species that replace those characteristic of SIR.LsacRS may persist for some time and delay recovery of the original biotope but recoverability is still considered likely to be high (see additional information below).

Decrease in salinity	High	High		Major decline	High

The biotope is described as occurring in low salinity suggesting that it survives in salinities of less than 18 psu (Connor *et al*., 1997a). However, the richness of the communities described in examples of the sub-biotopes and the presence of species not generally associated with low salinity (many red algae, echinoderms and crustaceans especially) suggests that at most it occurs in reduced salinity conditions. However, *Saccharina latissima* (studied as *Laminaria saccharina*) can survive in salinities of 8 psu although growth is retarded below 16 psu (Kain 1979). *Delesseria sanguinea* is also tolerant of salinities as low as 11 psu in the North Sea Rietema (1993) whilst *Halichondria panicea* occurs in the reduced salinity of the western Baltic probably as low as 14 psu. Most of the species in the biotope are unlikely to survive further reduction in salinity and an intolerance of high is reported. Recovery is expected to be high (see additional information below).

Changes in oxygenation	Intermediate	High	Low	Decline	Very low

The still water conditions that characterize this biotope suggest that some tolerance of reduced oxygen conditions is likely. Sponges and ascidians produce their own feeding currents and may be important in circulating water. Also, the algae in the biotope produce oxygen. However, any dead material is likely to rot and cause local pockets of de-oxygenation. If the water becomes very still, de-oxygenation might occur and the sort of situation that develops in Abereiddy Quarry (Hiscock & Hoare, 1973) may develop with organisms below a thermocline dying. Cole *et al.* (1999) suggest possible adverse effects on marine species below 4 mg/l and probable adverse effects below 2mg/l. Whilst there is some tolerance of deoxygenation, some of the species in the biotope may die and so an intolerance of intermediate is suggested. However, on return to oxygenated conditions, rapid recovery of surviving organisms is likely and others will settle readily (see additional information below).

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Richness	Confidence
Introduction of microbial pathogens/parasites	Low	Very high	Very Low	No change	Low

There is little information on microbial pathogen effects on the characterizing species in this biotope. However, *Saccharina latissima* 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 (Peters & Scaffelke, 1996). Infection can reduce growth rates of host algae. It is likely that microbial pathogens will have only a minor possible impact on this biotope and an intolerance of low has been reported

Introduction of non-native species	High	High	Moderate	Decline	Very low

The sub-biotope A3.225 which occurs in south-west Britain is colonized by the slipper limpet *Crepidula fornicata*and by the solitary ascidian *Styela clava* at a few locations. *Crepidula fornicata* may be common in some examples of the biotope and is known to smother areas of seabed both by itself and through the pseudofaeces it produces. *Styela clava* occurs in small numbers and occupies little space. *Crepidula* could extend its distribution northwards and may have a significant impact. Another non-native species that might colonize this biotope is *Sargassum muticum* which is generally considered to be a 'gap-filler'. However, it may displace some native species. The biotope does seem to be threatened to some degree by non-native species and an intolerance of high is proposed by with a very low confidence. Recovery would be high (see additional information below).

Extraction of this species	High	High	Moderate	Rise	Low

Psammechinus miliaris is important as both a characterizing and a key functional species. Extraction of *Psammechinus miliaris* is becoming increasingly more likely to be a factor. An alternative source of the continental delicacy of urchin gonads is sought as other urchin species are declining due to over extraction (e.g. *Paracentrotus lividus*). The aquaculture potential of this smaller species is being investigated (Kelly *et al*., 1998). Collecting of *Echinus esculentus* for the curio trade was studied by Nichols (1984). He concluded that the majority of divers collected only large specimens that are seen quickly and often missed individuals covered by seaweed or under rocks, especially if small. As a result, a significant proportion of the population remains. He suggested that exploited populations should not be allowed to fall below 0.2 individuals per square metre. Similar principles should apply to *Psammechinus miliaris*. Recruitment to the remaining population will occur by larval settlement from the plankton. Although *Psammechinus miliaris* is quite long lived (up to 12 years) (Allain, 1978), it has immature gonads within a year of settling (Jensen, 1969) and probably breeds the following year. Breeding occurs in spring/early summer each year (Mortensen, 1927; Sukarno *et al*., 1979) and fecundity is likely to be high (MacBride, 1903) and the larvae are long lived (30-40 days) (Jensen, 1969; Massin, 1999b. Dispersal potential is therefore large. For the sub-biotope A3.322, intolerance to extraction is therefore high as it would be likely to change to a different sub-biotope (probably SIR.Lsac.Phy). However, because intense urchin grazing reduces diversity, extraction may allow for increased species richness. Recoverability is likely to be high (see additional information below).

Extraction of other species	Not relevant	Not relevant	Not relevant	Not relevant	High

Additional information

Recoverability

The main characterizing species, *Saccharina latissima*, rapidly colonizes cleared areas of the substratum and Kain (1975) recorded that *Saccharina latissima* (studied as *Laminaria saccharina*) was abundant six months after the substratum was cleared. Foliose algae would probably settle and grow rapidly. For instance, Hawkins & Harkin (1985) observed a rapid increase in the number of red algae, *Palmaria palmata*, sporelings and the species came to dominate cleared plots within five months. Rhodophyceae have non flagellate, and non-motile spores that stick on contact with the substratum. Norton (1992) noted that algal spore dispersal is probably determined by currents and turbulent deposition. However, red algae produce large numbers of spores that may settle close to the adult especially where currents are reduced by an algal turf or in kelp forests. It is likely that species in this biotope could recolonize an area from adjacent populations within a short period of time in ideal conditions. However, recolonization from distant populations would probably take much longer. The main species covering rock, *Lithophyllum incrustans*, grows at a rate of only <7mm a year (Irvine & Chamberlain 1994) and will take much longer to colonize than foliose algae. In £SIR.LsacRS.Psa£, *Psammechinus miliaris* are likely to produce larvae every year and settlement from long-lived plankton would recolonize locations within a year. However, growth rate is unclear although Elmhirst (1922; cited in Gage, 1991) noted that maturity was reached in the first year after settlement. Bull, (1939) estimated longevity to be up to 6 years, Jensen, (1969) up to 8 years and Allain, (1978) up to 10 or 12 years. *Ascidiella scabra* has a high fecundity and settles readily, probably for an extended period from spring to autumn. Svane (1988) describes it as "an annual ascidian" and demonstrated recruitment onto artificial and scraped natural substrata. Eggs and larvae are free-living for only a few hours and so recolonization would have to be from existing individuals no more than a few km away. It is also likely that *Ascidiella scabra* larvae are attracted by existing populations and settle near to adults (Svane *et al.*, 1987) . Fast growth means that a dense cover could be established within about 2 months. Most other characterizing species have a planktonic larva and/or are mobile and so can migrate into the affected area. Many or most of the species in the biotope grow rapidly. For instance, *Halichondria panicea* increases in size by about 5% per week (Barthel, 1988). Some species present in the biotope may not colonize for several years after a catastrophic event but the appearance of the biotope, whether dominated by algae or grazed by urchins will be much as before the impact within two or three years. A recoverability of high is suggested even after a catastrophic event.

Bibliography

Allain, J-Y. 1978. Age et croissance de *Paracentrotus lividus* (Lamarck) et de *Psammechinus miliaris* (Gmelin) des côtes nord de Bretagne (Echinoidea). *Cahiers de Biologie Marine*, **19**, 11-21.

Barthel, D., 1988. On the ecophysiology of the sponge *Halichondria panicea* in Kiel Bight. II. Biomass, production, energy budget and integration in environmental processes. *Marine Ecology Progress Series*, **43**, 87-93.

Bishop, G.M. & Earll, R., 1984. Studies on the populations of *Echinus esculentus* at the St Abbs and Skomer voluntary Marine Nature Reserves. *Progress in Underwater Science*, **9**, 53-66.

Bull, H.O., 1939. The growth of *Psammechinus miliaris* (Gmelin) under aquarium conditions. *Report of the Dove Marine Laboratory, Series 6*, 39-41.

Cole, S., Codling, I.D., Parr, W. & Zabel, T., 1999. Guidelines for managing water quality impacts within UK European Marine sites. *Natura 2000 report prepared for the UK Marine SACs Project.* 441 pp., Swindon: Water Research Council on behalf of EN, SNH, CCW, JNCC, SAMS and EHS. [UK Marine SACs Project.], http://www.ukmarinesac.org.uk/

Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F. & Sanderson, W.G., 1997a. Marine biotope classification for Britain and Ireland. Vol. 2. Sublittoral biotopes. *Joint Nature Conservation Committee, Peterborough, JNCC Report* no. 230, Version 97.06., *Joint Nature Conservation Committee, Peterborough, JNCC* Report no. 230, Version 97.06.

Conolly N.J. & Drew, E.A., 1985. Physiology of *Laminaria*. III. Effect of a coastal eutrophication on seasonal patterns of growth and tissue composition in *Laminaria digitata* and *L. saccharina*. *Marine Ecology, Pubblicazioni della Stazione Zoologica di Napoli I*, **6**, 181-195.

Davies, C.E. & Moss, D., 1998. European Union Nature Information System (EUNIS) Habitat Classification. *Report to European Topic Centre on Nature Conservation from the Institute of Terrestrial Ecology, Monks Wood, Cambridgeshire.* [Final draft with further revisions to marine habitats.], Brussels: European Environment Agency.

Fletcher, R.L., 1996. The occurrence of 'green tides' - a review. In *Marine Benthic Vegetation. Recent changes and the Effects of Eutrophication* (ed. W. Schramm & P.H. Nienhuis). Berlin Heidelberg: Springer-Verlag. [Ecological Studies, vol. 123].

Gage, J.D., 1991. Skeletal growth zones as age-markers in the sea urchin *Psammechinus miliaris*. *Marine Biology*, **110**, 217-228.

Hawkins, S.J. & Harkin, E., 1985. Preliminary canopy removal experiments in algal dominated communities low on the shore and in the shallow subtidal on the Isle of Man. *Botanica Marina*, **28**, 223-30.

Hiscock, K. & Hoare, R., 1975. The ecology of sublittoral communities at Abereiddy Quarry, Pembrokeshire. *Journal of the Marine Biological Association of the united Kingdom*, **55**, 833-864.

Hiscock, K., 1983. Water movement. In *Sublittoral ecology. The ecology of shallow sublittoral benthos* (ed. R. Earll & D.G. Erwin), pp. 58-96. Oxford: Clarendon Press.

Hiscock, S., 1986c. Skomer Marine Nature Reserve subtidal monitoring project. Algal results. August 1984 to February 1986. *Nature Conservancy Council, Peterborough, CSD Report* no. 620., Peterborough, Nature Conservancy Council. (CSD Report No. 620.)

Holt, T.J., Jones, D.R., Hawkins, S.J. & Hartnoll, R.G., 1995. The sensitivity of marine communities to man induced change - a scoping report. *Countryside Council for Wales, Bangor, Contract Science Report*, no. 65.

Irvine, L. M. & Chamberlain, Y. M., 1994. *Seaweeds of the British Isles*, vol. 1. *Rhodophyta*, Part 2B *Corallinales, Hildenbrandiales.* London: Her Majesty's Stationery Office.

Jensen, M., 1969. Breeding and growth of *Psammechinus miliaris* (Gmelin).

JNCC, 2015. The Marine Habitat Classification for Britain and Ireland Version 15.03. (20/05/2015). Available from https://mhc.jncc.gov.uk/

JNCC (Joint Nature Conservation Committee), 1999. *Marine Environment Resource Mapping And Information Database (MERMAID): Marine Nature Conservation Review Survey Database.* [on-line] http://www.jncc.gov.uk/mermaid

Kain, J.M., 1975a. Algal recolonization of some cleared subtidal areas. *Journal of Ecology*, **63**, 739-765.

Kain, J.M., 1979. A view of the genus *Laminaria*. *Oceanography and Marine Biology: an Annual Review*, **17**, 101-161.

Kelly, M.S., Brodie, C.C., & McKenzie, J.D., 1998. Somatic and gonadal growth of the sea urchin *Psammechinus miliaris* (Gmelin) maintained in polyculture with the Atlantic salmon. *Journal of Shellfish Research*, **17**, 1557-1562.

Livingstone, D.R. & Pipe, R.K., 1992. Mussels and environmental contaminants: molecular and cellular aspects. In *The mussel* Mytilus*: ecology, physiology, genetics and culture*, (ed. E.M. Gosling), pp. 425-464. Amsterdam: Elsevier Science Publ. [Developments in Aquaculture and Fisheries Science, no. 25]

Lundälv, T., 1990. Effects of eutrophication and plankton blooms in waters bordering the Swedish west coast - an overview. *Water Pollution Research Reports*, **12**, 195-213.

MacBride, E.W., 1903. The development of *Echinus esculentus* together with some points on the development of *E. miliaris* and *E. acutus*. *Philosophical Transactions of the Royal Society of London, Series B*, **195**, 285-327.

Massin, C., 1999b. *Psammechinus miliaris*. http://staff.umh.ac.be/Sheridan.Richard/inventaire/ech/htm/psammechinus.htm, 2000-09-21

Mortensen, T.H., 1927. *Handbook of the echinoderms of the British Isles.* London: Humphrey Milford, Oxford University Press.

Nichols, D., 1984. An investigation of the population dynamics of the common edible sea urchin (*Echinus esculentus* L.) in relation to species conservation management. *Report to Department of the Environment and Nature Conservancy Council from the Department of Biological Sciences, University of Exeter*.

Norton, T.A., 1992. Dispersal by macroalgae. *British Phycological Journal*, **27**, 293-301.

O'Brien, P.J. & Dixon, P.S., 1976. Effects of oils and oil components on algae: a review. *British Phycological Journal*, **11**, 115-142.

Peattie, M.E. & Hoare, R., 1981. The sublittoral ecology of the Menai Strait. II. The sponge *Halichondria panicea* (Pallas) and its associated fauna. *Estuarine, Coastal and Shelf Science*, **13**, 621-635.

Peters, A.F. & Schaffelke, B., 1996. *Streblonema* (Ectocarpales, Phaeophyceae) infection in the kelp *Laminaria saccharina* in the western Baltic. *Hydrobiologia*, **326/327**, 111-116.

Pyefinch, K.A. & Mott, J.C., 1948. The sensitivity of barnacles and their larvae to copper and mercury. *Journal of Experimental Biology*, **25**, 276-298.

Rainbow, P.S., 1987. Heavy metals in barnacles. In *Barnacle biology. Crustacean issues 5* (ed. A.J. Southward), 405-417. Rotterdam: A.A. Balkema.

Read, P.A., Anderson, K.J., Matthews, J.E., Watson, P.G., Halliday, M.C. & Shiells, G.M., 1983. Effects of pollution on the benthos of the Firth of Forth. *Marine Pollution Bulletin,* **14**, 12-16.

Rietema, H., 1993. Ecotypic differences between Baltic and North Sea populations of *Delesseria sanguinea* and *Membranoptera alata*. *Botanica Marina*, **36**, 15-21.

Schmidt, G.H., 1983. The hydroid *Tubularia larynx* causing 'bloom' of the ascidians *Ciona intestinalis* and *Ascidiella aspersa*. *Marine Ecology Progress Series*, **12**, 103-105.

Smith, J.E. (ed.), 1968. 'Torrey Canyon'. *Pollution and marine life.* Cambridge: Cambridge University Press.

Suchanek, T.H., 1993. Oil impacts on marine invertebrate populations and communities. *American Zoologist*, **33**, 510-523.

Sukarno, Jangoux, M., & van Impe, E., 1979. Le cycle reproducteur annuel de *Psammechinus miliaris* (Gmelin)(Echinoidea) en Zeeland. In *Echinoderms: present and past* (ed. M. Jangoux), Rotterdam: Balkema.

Svane, I, Havenhund, J.N. & Jorgensen, A.J., 1987. Effects of tissue extract of adults on metamorphosis in *Ascidia mentula* O.F. Mueller and *Ascidiella scabra* (O.F. Müller). *Journal of Experimental Marine Biology and Ecology*, **110**, 171-181.

Svane, I., 1988. Recruitment and development of epibioses on artificial and cleared substrata at two site in Gullmarsfjorden on the Swedish west coast. *Ophelia*, **29**, 25-41.

Thompson, R.S. & Burrows, E.M., 1984. The toxicity of copper, zinc and mercury to the brown macroalga *Laminaria saccharina*. In *Ecotoxicological testing for the marine environment* (ed. G. Persoone, E. Jaspers, & C. Claus), Vol. 2, pp. 259-269. Ghent: Laboratory for biological research in aquatic pollution, State University of Ghent.

Widdows, J. & Donkin, P., 1992. Mussels and environmental contaminants: bioaccumulation and physiological aspects. In *The mussel* Mytilus: *ecology, physiology, genetics and culture,* (ed. E.M. Gosling), pp. 383-424. Amsterdam: Elsevier Science Publ. [Developments in Aquaculture and Fisheries Science, no. 25]