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Novocrania anomala, Dendrodoa grossularia and *Sarcodictyon roseum* on variable salinity circalittoral rock

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

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***Neocrania anomala*, *Dendrodoa grossularia* and *Sarcodictyon roseum* on variable salinity circalittoral rock**
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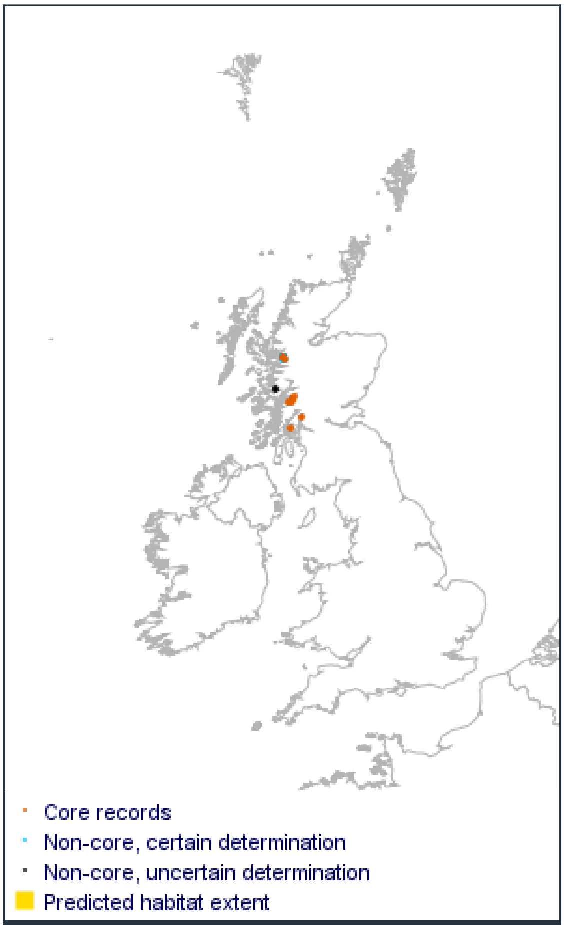

17-09-2018
Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by John Readman **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A4.3142	*Neocrania anomala*, *Dendrodoa grossularia* and *Sarcodictyon roseum* on variable salinity circalittoral rock
JNCC 2015	CR.LCR.BrAs.NovPro.VS	*Novocrania anomala*, *Dendrodoa grossularia* and *Sarcodictyon roseum* on variable salinity circalittoral rock
JNCC 2004	CR.LCR.BrAs.NeoPro.VS	*Neocrania anomala*, *Dendrodoa grossularia* and *Sarcodictyon roseum* on variable salinity circalittoral rock
1997 Biotope	CR.SCR.BrAs.NeoPro.Den	*Neocrania anomala*, *Dendrodoa grossularia* and *Sarcodictyon roseum* on reduced or low salinity circalittoral rock

Description

This variant typically occurs on lower circalittoral silty, bedrock or boulder cliffs and ridges in very wave-sheltered fjordic sealochs subjected to variable salinity regimes (such as Loch Etive). In these sheltered conditions, there are frequently dense populations of the ascidian Dendrodoa grossularia, the brachiopod *Novocrania anomala* and to a lesser extent, the brachiopod Terebratulina retusa, which are able to tolerate the variable salinity. Other solitary ascidians that may be present include *Ciona intestinalis*, *Corella parallelogramma*, *Ascidiella scabra*, *Ascidia mentula*, *Ascidia virginea* and *Polycarpa pomaria*. The anemone *Protanthea simplex* is occasionally seen, although to a lesser extent than in NovPro, possibly due to the variable salinity. The hydroids *Bougainvillia ramosa* and *Lafoea dumosa*, the cup-coral *Caryophilia smithii* and *Sarcodictyon roseum* are occasionally present. The tubes formed by the polychaete *Sabella pavonina* may be observed standing erect from the rock surface. The rest of the rock surface is usually covered by encrusting red algae and the polychaete *Spirobranchus triqueter* and *Protula tubularia*. The sea cucumber *Psolus phantapus* may be found on the underside of boulders. Other species such as the hermit crab Pagurus bernhardus and the spider crab *Hyas araneus* may be found amongst the rock/boulders. The starfish *Asterias rubens*, *Crossaster papposus*, and *Henricia* spp. and the sea urchin *Psammechinus miliaris* are also recorded within this variant. The relatively bare, silty rock supports low numbers of a relatively few species. Although barren rock grazed by the sea urchin *Echinus esculentus* is found in other sea loch biotopes (see FaAlCr.Spi and FaAlCr.Car), *Echinus esculentus* is virtually absent within NovPro.VS. (Information from Connor *et al*., 2004).

Depth range

5-10 m, 10-20 m, 20-30 m, 30-50 m

Additional information

-

Listed By

- none -

Further information sources

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Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

CR.LCR.BrAs.NovPro and its sub-biotopes CR.LCR.BrAs.NovPro.FS and CR.LCR.BrAs.NovPro.VS occur on steep or vertical sheltered bedrock and boulder slopes in the circalittoral, typically in fjordic sealochs. CR.LCR.BrAs.NovPro experiences full or variable salinity, and its two sub-biotopes differ in salinity; the low to full salinity NovPro.VS (salinity between <18-35 psu) and the full salinity NovPro.FS (salinity of between 30-35 psu).

The brachiopod *Novocrania anomala* (previously *Neocrania anomala)* is the characterizing species for this group. The anemone *Protanthea simplex* is a characterizing species of the full salinity NovPro.FS, but is only occasionally seen in the variable salinity NovPro.VS. In the variable salinity sub-biotope (NovPro.VS), a diverse range of ascidians, including *Dendrodoa grossularia*, *Ciona intestinalis* and *Ascidia mentula* become more dominant. *Sarcodictyon roseum* is present in the CR.LCR.BrAs.NovPro.VS, although the description and species list only record species as occasionally present and is considered where appropriate. Other species present in these biotopes are considered transient, mobile or ubiquitous and are, therefore, not considered significant to assessment of the sensitivity of these biotopes. Hence, sensitivity assessments focus on *Novocrania anomala*, *Protanthea simplex* and the ascidians (including *Dendrodoa grossularia*, *Ciona intestinalis* and *Ascidia mentula*).

Resilience and recovery rates of habitat

Novocrania anomala (previously *Neocrania anomala*) is an inarticulate brachiopod that cements its lower shell to the hard substrata (and is therefore sessile) following a pelagic larval stage (Nielsen, 1991, Alvarez & Emig 2000). Brachiopods tend to grow quickly initially, in order to increase survival in the early, most vulnerable life stage. Growth subsequently becomes more stable, diminishing in the latest stages. In general, brachiopods to live up to about 10 years (Alvarez & Emig, 2000).

Novocrania anomala possesses no pedicle, instead cementing its ventral valve directly to the substratum and orientating with the dorsal side up, the anterior margin directed upwards away from the substratum (Ruppert & Barnes, 1994).

The species is free-spawning and fertilization is external in the surrounding water column. The eggs are more dense than seawater and hatch into a free-swimming larval stage. The larvae are fully developed within three days and settle out in no more than a few days, limiting the dispersal range. Although the species may inhabit areas with water flow rates of up to 3 knots, it is often restricted to sheltered habitats such as sea lochs, which may reduce dispersal ability (Jackson, 2000). No information was available about fecundity.

Reproduction occurs annually and over an extended period of time (Long & Stricker, 1991; James *et al*., 1992) with spawning reported between April and October in the South of France and Scotland (Joubin, 1886; Rowell, 1960 cited in James *et al*., 1992).

Novocrania anomala is also capable of recovery from considerable damage to the shell and soft tissue, the adults can be maintained quite well in aquaria and are generally hardy organisms (James et al., 1992).

Protanthea simplex is a small (2cm high), delicate anemone (Jackson, 2008) commonly found in Scottish lochs (Wood, 2005), which appears to be the southern limit to this species' distribution (NBN, 2016), although one record exists off Connemara, Ireland (Seeley, 2006). This anemone is sociable and beds of up to 2000 per m^2 are found in Scandinavia (Wood, 2005). *Protanthea simplex* has long-lived pelagic larval stage (15-20 days, at 10-12 °C, in the plankton before settling) and therefore has considerable dispersal potential, with breeding taking place between September and October in Sweden (Jackson, 2008). Fragments of tissue in this species (except the tentacles) are capable of regenerating into complete anemones, a form of vegetative, asexual reproduction (Manuel, 1988).

Anemones are not completely sessile, and are capable of slow movement. For example, Sebens (1981) observed immigration to cleared patches of the long-lived anemone *Anthopleura xanthogrammica* as the primary driver towards recovery. Sebens (1981) cleared intertidal patches of *Anthopleura xanthogrammica* at Mukkaw Bay, WA observing the effects over 4 years. Even after 4 years, cleared areas were not back to pre-removal population densities. Chia & Spaulding (1972) studying the anemone *Tealia crassicornis* found no sign of gonad development at 14 months old.

Solitary ascidians are discrete creatures which do not fuse with others (unlike colonial ascidians), but may still form dense beds (e.g. up to 5000 individuals/m□ for *Ciona intestinalis*) (Naylor, 2011). *Dendrodoa grossularia*, *Ascidia mentula* and *Ciona intestinalis* occur across the western, northern and southern coasts of the UK, with more scattered records on the eastern coast (NBN, 2015).

Dendrodoa grossularia is a small solitary ascidian (1.5-2 cm diameter (Miller, 1954)). Settlement occurs from April-June, by the following summer individuals reach their maximum size. Life expectancy is expected to be 18-24months. Sexual maturity is reached within the second year of growth and the release of gametes occurs from spring-autumn, with peaks in early spring and another in late summer. Gamete release is reduced at temperatures above 15 °C and totally suppressed above ca. 20 °C (Miller, 1954). Kenny & Rees (1994) observed *Dendrodoa grossularia* was able to recolonize rapidly following aggregate dredging. Following experimental dredging of a site off the English coast, which extracted an area of 1-2m wide and 0.3-0.5m deep, *Dendrodoa grossularia* was able to recolonize and attained 40% of pre-dredge abundance and 23% of biomass within 8 months. This recover rate combined with the ability of this species to reach sexual maturity within its first year suggests that *Dendrodoa grossularia* can recover from disturbance events within 2 years.

In *Ciona intestinalis*, spawning has been reported as year round in temperate conditions (MBA, 1957, Yamaguchi, 1975, Caputi *et al*., 2015) with seasonal spawning observed in colder climates from May to June on the Canadian coast (Carver *et al*., 2006) and in shallower habitats in Sweden (Svane & Havenhand, 1993). Oviparous solitary ascidians generally spawn both oocytes and sperm into the water column, where the resultant fertilized eggs develop into free swimming, non-feeding larvae.

The eggs are negatively buoyant and slightly adhesive and are either released freely or in mucus strings that are especially adhesive. These strings have a tendency to settle close to or on the parent ascidian. *In vitro* studies conclude that fertilization proceeds normally whether in the water column or attached to the mucus string. The hatched free-swimming larvae settle nearby, are held by the mucus string until settlement or escape as plankton. Retention in the mucus string may explain the dense aggregations of adults found (Svane & Havenhand, 1993). *In vitro* studies indicate that both spawning and settlement are controlled by light. However, *Ciona intestinalis* has been observed *in vivo* to spawn and settle at any time of the day (Whittington, 1967; Svane &

Havenhand, 1993).

In the Mediterranean, population collapses of *Ciona intestinalis* were observed, followed by recovery within 1-2 years (Caputi *et al.*, 2015). The collapses are still poorly understood, although low salinity (Pérès, 1943) and temperature (Sabbadin, 1957) were suggested as possible drivers.

Ascidia mentula is a larger (up to 18 cm long) and longer lived (up to 7 years) ascidian compared to *Ciona intestinalis* (Rowley, 2008). Recruitment was reported to occur year round in Sweden at depths greater than 20 m, with seasonal spawning occurring at 15 m (where sea temperature variability is much greater). Both active larvae settlement distribution and passive deposition of larvae (i.e. purely hydrodynamic processes) have been proposed (Havenhand & Svane, 1991 see also Meadows & Campbell, 1972; Scheltema, 1974; Butman, 1987). Long-term data from populations of the ascidian *Ascidia mentula* on subtidal vertical rock indicated that recruitment of *Ascidia mentula* larvae was positively correlated with adult population density, and then by subsequent active larval choice at smaller scales. Factors influencing larval settlement have been listed as light, substratum inclination and texture (Havenhand & Svane, 1989). Sebens (1985, 1986) described the recolonization of epifauna on vertical rock walls. Rapid colonizers such as encrusting corallines, encrusting bryozoans, amphipods and tubeworms recolonized within 1-4 months. Ascidians such as *Dendrodoa carnea*, *Molgula manhattensis* and *Aplidium* spp. achieved significant cover in less than a year, and, together with *Halichondria panicea*, reached pre-clearance levels of cover after 2 years. A few individuals of *Alcyonium digitatum* and *Metridium senile* colonized within 4 years (Sebens, 1986) and would probably take longer to reach pre-clearance levels.

Sarcodictyon roseum forms small colonies on rock surfaces and occasionally on shell, with polyps that reach up to 1 cm in height. It is found from the intertidal to ca 100m and from the Mediterranean to the North Sea (Bay-Nouailhat, 2007; Hayward & Ryland, 1995b). It is found across the western coasts of the British Isles from the Channel Isles to the north coast of Scotland (NBN, 2016) and, more widely, from the Mediterranean to Sweden (Dyntaxa, 2013; van Ofwegen et al., 2001, cited from van Ofwegen, 2015). Very little information is available for this species.

Resilience assessment:

The ascidians are likely to recover from any level of mortality relatively quickly, however *Novocrania anomala* and *Protanthea simplex* are longer lived, slower growing and are unlikely to fully recover from significant mortality within 2 years. When resistance is None or Low, resilience is classed as '**Medium**', but when resistance is Medium or High, Resilience is classed as '**High**'.

Hydrological Pressures

	Resistance	Resilience	Sensitivity
Temperature increase (local)	High Q: Medium A: Medium C: Medium	High Q: High A: High C: High	Not sensitive Q: Medium A: Medium C: Medium

Novocrania anomala extends as far south as the Mediterranean. Radolović *et al.* (2015) describe the gregarious settlement of *Novocrania anomala* in a cave in the Adriatic coast of Croatia. Despite this geographical range, Hiscock (1985 cited in Hartnoll, 1998), noted that seasonal shallow thermoclines may form, particularly in sheltered areas such as sea lochs, and extend down to 15 m. Some animals such as the brachiopods *Crania* (syn. *Novocrania*) and *Terebratulina* seem restricted to below this thermocline. It is, therefore, possible that geographical populations may acclimate to local temperature (Hartnoll, 1998).

Protanthea simplex is a northerly species, with its southern distribution limit typically in Scotland, although one record exists off Connemara, Ireland (Seeley, 2006). *Protanthea simplex* experienced a marked long-term decline in Swedish and Norwegian sites between 1972 and 1982, experiencing ca 50% mortality (density of ca 600 to ca 300) at 20 m and virtual population collapse at 15 m (reduction in density from 400-500 to <50) over ten years (Heip *et al.*, 1985). This decline appeared to coincide with a warm period between 1973 and 1978 of up to ca +2°C deviation and an increase in *Novocrania anomala* (Heip *et al.*, 1985).

Ciona intestinalis is considered a cold water or temperate species but has been found as far south as Cape Verde, although these tropical populations are likely transitory (Monniot & Monniot, 1994). Temperature tolerance varies among geographical populations or ecotypes. Adult *Ciona intestinalis* is reported as tolerant of temperatures up to 30°C (Dybern, 1965; Therriault & Herborg, 2008), although Petersen & Riisgard (1992) noted that filtration rates declined above 21°C, which suggested thermal stress, and indicated that long-term survival was likely to require temperatures lower than the 30°C. Other studies also indicated that *Ciona intestinalis* exhibits a decline in ammonia excretion rate and oxygen consumption rate above 18°C (Zhang & Fang 1999, Zhang *et al.*, 1999).

The effect of higher temperatures on *Ascidia mentula* is not as well researched. It is distributed from Norway through to the Mediterranean and the Black Sea, and the species appears to tolerate a broad range of temperatures. Svane (1984) found that in Sweden, whilst lower temperatures decreased recruitment, populations responded positively to the “warm period” of 1972-1976 (Glantz, 2005), with an increase in population density across all sites in the study and a gradual decrease during the ensuing “cold period”, and minor fluctuations throughout. Unusually high mean temperatures in 1975 did result in higher recruitment, with colder temperatures in January 1976 and spring 1979 coinciding with very little recruitment. Svane (1984) found that, unlike recruitment, mortality was regulated locally and independent of temperature within the range of the study (mean monthly deviation of ±3°C)(Svane, 1984).

Sensitivity assessment. None of the characterizing species for this biotope are at their northern distribution limit and are unlikely to be affected by a reduction in temperature at the benchmark level. Resistance is therefore assessed as ‘**High**’, Resilience as ‘**High**’ and Sensitivity is therefore recorded as ‘**Not Sensitive**’.

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

The characterizing brachiopod *Novocrania anomala* has been recorded as far north as Svalbard (Greig, 1924, cited in Prestrud *et al.*, 2004) and the anemone *Protanthea simplex* is a northerly species, occurring in Scandinavia and recorded in across Scotland (Wood, 2005; NBN, 2015). A reduction in temperature would probably be beneficial and could result in distribution expansion of *Protanthea simplex.*

Tolerance for low temperatures varies among geographical populations of ascidians. In the Mediterranean, most adult *Ciona intestinalis* die when temperatures fall below 10°C, and the population is maintained by the survival of younger individuals, which are more tolerant of colder temperatures (Marin *et al.*, 1987). Observation of Scandinavian populations indicated a higher mortality rate of *Ciona intestinalis* during the coldest period of the year (temperatures down to 1°C)

(Dybern, 1965). In Scandinavian populations, normal egg development requires 8-22°C and larval development occurs between 6-24°C (Dybern, 1965). Larval temperature tolerances may play a part in successful recruitment in unseasonable temperature fluctuations. *Ciona savigny* larvae were found to acclimate to temperature, with embryos collected in the summer dividing normally between 14 - 27°C and embryos collected in the winter dividing normally between 10 - 20°C (Nomaguchi *et al.*, 1997).

Ascidia mentula is distributed from Norway through to the Mediterranean and the Black Sea, and the species appears to tolerate a broad range of temperatures. Svane (1984) found that in Sweden, whilst lower temperatures (of ±3°C of the monthly mean) decreased recruitment, mortality did not significantly increase. Shallow populations (15 m) experiencing much greater seasonal variability did exhibit seasonal spawning rather than year-round spawning that occurs in more temperate and deeper populations (Svane, 1984). Populations responded positively to the 'warm period' of 1972-1976 (Glantz, 2005), with an increase in population density across all sites in the study and a gradual decrease during the ensuing 'cold period', with minor fluctuations throughout. Unusually high mean temperatures in 1975 did result in higher recruitment, with colder temperatures in January 1976 and spring 1979 coinciding with very little recruitment. Svane (1984) found that, unlike recruitment, mortality was regulated locally and independent of temperature within the range of the study (mean monthly deviation of ±3°C).

Sensitivity assessment. None of the characterizing species for this biotope are at their northern distribution limit and are unlikely to be affected by a reduction in temperature at the benchmark level. Resistance is therefore assessed as '**High**', Resilience as '**High**' and Sensitivity is therefore recorded as '**Not Sensitive**'.

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

Novocrania anomala occurs in biotopes ranging across all salinity variants – from Low (<18 ppt) through to Full (30-35 ppt). No literature could be found relating to this brachiopod in hypersaline conditions, however Hammond (1983) reported that *Lingula anatina* could tolerate salinities ranging from 20‰ to 50‰ for more than four weeks, although Emig (1997) reported that two colonies of *Lingula anatina* (from Northern Japan and New Caledonia) were not able to tolerate salinities above 40-50‰. *Protanthea simplex* appears to prefer full salinity habitats over lower salinity as, whilst it is characterizing in NovPro.FS, it is only occasionally found in the variable salinity biotope NovPro.VS (Connor *et al.*, 2004). No evidence could be found for the effect of hypersaline conditions. *Ciona intestinalis* has been classified as euryhaline with a high salinity tolerance range (12-40‰) although it typically occurs in full salinity conditions (>30‰) (Tillin & Tyler-Walters, 2014). *Ciona intestinalis* has been found in salinities ranging from 11 to 33 PSU in Sweden, although the same study found that parent acclimation to salinity (high or low) has an overriding and significant effect on larval metamorphic success, independent of parent origins (Renborg, 2014).

Sensitivity assessment. NovPro.VS occurs across a range of salinity regimes, from Variable (18-40 ppt) to Low (<18 ppt). An increase at the benchmark level at the middle of this range would be tolerated by the characterizing species but the relative abundance of species is likely to change and the biotope may come to resemble the full saline sub-biotope (NovPro.FS). Nevertheless, the NovPro community will remain and after one year (the benchmark duration) return to its prior community. Resistance is, therefore, assessed as **'Medium'**, resilience as **'High'** and sensitivity as

'Low'.

Salinity decrease (local)	High Q: Medium A: Medium C: Medium	High Q: High A: High C: High	Not sensitive Q: Medium A: Medium C: Medium

Novocrania anomala occurs in biotopes ranging across all salinity variants, from Low (<18 ppt) through to full (30-35 ppt). In addition to Nov.Pro, two variants of this biotope occur, one in full salinity (NovPro.FS) and one in variable salinity (NovPro.VS). Whilst *Novocrania anomala* and the ascidians are likely to be unaffected by a decrease in salinity at the benchmark level, the reduced presence of *Protanthea simplex* from the variable salinity NovPro.VS indicates that it is at least partially intolerant of salinity decrease. It should also be noted that, given the biotope descriptions, a change from NovPro.FS to NovPro.VS would occur in the event of a salinity reduction at the benchmark level becoming permanent. Whilst no evidence could be found directly for *Novocrania anomala*, Hammond (1983) reported that *Lingula anatina* could tolerate salinities ranging from 20‰ to 50‰ for prolonged periods (more than four weeks) and survived in salinities as low as 5‰ for short periods of time (snap response failed at 1 day) and 11.5‰ for 19 days. Other studies report tolerances of ca 16 to 18‰ (Emig, 1997) reported more conservative tolerance. It should be noted that the ability for brachiopods to respire anaerobically within their closed shell would enable them to survive short-term changes (James *et al*., 1992). *Ciona intestinalis* has been classified as euryhaline with a high salinity tolerance range (12-40‰) although it typically occurs in full salinity conditions (>30‰) (Tillin & Tyler-Walters, 2014) but has been found in Scandinavian waters in salinities as low as 11 PSU (Renborg, 2014, Dybern, 1967). Adult acclimation to salinity was shown to have an overriding and significant effect on larval metamorphic success, independent of parent origins (Renborg, 2014). ‘Massive die-offs’ of *Ciona intestinalis* were observed following winter rains in Californian harbours with ‘massive recolonizations usually following in the spring’ (Lambert & Lambert, 1998). Population collapses of *Ciona intestinalis* in the Mediterranean have also been reported, and whilst the drivers for these events are not well understood, it has been postulated that low salinity could play a part (Péres, 1943; Caputi *et al*., 2015). Oxygen consumption rate has been shown to decline with decreasing salinity and ceased at 19‰ with siphons tightly closed. (Shumway, 1978). *Ascidia mentula* is found on the West coast of Norway in salinities greater than 20‰ (Dybern, 1969) and found in a brackish lake in Corsica with a salinity gradient of 6.5 to 18.5 ‰ Cl^- (Verhoeven, 1978). *Dendrodoa* was observed as one of the dominant species in a study area in Lübeck Bay, Norway, where salinity was recorded as between 11.1 -15.0‰ (Gulliksen, 1977).

Sensitivity assessment. NovPro.VS occurs across a range of salinity regimes, from Variable (18-40 ppt) to Low (<18 ppt). A reduction at the benchmark level in the middle of this range would be tolerated by the characterizing species. Resistance is, therefore, classed as **‘High’**, resilience as **‘High’** and the biotope is **‘Not sensitive’** at the benchmark level.

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

The CR.LCR.BrAs.NovPro biotope exists in weak to negligible tidal flow conditions (<0.5 m/sec.) Connor *et al.* (2004). High flow rates may reduce the abundance of *Novocrania anomala* and *Protanthea simplex*, although *Novocrania anomala* may inhabit areas with water flow rates of up to 3 knots (Jackson, 2000; 2008b). Decreases in water flow are unlikely to have any effect but increases in flow rate above weak may prevent the animals from maintaining posture and interfere with feeding. Increased flow rates may also sweep individuals off the substratum.

As sessile filter feeders, ascidians generally require a reasonable water flow rate in order to ensure sufficient food availability. It was shown that in stagnant water, phytoplankton density became reduced in a 20-30 cm layer immediately above a dense colony of *Ciona intestinalis* (Riisgård *et al*., 1996). However, *Ciona intestinalis* has been recognised as tolerant of low water flow environments which it uses as a competitive advantage in areas with minimal water exchange and renewal such as harbours, marinas and docks, (Carver *et al*., 2006). Whilst *Ciona intestinalis* is typically found in areas of low flow, it can reportedly withstand flow rates up to 3 knots (1.5 m/s) (Jackson 2008b). If dislodged, juveniles and adults have a limited capability to re-attach, given calm conditions and prolonged contact with the new substrata (Millar 1971; Carver *et al*., 2006; Jackson, 2008). Hiscock (1983) found that, for the solitary ascidian *Ascidia mentula*, siphons closed when current velocity rose above about 0.15 m/s.

Sensitivity assessment. Significant increases in water flow are likely to negatively affect the characterizing species, but mortality at the benchmark level is unlikely. Resistance is therefore assessed as '**High**', Resilience as '**High**' and the biotopes are considered '**Not sensitive**' at the pressure benchmark.

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

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

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

The NovPro biotope complex is found in sheltered to extremely sheltered wave exposure conditions. *Novocrania anomala* is unlikely to tolerate wave action and is found in sheltered. Increases in wave exposure above moderately exposed would probably cause death (Jackson, 2000). High energy wave action can be detrimental to ascidian populations. This is mainly through physical damage to the sea squirts and through the abrasive action of suspended sediment (Jackson, 2008). *Ciona intestinalis* is often dominant in highly sheltered areas such as harbours (Carver *et al*., 2006). Decreases in wave exposure are unlikely to have any effect. If dislodged, juvenile and adult *Ciona intestinalis* have a limited capability to re-attach, given calm conditions and prolonged contact with the new substratum (Millar 1971; Carver *et al*., 2006; Jackson 2008;) but increases in wave exposure above moderately exposed are likely to cause a proportion of the population to die, especially in the shallower examples of the biotope if the cobbles and pebbles on which the biotope occurs are mobilized by wave action. *Ascidia mentula* has rarely been recorded at depths shallower than 15 m (Svane, 1984), it is possible that damage could occur if subjected to increased wave exposure.

Sensitivity assessment. Whilst the characterizing species are likely to be affected by an increase in wave exposure, the NovPro biotope complex is found in sheltered to extremely sheltered wave exposure conditions and a change at the benchmark level is unlikely to increase mortality. Resistance is therefore assessed as '**High**', with resilience as '**High**' and the biotope is therefore 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

Mercier *et al.* (1998) studied response to TBT exposure of temperate anemones (*Metridium senile* and *Bunodactis stella)*, which metabolised and regulated butyl-tin uptake, and accumulated less than mussels (Fent, 1996) or symbiotic anemones (Mercier *et al.*, 1996). Regulation of butyl-tin compounds in temperate sea anemones seemed to parallel that of trace metals (Mercier *et al.*, 1998).