Ocnus planci aggregations on sheltered sublittoral muddy sediment

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

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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/325]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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Aggregation of *Ocnus planci* on broken shell and cobbles.
Photographer: Dominic Counsell
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- Core records
- Non-core, certain determination
- Non-core, uncertain determination
- Predicted habitat extent

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

Researched by	Dr Harvey Tyler-Walters	**Refereed by**	This information is not refereed.

Summary

☰ UK and Ireland classification

EUNIS 2008	A5.344	*Ocnus planci* aggregations on sheltered sublittoral muddy sediment
JNCC 2015	SS.SMu.IFiMu.Ocn	*Ocnus planci* aggregations on sheltered sublittoral muddy sediment
JNCC 2004	SS.SMu.IFiMu.Ocn	*Ocnus planci* aggregations on sheltered sublittoral muddy sediment
1997 Biotope	SS.IMU.MarMu.Ocn	*Ocnus planci* aggregations on sheltered sublittoral muddy sediment

🏷 Description

Dense aggregations of *Ocnus planci* (or *Ocnus brunneus*?) on various substrata, typically muddy but sometimes with stones or shells, in sheltered conditions such as sea lochs. Associated species vary

but are typical of very sheltered muddy habitats. *Melanella alba*, which parasitises holothurians, was found in large numbers at one site. (Information taken from the Marine Biotope Classification for Britain and Ireland, Version 97.06: Connor *et al.,* 1997a, b).

⬇ Depth range

0-5 m, 5-10 m, 10-20 m, 20-30 m

🏛 Additional information

The description of this biotope is based on only four records (Erwin *et al.*, 1990; Connor *et al.*, 1997a). The taxonomic status of *Ocnus planci* and *Ocnus brunneus* is under review and the species may have been confused. However, the two species are ecologically similar and have been discussed together for the sake of this review.

✔ Listed By

- none -

🔗 Further information sources

Search on:

G 👣 G JNCC

Habitat review

⟳ Ecology

Ecological and functional relationships

Little information on this biotope was found. Shallow records of the biotope are similar to IMU.PhiVir with the addition of epifaunal species including abundant *Ocnus*, while deeper records share some species with sea pen and burrowing macrofauna communities (see CMU.SpMeg). The following information has been inferred from survey records (Erwin *et al.*, 1990; Connor *et al.*, 1997a; Howson *et al.*, 1994; Dipper & Beaver, 1999; Murray *et al.*, 1999; JNCC, 1999), papers on general ecology of *Ocnus planci* (Ölscher & Fedra, 1977) and reviews of sublittoral mud communities (e.g. Hughes, 1998b) and *MarLIN* reviews of IMU.PhiVir and CMU.SpMeg.

- Phytoplankton, benthic microalgae and macroalgae present in the shallow extent of the biotope (e.g. *Phycodrys rubens*, or *Saccharina latissima*) provide primary productivity within the biotope.
- Active epifaunal suspension feeders generate localized currents to collect food such as organic particulates and phytoplankton. They include the sponge *Suberites ficus*, the soft coral *Alcyonium digitatum*, tubeworms (e.g. *Chaetopterus variopedatus* and *Spirobranchus triqueter*), fanworms (e.g. *Sabella pavonina* and *Myxicola infundibulum*), the barnacle *Balanus balanus*, bivalves (e.g. *Pecten maximus*, *Aequipecten opercularis* and *Modiolus modiolus*) and ascidians such as *Ascidiella* spp., *Ascidia* spp. and *Ciona intestinalis*.
- Passive epifaunal suspension feeders collect organic particulates and small zooplankton from the passing water column and include hydroids (e.g. *Bougainvillia ramosa*), the sea pens *Virgularia mirabilis* and *Pennatula phosphorea*, brittlestars (e.g. *Ophiothix fragilis* and *Ophiocomina nigra*), and the sea cucumbers *Ocnus planci* and *Ocnus lateus*.
- Infaunal suspension feeders include burrowing bivalves such as *Mya truncata* and *Abra alba*, the commensal *Kurtiella bidentata* often found in the burrows of other organisms and the gastropod *Turritella communis*.
- The mud also supports surface deposit feeding terebellid polychaetes (e.g. *Eupotymnia nebulosa*) and the sea cucumber *Leptosynapta* sp.
  Grazers may include the chiton *Leptochiton asellus* and the sea hare *Aplysia punctata* feeding on microalgae and macroalgae, while sea urchins (e.g. *Psammechinus miliaris* and *Echinus esculentus* feed on macroalgae, algal fragments and epifaunal crusts (e.g. hydroids).

- Infaunal predators include the sea slug *Philine quadripartita* feeding on polychaetes, gastropods and bivalves at the sediment surface, and the necklace shell *Polinices catera* which preys on bivalves.
- The burrowing anemone *Cerianthus lloydii* is a passive carnivore feeding on small invertebrates.
- Mobile epifaunal generalist predators include the crabs (e.g. *Cancer pagurus* and *Liocarcinus* species) and the starfish *Asterias rubens*, while the larger starfish *Luidia sarsi* and *Solaster endeca* prey on other echinoderms. The sea slug *Armina loveni* is a specialist predator of *Virgularia mirabilis.*
- Starfish, crabs, hermit crabs (e.g. *Pagurus bernhardus*) and brittlestars (e.g. *Ophiura albida*, *Ophiocomina nigra* and *Ophiothrix fragilis*) are probably scavengers within the biotope.
- Dermersal fish such as the small-spotted catshark *Scyliorhinus canicula*, and gobies (e.g. *Pomatoschistus minutus*) are probably generalist predators.
- the sea lemon *Doris pseudoargus* feeds on sponges.

- The small gastropod *Melanella alba* parasites holothurians, sucking on their body fluids (Graham, 1988).

Many of the species living in deep mud biotopes are generally cryptic in nature and not usually subject to predation. Evidence of predation on *Virgularia mirabilis* by fish seems limited to a report by Marshall & Marshall (1882 in Hoare & Wilson, 1977) where the species was found in the stomach of haddock. Many specimens of *Virgularia mirabilis* lack the uppermost part of the colony which has been attributed to nibbling by fish. Observations by Hoare & Wilson (1977) suggest however, that predation pressure on *Virgularia mirabilis* is low.

Epifauna probably compete for the limited space for attachment provided by cobbles, pebbles and shell debris, with ascidians, sponges and soft corals probably representing later stages in colonization (succession) (see MCR.Flu for further detail). However, *Ocnus* species are probably capable of climbing on any available surface, including other epifauna, to raise their feeding tentacles into the prevailing current (see Ölsher & Fedra, 1977; McKenzie, 1991). Bioturbation by deposit feeding or infaunal species is likely to modify the substratum and resuspend sediment, potentially inhibiting suspension feeding organisms, especially small colonies or juveniles.

Seasonal and longer term change

Species such as the sea pen *Virgularia mirabilis* appear to be long-lived and are unlikely to show any significant seasonal changes in abundance or biomass. Sea pen faunal communities appear to persist over long periods at the same location. Movement of the sea pen *Virgularia mirabilis* in and out of the sediment may be influenced by tidal conditions (Hoare & Wilson, 1977; Hughes, 1988). The numbers of some of the other species in the biotope may show peak abundances at certain times of the year due to seasonality of breeding and larval recruitment.

Microphytobenthos and algal production may increase in spring, resulting in the formation of mats of ephemeral algae, and be reduced in winter. High summer temperatures may increase the microbial activity resulting in deoxygenation (hypoxia or anoxia), or alternatively result in thermoclines in shallow bays and resultant hypoxia of the near bottom water (Hayward, 1994; Elliot *et al.*, 1998; Hughes, 1998). Flatfish and crabs often migrate to deeper water in the winter months, and therefore, predation pressure may be reduced in this biotope. Mud habitats of sheltered areas are relatively stable habitats, however especially cold winter or hot summers could adversely affect the macrofauna (see sensitivity). In addition, extreme freshwater runoff resulting from heavy rains and storms may result in low salinity conditions in the most shallow parts of the biotope or in haloclines, again potentially causing local hypoxia. No information on long-term change was found. But storms events and extreme wave action may resuspend the bottom sediment and move the cobbles, pebbles and shell debris, resulting in loss or burial of epifauna at irregular intervals.

Habitat structure and complexity

This biotope is characterized by a soft to flocculant mud substratum with the presence of hard substrata such a shell debris, living epifauna, rock, cobbles and pebbles. The soft mud supports epifauna and infauna typical of sheltered soft mud habitats (e.g. IMU.PhiVir), while the hard substrata provides habitat for attached epifaunal species and niches and interstices for other epifaunal species (e.g. brittlestars and *Ocnus*). The habitat can be divided into the following niches:

- a mobile epifauna of scavengers and opportunistic predators;
- a sediment surface flora of microalgae such as diatoms and euglenoids, together with

aerobic microbes;
- an aerobic upper layer of sediment (depth depending on local conditions) supporting shallow burrowing species;
- a reducing layer and a deeper anoxic layer supporting chemoautotrophic bacteria, burrowing polychaetes (e.g. terebellids), burrowing synaptid holothurians (e.g. *Leptosynapta* sp.) and bivalves (e.g. *Abra alba* and *Mya truncata*) that can irrigate their burrows.
- an epifauna of sea pens, burrowing anemones, scallops or horse mussels sitting in or on the sediment surface;
- an epifauna of tubeworms, barnacles, sponges, and ascidians attached to hard substrata;
- a more mobile epifauna of brittlestars on or between hard substrata and *Ocnus* on any available raised surface.

Burrowing megafauna are generally rare or absent, therefore there will be few burrows available for colonization by other species. Several species, such as the sea pen *Virgularia mirabilis*, the anemone *Cerianthus lloydii*, the tubeworm *Chaetopterus variopedatus* and fan worms *Sabella pavonina* and *Myxicola infundibulum* extend above the sediment surface. Apart from a couple of species of nudibranch living on the sea pens and the tubiculous amphipod *Photis longicaudata* associated with *Cerianthus lloydii* (Moore & Cameron, 1999) the large species characteristic of the biotope do not provide significant habitat for other fauna. Brittlestars such as *Ophiothrix fragilis* probably utilize gaps between cobbles and pebbles and inside dead shells of bivalves. Excavation of sediment by infaunal organisms, such as errant polychaetes, bivalves and *Philine quadripartita*, ensures that sediment is oxygenated to a greater depth but little information on the infauna was found.

Productivity

Primary productivity is derived from phytoplankton, benthic microalgae and from macroalgae. However, most of the productivity with the biotope is probably secondary, derived from zooplankton, detritus, dissolved organic material and organic particulates. The biotope is dominated by suspension feeding organisms, especially passive suspension feeders such as brittlestars, sea pens and abundant *Ocnus*. Ölscher & Fedra (1977) examined passive suspension feeding in the brittlestar *Ophiothrix quinquemaculata* and the holothurian *Ocnus planci* (as *Cucumaria planci*). They noted that passive suspension feeders usually constitute about one third of the community biomass in suspension feeder communities but that they metabolic activity of passive suspension feeders is twice as great due to their small size. They noted the importance of suspension feeding communities to linking the pelagic and benthic ecosystems. Similarly, the importance of bivalve suspension feeding in 'pelago-benthic coupling' has been discussed by Dame (1996) (see also MCR.ModT).

Recruitment processes

Ocnus planci and *Ocnus brunneus* are dioecious, with separate sexes but are also capable of reproducing asexually by fission. Fertilization is external and spawning occurs in March and April. The eggs are retained after spawning on the tentacles of the female. Development is direct, the larvae adopting the adult body plan without metamorphosis. The larvae are released as a ciliated vitellaria larvae, which is lecithotrophic, completing its development in the plankton (Hyman, 1955; Smiley *et al.*, 1991). No estimate of fecundity was found but other Cucumariidae exhibit clutch sizes between 19 and 340 (Smiley *et al.*, 1991). Planktonic development provides the larvae with potentially long range dispersal capabilities. However, recruitment in echinoderms is known

to be sporadic, unpredictable and poorly understood. *Ocnus planci* and *Ocnus brunneus* are fissiparous, each individual being able to divide into two or more fragments, over a period of about 14hrs, which then regenerate into complete individuals (Emson & Wilkie, 1980; Smiley *et al.*, 1991). McKenzie (1991) suggested that the large aggregations of *Ocnus brunneus* may be clones. Fissiparity may provide *Ocnus* with a mechanism to exploit favourable conditions quickly, although no evidence to this effect was found.

The reproductive biology of British sea pens has not been studied but, in other species, for instance *Ptilosarcus guerneyi* from Washington State in the USA, the eggs and sperm are released from the polyps and fertilization takes place externally. The free-swimming larvae do not feed and settle within seven days if a suitable substratum is available (Chia & Crawford, 1973). The limited data available from other species would suggest a similar pattern of patchy recruitment, slow growth and long lifespan for *Virgularia mirabilis*.

The associated macroalgae, epifauna and interstitial fauna probably depend on locality and recruit from the surrounding area. Many hydroids, ascidians and probably sponges have short lived planktonic or demersal larvae with relatively poor dispersal capabilities. Exceptions include *Alcyonium digitatum* and hydroids that produce medusoid life stages and probably exhibit relatively good dispersal potential. Hydroids are opportunistic, rapid growing species, with relatively widespread distributions, which colonize rapidly and are often the first groups on species to occur on settlement panels. Sponges may take longer to recruit to the habitat but are good competitors for space. Recruitment in epifauna communities is discussed in detail in the faunal turf biotopes MCR.Flu, CR.Bug and in *Modiolus modiolus* beds (MCR.ModT).

Mobile epifaunal species, such as echinoderms (starfish and brittlestars), crustacea, and fish are fairly vagile and capable of colonizing the community by migration from the surrounding areas. In addition, most echinoderms and crustaceans have long-lived planktonic larvae with potentially high dispersal potential, although, recruitment may be sporadic, especially in echinoderms.

Time for community to reach maturity

No information concerning community development was found. Recruitment to available hard substrata by epifauna such as hydroids, and ascidians is probably fairly rapid (see MCR.Flu or CR.Bug), with sponges and soft corals taking longer to develop. Very little is known about the population dynamics and longevity of *Virgularia mirabilis* in Britain, however information from other species suggest that this species is likely to be long-lived and slow growing with patchy and intermittent recruitment. Other burrowing species representative of this biotope vary in longevity and reproductive strategies. The time taken for the population of *Ocnus* to grow to the abundances reported in this biotope, by either sexual and/or asexual reproduction, is unknown.

Additional information

None entered

🖼 Preferences & Distribution

Habitat preferences

Depth Range	0-5 m, 5-10 m, 10-20 m, 20-30 m
Water clarity preferences	No information found

Limiting Nutrients	Not relevant
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Physiographic preferences	Enclosed coast / Embayment, Sea loch / Sea lough
Biological zone preferences	Circalittoral, Infralittoral
Substratum/habitat preferences	Cobbles, Mud and sandy mud, Pebbles, Small boulders
Tidal strength preferences	Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Extremely sheltered, Moderately exposed, Sheltered, Very sheltered
Other preferences	Hard substrata

Additional Information

The biotope is characterized by the presence of hard substrata (cobbles, pebbles, gravel, and shell debris) in muddy or sandy habitats.

🐾 Species composition

Species found especially in this biotope

- *Melanella alba*
- *Ocnus planci*

Rare or scarce species associated with this biotope

-

Additional information

The MNCR recorded 131 species within this biotope, although not all species occurred in all records of the biotope.

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

This community is characterized by the abundance of *Ocnus planci* (or *Ocnus brunneus*). Loss of the *Ocnus* population would result in loss of the biotope as described and, therefore *Ocnus* is considered to be important characterizing. Therefore, the sensitivity of the biotope is dependent on the sensitivity of *Ocnus planci* (or *Ocnus brunneus*).

The other species in the community are common and characteristic of the wave sheltered muddy habitats in which the biotope is found. Therefore, the dominant associated species vary with location and have little significant association with the *Ocnus* population itself. Reference is made to *Nemertesia ramosa* to represent hydroids *Spirobranchus triqueter* to represent tubeworms, *Ciona intestinalis* to represent ascidians, and *Alcyonium digitatum* to represent anthozoans, and *Echinus esculentus*, *Ophiothrix fragilis*, *Amphiura filiformis* to represent echinoderms, where required.

Resilience and recovery rates of habitat

Ocnus planci and *Ocnus brunneus* are dioecious, with separate sexes but are also capable of reproducing asexually by fission. Fertilization is external and spawning occurs in March and April. The eggs are retained after spawning on the tentacles of the female. Development is direct, the larvae adopting the adult body plan without metamorphosis. The larvae are released as a ciliated vitellaria larvae, which is lecithotrophic, completing its development in the plankton (Hyman, 1955; Smiley *et al.*, 1991). No estimate of fecundity was found but other Cucumariidae exhibit clutch sizes between 19 and 340 (Smiley *et al.*, 1991). Planktonic development provides the larvae with potentially long range dispersal capabilities. Therefore, local recruitment may be good but long distance recruitment will depend on the local currents. However, recruitment in echinoderms is known to be sporadic, unpredictable and poorly understood. *Ocnus planci* and *Ocnus brunneus* are fissiparous, each individual being able to divide into two or more fragments, over a period of about 14hrs, which then regenerate into complete individuals (Emson & Wilkie, 1980; Smiley *et al.*, 1991). McKenzie (1991) suggested that the large aggregations of *Ocnus brunneus* may be clones. Fissiparity may provide *Ocnus* with a mechanism to exploit favourable conditions quickly, although no evidence to this effect was found. *Ocnus* is probably fairly long-lived. A specimen of *Ocnus planci* (as *Cucumaria planci*) was maintained in an aquarium for three years and four months (Hyman, 1955).

The associated macroalgae, epifauna and interstitial fauna probably depend on locality and recruit from the surrounding area. Many hydroids, ascidians and probably sponges have short lived planktonic or demersal larvae with relatively poor dispersal capabilities. Exceptions include *Alcyonium digitatum* and hydroids that produce medusoid life stages and probably exhibit relatively good dispersal potential. Hydroids are opportunistic, rapid growing species, with relatively widespread distributions, which colonize rapidly and are often the first groups on species to occur on settlement panels. Sponges may take longer to recruit to the habitat but are good competitors for space. Recruitment in epifauna communities is discussed in detail in the faunal turf biotopes CR.HCR.XFa.FluCoAs and *Modiolus modiolus* beds (SS.SBR.SMus.ModT).

Mobile epifaunal species, such as echinoderms (starfish), crustacea, and fish are fairly vagile and capable of colonizing the community by migration from the surrounding areas. In addition, most echinoderms and crustaceans have long-lived planktonic larvae with potentially high dispersal potential, although, recruitment may be sporadic, especially in echinoderms. Brittlestars vary in

their recruitment ability. *Ophiothrix fragilis* produces numerous, long-lived planktonic larvae capable of long distance dispersal, and reach reproductive maturity with six to ten months, and are probable capable of recovery within less than five years. *Amphiura filiformis* also produces numerous planktonic larvae with high dispersal potential but exhibit high juvenile mortality, so that net recruitment is probably low. Adults also take five to six years to reach maturity, so that recovery may be prolonged. However, *Amphiura filiformis* was reported to recover to a population of 100/m within two years. Brittlestars are mobile, potentially able to migrate from the surrounding area but the above species are not thought to be actively mobile. Therefore, the recovery of brittlestars will depend on the sporadic good larval recruitment, local hydrography, and will vary between species, some recovering with a few years while other may take longer.

Many epifaunal species, e.g. hydroids, colonial ascidians, some sponges and *Metridium senile* are capable of asexual reproduction and colonize space rapidly. For example, in studies of subtidal epifaunal communities in New England, Sebens (1985, 1986) reported that cleared areas were colonized by erect hydroids, bryozoans, crustose red algae and tube worms within one to four months in spring, summer and autumn. Tunicates such as *Dendrodoa carnea* and *Aplidium* spp. appeared within a year, *Aplidium* sp., and *Halichondria panacea* achieved pre-clearance cover within >two years, while only a few individuals of *Metridium senile* and *Alcyonium* sp. colonized within four years. Other burrowing species representative of this biotope vary in longevity and reproductive strategies.

The time taken for the population of *Ocnus* to grow to the abundances reported in this biotope is unknown. *Ocnus* is a mobile species, using raised surfaces to aid feeding, and would probably recruit to, and aggregate, in areas of raised hard substrata from the surrounding area. Subsequent development of large populations is probably aided by fissiparous asexual reproduction, although the rate of reproduction is unknown. Recruitment is likely to be slow and recovery of a large population may be prolonged by sexual reproduction alone. However, its ability to reproduce asexually may allow the population to grow relatively quickly. Therefore, where a significant proportion of the population remains resilience may be **High** (< 2 years). But recovery may take longer where a significant proportion of the population is removed (e.g. resistance is 'Low' or 'None') and recovery is dependent on recruitment alone, in which case, resilience is probably **Medium** (2-10 years).

⚓ Hydrological Pressures

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

Hughes (1998a) suggested that in shallow sea lochs, sedimentary biotopes would probably experience a seasonal temperature range between about 5-15 °C. Greater temperature extremes may be experienced in unusually warm summers or cold winters, although the effects on sedimentary communities is unknown (Hughes, 1998a). Burrowing species would probably be able to avoid extreme temperatures within the sediment so that epifauna were likely to be more vulnerable.

Ocnus planci and *Ocnus brunneus* reach their northern limit in northern Europe and the British Isles. *Ocnus brunneus* is reported from France and Denmark while *Ocnus planci* is reported from the Mediterranean and Senegal. Therefore, they are unlikely to be adversely affected by a long-term

temperature rise. Similarly, most other dominant species within the biotope are found to the south of the British Isles and unlikely to be affected adversely by long-term temperature rise. The growth and fecundity of *Amphiura filiformis* may increase with increased average temperatures while *Ophiothrix fragilis* was reported to recruit in high numbers after mild winters (see *MarLIN* reviews).

Overall, most species in the biotope are unlikely to be adversely affected by long-term temperature rise and are buffered from extremes of temperature by their depth. Therefore, a resistance of **High** has been recorded to represent effects on growth rates and metabolism. Therefore, resilience is **High** and the biotope is assessed as **Not sensitive** at the benchmark level. In shallow, isolated waters (e.g. sea lochs) increased summer temperatures may result in stratification of the water column (a thermocline) and increased oxygen demand resulting in deoxygenation of the bottom waters (Hughes, 1998a)(see deoxygenation below).

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

Ocnus planci and *Ocnus brunneus* reach their northern limit in British waters, however, no information on their temperature tolerance was found. Most of the other common species within the biotope are recorded north of British and Irish waters and are unlikely to be affected by long-term decreases in temperature. However, shallow waters population may be more vulnerable to low temperatures in extreme winters (Hughes, 1998a). For example, a population of *Amphiura filiformis* at 27 m depth off the Danish coast was killed by the winter of 1962-63 (Muus, 1981) and a population at 35-50 m depth in the inner German Bight was killed in the winter of 1969-1970 and a new population did not re-establish until 1974 (Gerdes, 1976). Ursin (cited in Gerdes, 1978) suggested that *Amphiura filiformis* did not occur in areas with winter temperatures below 4°C although in Helgoland waters it can tolerate temperatures as low as 3.5°C. Low temperatures are a limiting factor for breeding in this species, which takes place during the warmest months in the British waters. Similarly, *Ophiothrix fragilis* occurs in shallow, enclosed waters that regularly drop to 3 °C but is absent from areas where temperatures drop to 0°C. In addition, temperature influences growth and reproduction in many species of hydroids and ascidians (see species reviews).

Overall, most species will probably not be adversely affected by a long-term decrease in temperatures, although short-term acute decreases in temperatures associated with extreme winters may result in loss of a few species. Therefore, resilience is **High** and the biotope is assessed as **Not sensitive** at the benchmark level.

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

Echinoderms are generally regarded as stenohaline and most species are exclusively marine (Binyon, 1966; Pawson, 1966; Stickle & Diehl, 1987; Lawrence, 1996, Russell, 2013). An increase in salinity at the benchmark level would result in a salinity of >40 psu, and as hypersaline water is likely to sink to the seabed, the biotope may be affected by hypersaline effluents. Roberts *et al.* (2010b) suggested that hypersaline effluent dispersed quickly but was more of a concern at the seabed and in areas of low energy where widespread alternations in the community of soft sediments were observed. In several studies, echinoderms and ascidians were amongst the most sensitive groups examined (Roberts *et al.*, 2010b).

Sensitivity assessment. An increase in salinity from full to >40 psu is probably detrimental to the

important characteristic species of the biotope. Although, there is no direct evidence of the effects of hypersaline water, the stenohaline nature of the echinoderm dominated community suggests that hypersaline conditions may cause mortality. Therefore, a resistance of **Low** is recorded but at Low confidence. Resilience would probably be **Medium** so that sensitivity may be **Medium**.

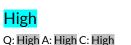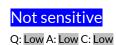| Salinity decrease (local)	None	Medium	Medium
	Q: Medium A: Medium C: Medium	Q: Low A: NR C: NR	Q: Low A: Low C: Low

Echinoderms are generally regarded as stenohaline and most species are exclusively marine (Binyon, 1966; Pawson, 1966; Stickle & Diehl, 1987; Lawrence, 1996, Russell, 2013). Lawrence (1996) cited several examples of mass mortalities in echinoderms due to sudden increases in river discharge or localized heavy rains. However, some euryhaline species have been reported and local adaptation may occur in some species (see Binyon, 1966 and Stickle & Diehl, 1987 for reviews). A decrease in salinity from e.g. full to reduced for a year (see benchmark) is likely to result in marked changes in community composition, including loss of the *Ocnus* aggregations. Therefore, a resistance of **None** has been suggested. Resilience is probably **Medium** so that sensitivity is assessed as **Medium.**

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

The biotope is only found in areas of weak or very weak tidal streams and so a decrease in flow is unlikely but it is likely to be intolerant of increases in water flow. Some tidal flow is necessary for the supply of food in the form of organic particles by resuspension and advective transport, gaseous exchange and the removal of wastes, influencing the growth rate of suspension-feeding benthos (Dauwe, 1998). *Ocnus planci* has been recorded from moderately strong to very weak tidal streams (Connor *et al.*, 1997b). The feeding efficiency of suspension feeding species may be impaired in strong flow, while allowing other species to colonize.

An increase in water flow will probably result in a marked change in the community due to modification of the substratum, removing finer particulates such as muds and favouring the deposition of coarser deposits. The resultant sediment scour may adversely affect epifaunal species. Increased water flow may also cause small stones, pebbles, and cobbles to roll along the substratum resulting in further abrasion for epifauna.

Sensitivity assessment. A significant increase in water flow may winnow away the mud surface or even remove the mud habitat and hence the biotope if prolonged. An increase of 0.2 m/s may begin to erode the mud surface where the site is already subject to flow (e.g. weak flow at the seabed), based on sediment erosion deposition curves (Wright, 2001). However, the dominant suspension feeding echinoderms position themselves on the stones, shells and rocks on the surface of the muddy substratum, and may not be affected adversely by an increase of 0.1-0.2 m/s. Therefore, a resistance of **High** is recorded but with Low confidence. Therefore, resilience is probably **High** so that the biotope is assessed as **Not sensitive** at the benchmark level.

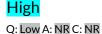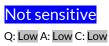| Emergence regime changes	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

The pressure benchmark is relevant only to littoral and shallow sublittoral fringe biotopes.

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

Ocnus planci was recorded from moderately wave exposed to extremely wave sheltered habitats (Connor *et al.*, 1997b). But this biotope (IFiMu.Ocn) is only recorded from moderately wave exposed to extremely wave sheltered conditions. An increase in wave exposure and the resultant increase in oscillatory water movement at the sediment surface is likely to resuspend fine particulates, and deposit coarser sediment types, e.g. sands and gravels resulting in loss of many of the mud dwelling species. Water movement is also likely to roll, or move stones, cobbles , pebbles and shell fragments, resulting in increased sediment scour and abrasion, and probably loss of many of the epifaunal species. *Ocnus* species may survive on coarser substrata but are rare in wave exposed environments (Connor *et al.*, 1997b). Overall, the community is likely to change significantly and the aggregations of *Ocnus* lost. However, a change of 0.3-0.5% of significant wave height (the benchmark) is unlikely to be significant, especially at depth. Therefore, a resistance of **High** is suggested so that resilience also **High** and the biotope is assessed as **Not sensitive** at the benchmark level.

⚗ Chemical Pressures

	Resistance	Resilience	Sensitivity
Transition elements & organo-metal contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

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

Bryan (1984) reported that early work had shown that echinoderm larvae were sensitive to heavy metals, e.g. the intolerance of larvae of *Paracentrotus lividus* to copper (Cu) had been used to develop a water quality assessment. Kinne (1984) reported developmental disturbances in *Echinus esculentus* exposed to waters containing 25 µg / l of copper (Cu) and heavy metals caused reproductive anomalies in the starfish Asterias rubens (Besten, *et al.*, 1989, 1991). Sea-urchins, especially the eggs and larvae, are used for toxicity testing and environmental monitoring (reviewed by Dinnel *et al.* 1988). Crompton (1997) reported that mortalities occurred in echinoderms after 4-14 day exposure to above 10-100 µg/l Cu, 1-10 mg/l Zn and 10-100 mg/l Cr but that mortalities occurred in echinoderm larvae above10-100 µg/ l Ni.

Various heavy metals have been show to have sublethal effects on growth in the few hydroids studied experimentally (Stebbing, 1981; Bryan, 1984; Ringelband, 2001). Gastropod molluscs have been reported to relatively tolerant of heavy metals while a wide range of sublethal and lethal effects have been observed in larval and adult crustaceans (Bryan, 1984). Bryan (1984) suggested that polychaetes are fairly resistant to heavy metals, based on the species studied. Short-term toxicity in polychaetes was highest to Hg, Cu and Ag, declined with Al, Cr, Zn and Pb whereas Cd, Ni, Co and Se the least toxic.

Tri-butyl tin (TBT) has a marked effect on numerous marine organisms (Bryan & Gibbs, 1991). Bryan & Gibbs (1991) reported that virtually no hydroids were present on hard bottom communities in TBT contaminated sites and suggested that some hydroids were intolerant of TBT levels between 100 and 500 ng/l. Copepod and mysid crustaceans were particularly intolerant of TBT while crabs were more resistant (Bryan & Gibbs, 1991), although recent evidence suggests

some sublethal endocrine disruption in crabs. The effect of TBT on *Nucella lapillus* and other neogastropods is well known (see review), and similar effects on reproduction may occur in other gastropod molluscs, including nudibranchs. Rees *et al.* (2001) reported that the abundance of epifauna had increased in the Crouch estuary in the five years since TBT was banned from use on small vessels. Rees *et al.* (2001) suggested that TBT inhibited settlement in ascidian larvae. This report suggests that epifaunal species (including, bryozoan, hydroids and ascidians) may be at least inhibited by the presence of TBT.

Overall, while some invertebrate groups are tolerant, many of the other groups, including echinoderms are probably intolerant, especially their larvae.

Hydrocarbon & PAH contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

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

Sheltered embayments and lagoons, where this biotope is found, are particularly vulnerable to oil pollution, which may settle onto the sediment and persist for years (Cole *et al.*, 1999). Subsequent digestion or degradation of the oil by microbes may result in nutrient enrichment and eutrophication (see nutrients below). Although protected from direct smothering by oil by its depth, the biotope is relatively shallow and would be exposed to the water soluble fraction of oil, water soluble PAHs, and oil adsorbed onto particulates.

Suchanek (1993) reviewed the effects of oil spills on marine invertebrates and concluded that, in general, on soft sediment habitats, infaunal polychaetes, bivalves and amphipods were particularly affected. Crude oil and refined oils were shown to have little effect on fertilization in sea urchin eggs but in the presence of dispersants fertilization was poor and embryonic development was impaired (Johnston, 1984). Sea urchin eggs showed developmental abnormalities when exposed to 10-30 mg/l of hydrocarbons and crude oil : Corexit dispersant mixtures have been shown to cause functional loss of tube feet and spines in sea urchins (Suchanek, 1993). Olsgard & Gray (1995) found the brittlestar Amphiura filiformis to be very sensitive to oil pollution. During monitoring of sediments in the Ekofisk oilfield, Addy *et al.* (1978) suggest that reduced abundance of *Amphiura filiformis* within 2-3 km of the site was related to discharges of oil from the platforms and to physical disturbance of the sediment. Although acute toxicity test showed that drill cuttings containing oil based muds had a very low toxicity (LC50 52,800 ppm total hydrocarbons in test sediment), Newton & McKenzie (1998) suggest these are a poor predictor of chronic response. Chronic sub-lethal effects were detected around the Beryl oil platform in the North Sea where the levels of oil in the sediment were very low (3 ppm) and Amphiura filiformis was excluded from areas nearer the platform with higher sediment oil content. Similarly, in *Ophiothrix fragilis*, exposure to 30,000 ppm oil reduces its load of symbiotic bacteria by 50% and brittle stars begin to die (Newton & McKenzie, 1995). Crude oil from the *Torrey Canyon* and the detergent used to disperse it caused mass mortalities of echinoderms; *Asterias rubens, Echinocardium cordatum, Psammechinus miliaris, Echinus esculentus, Marthasterias glacialis* and *Acrocnida brachiata* (Smith, 1968).

Suchanek (1993) reported that the anemones *Anthopleura* spp. and *Actinia* spp. survived in waters exposed to spills and chronic inputs of oils. Similarly, one month after the *Torrey Canyon* oil spill the dahlia anemone, *Urticina felina*, was found to be one of the most resistant animals on the shore, being commonly found alive in pools between the tide-marks which appeared to be devoid of all other animals (Smith, 1968). If the physiology within different animals groups can be assumed to

be similar, then amphipods, echinoderms, and soft corals may be intolerant of hydrocarbon contamination while hydroids may demonstrate sublethal effects and anemones and some species of sponge are relatively tolerant.

Synthetic compound contamination	Not Assessed (NA)	Not assessed (NA)	Not assessed (NA)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

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

Little information on the toxicity of synthetic chemicals to holothurians was found. Newton & McKenzie (1995) suggested that echinoderms tend to be very intolerant of various types of marine pollution but gave no detailed information. Cole *et al.* (1999) reported that echinoderm larvae displayed adverse effects when exposed to 0.15mg/l of the pesticide Dichlorobenzene (DCB). Smith (1968) demonstrated that 0.5 -1 ppm of the detergent BP1002 resulted in developmental abnormalities in echinopluteus larvae of Echinus esculentus. Smith (1968) also noted that large numbers of dead Echinus esculentus were found between 5.5 and 14.5 m in the vicinity of Sennen, presumably due to a combination of wave exposure and heavy spraying of dispersants in that area. TBT was shown to inhibit arm regeneration in the brittlestar *Ophioderma brevispina*, at 10ng/l and produce significant inhibition at 100 ng/l. It was suggested that TBT acts via the nervous system, although direct action on the tissues at the point of breakage could not be excluded (Bryan & Gibbs, 1991) Therefore, holothurians and their larvae may also be intolerant of synthetic chemicals.

The species richness of hydroid communities decreases with increasing pollution (Boero, 1984; Gili & Hughes, 1995). *Alcyonium digitatum* at a depth of 16m in the locality of Sennen Cove (Pedu-men-du, Cornwall) died resulting from the offshore spread and toxic effect of detergents e.g. BP 1002 sprayed along the shoreline to disperse oil from the *Torrey Canyon* tanker spill (Smith, 1986). Possible sub-lethal effects of exposure to synthetic chemicals may result in a change in morphology, growth rate or disruption of the reproductive cycle.

Therefore, hydroids, crustaceans, gastropods, and ascidians are probably intolerant of TBT contamination. Echinoderms, including *Ocnus*, may be intolerant of synthetic chemicals.

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

No evidence was found

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

This pressure is **Not assessed.**

De-oxygenation	Low	Medium	Medium
	Q: High A: High C: Medium	Q: Low A: NR C: NR	Q: Low A: Low C: Low

Lawrence (1996) reported mass mortality of echinoderms in the Gulf of Trieste due to hypoxia caused by a strong thermocline combined with high pelagic productivity and eutrophication. The

brittlestar *Ophiura quinquemaculata* was killed with a few days, and holothurians including *Ocnus planci* (as *Cucumaria planci*), starfish *Asteropecten* sp. and the remaining brittlestars were killed within a week. In experiments, *Amphiura filiformis* only left its protected position in the sediment when oxygen levels fell below 0.85mg/l (Rosenberg *et al.*, 1991). Mass mortality of *Amphiura filiformis* was observed during severely low oxygen events (<0.7 mg/l) (Nilsson, 1999). However, at oxygen concentrations between 0.85 mg/l and 1.0 mg/l Rosenberg *et al.* (1991) observed the species was able to survive for several weeks. Echinoderms were shown to be intolerant of the effects of algal blooms, resulting in mortalities of the sea urchins *Echinus esculentus* and *Paracentrotus lividus*, and the holothurian *Labidoplax digitata* amongst other echinoderms, probably due to hypoxia caused by death of the algal bloom algae (Boalch, 1979; Forster, 1979; Griffiths *et al.*, 1979; Lawrence, 1996). Diaz & Rosenberg (1995, Figure 5)) suggested that shrimp and crustaceans were lost as oxygen levels dropped below ca 0.75 ml/l and that the macroinfauna was reduced below ca 0.4ml/l. Vaquer-Sunyer & Duarte (2008) suggested a median sublethal oxygen concentration of 1.22 mg O_2/l (± 0.25) for a number of echinoderms reviewed in their study. Echinoderms were neither the most or the least sensitive of the taxonomic groups examined. Riedel *et al.* (2012) examined the effects of hypoxia and anoxia on macrofauna in the North Adriatic, using *in situ* experimental apparatus. The concluded that, decapods, echinoderms and polychaetes were amongst the most sensitive to hypoxia while ascidians and anthozoans were amongst the most resistant of the species encountered in their study. However, *Ocnus planci* survived moderate (<0.8 ml O_2/l, <1.12 mg O_2/l) to severe (<0.5 ml O_2/l, <0.7 mg O_2/l) hypoxia but died with several hours (median duration of 23.3 hrs) of anoxic conditions; anoxia was reached after 48 hrs of the onset of the experiment (Riedel *et al.*, 2012).

Overall, based on the evidence cited above, echinoderms appear to be intolerant of hypoxic conditions. However, *Ocnus planci* may be amongst the most resistant of those studied by Riedel *et al.* (2012) in their 3 to 4 day experiment. Therefore, a decrease in oxygen levels to below 2 mg O_2 /l for a week is likely to result in loss of most of the suspension feeding echinoderms and a proportion of the *Ocnus* spp. population, based on the observation in the Gulf of Trieste, and a resistance of **Low** is suggested. Resilience is probably **Medium** so that sensitivity is assessed as **Medium**.

Nutrient enrichment	Not relevant (NR)	Not relevant (NR)	Not sensitive
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

Hughes (1998a) suggested that sea loch sediments, where this biotope occurs, were naturally rich in organic matter. Moderate enrichment is likely to increase food availability and hence, the abundance of deposit feeding organisms. Increases in nutrients and low oxygen conditions result in anaerobic conditions within the sediment. Nutrient enrichment may also result in algal blooms. For example *Cerianthus lloydii* was found near the centre of sewage sludge dumping groups at ca 10% organic carbon but more abundant at intermediate nutrient enrichment (Hughes, 1998a) and echinoderms were shown to be intolerant of the effects of algal blooms, resulting in mortalities of the sea urchins *Echinus esculentus* and *Paracentrotus lividus, a*nd the holothurian *Labidoplax digitata* amongst other echinoderms, probably due to hypoxia caused by death of the algal bloom algae (Boalch, 1979; Forster, 1979; Griffiths *et al.*, 1979; Lawrence, 1996). Therefore, while moderate enrichment may be beneficial, echinoderms are indirectly intolerant due to sudden hypoxia resulting from the death of algal blooms.

Nevertheless, the biotope is assessed as **Not sensitive** at the pressure benchmark that assumes compliance with good status as defined by the WFD.

Organic enrichment

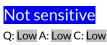| High	High	Not sensitive
Q: Low A: NR C: NR	Q: High A: High C: High	Q: Low A: Low C: Low

Hughes (1998a) suggested that sea loch sediments, where this biotope occurs, were naturally rich in organic matter. Moderate enrichment is likely to increase food availability and hence, the abundance of deposit feeding organisms.

Cerianthus lloydii was found near the centre of sewage sludge dumping groups at ca 10% organic carbon but was more abundant at intermediate nutrient enrichment (Hughes, 1998b). But Borja *et al.* (2000) and Gittenberger and van Loon (2011) both assigned *Cerianthus lloydii* to their Ecological Group I, 'species very sensitive to organic enrichment and present under unpolluted conditions (initial state)' in of the AZTI Marine Biotic Index (AMBI) index to assess disturbance (including organic enrichment). The basis for their assessment and relation to the pressure benchmark is not clear.

However, no information on the effects of organic enrichment on *Ocnus planci* was found.

Sensitivity assessment. In the absence of direct evidence, it is assumed that muddy habitats in sea lochs are probably naturally rich in organic matter (Hughes, 1998a). Therefore, a resistance of High is suggested with Low confidence. Hence, resilience is **High** and the biotope assessed as **Not sensitive** at the benchmark level.

♟ Physical Pressures

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

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

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

This biotope (IFiMu.Ocn) is an epifaunal overlay on an otherwise sedimentary biotope. The important charactersitic epifauna (*Ocnus planci*) position themsleves on stones, pebbles shells and other hard substrata to avail themsleves of the passing current. Other suspension feeding brittlestar may do the same. Yet the biotope is only recorded on muddy habitats with stones and shell on the surface (Connor *et al.*, 2004). If sedimentary substrata were replaced with rock substrata the biotope would be lost, as it would not longer be a sedimentary habitat and no longer recognised under the habitat clasification.

Sensitivity assessment. Resistance to the pressure is considered '**None**', and resilience '**Very low**' or 'None' (as the pressure represents a permanent change) and the sensitivity of this biotope is assessed as '**High'**.

Physical change (to another sediment type)

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

This biotope (IFiMu.Ocn) is an epifaunal overlay on an otherwise sedimentary biotope. The important characteristic epifauna (*Ocnus planci*) position themselves on stones, pebbles shells, and other hard substrata to avail themselves of the passing current. Other suspension feeding brittlestars may do the same.Yet the biotope is only recorded on muddy habitats with stones and shell on the surface (Connor *et al.*, 2004). It is unknown why the aggregations of suspension feeding echinoderms occur in this habitat. But a change in sediment type by one Folk class t, for example, muddy sand or sand, would result in the loss of the biotope as described under the habitat classification.

Sensitivity assessment. Resistance to the pressure is considered '**None**', and resilience '**Very low**' or 'None' (as the pressure represents a permanent change) and the sensitivity of this biotope is assessed as '**High'**.

Habitat structure changes - removal of substratum (extraction)

None	Medium	Medium
Q: Low A: NR C: NR	Q: Low A: NR C: NR	Q: Low A: NR C: NR

This biotope (IFiMu.Ocn) is an epifaunal overlay on an otherwise sedimentary biotope. The important characteristic epifauna (*Ocnus planci*) position themselves on stones, pebbles shells, and other hard substrata to avail themselves of the passing current. Other suspension feeding brittlestars may do the same. The extraction of the sediment to a depth of 30 cm would remove the mud infauna and the surface epifauna with the affected area. Therefore, a resistance of **None** is suggested based on expert judgement. Resilience is probably **Medium** so that the sensitivity is assessed as **Medium.**

Abrasion/disturbance of the surface of the substratum or seabed

Low	Medium	Medium
Q: High A: Medium C: Medium	Q: Low A: NR C: NR	Q: Low A: Low C: Low

Stable sedimentary habitats, such as mud were amongst the most vulnerable to fishing activities, e.g. otter board trawling (Ball *et al.*, 2000b; Collie *et al.*, 2000). Tracks left by otter boards were visible 18 months after experimental trawls in Gareloch (Ball *et al.*, 2000b). Ball *et al.*, (2000b) concluded that trawling modified the benthic community due to an increase in opportunistic polychaetes. However, Kaiser *et al.* (2006) concluded that otter boards had a significant initial effect on muddy sands and muds, but that the effects were short-lived in mud habitats.

Erect epifaunal species are particularly vulnerable to physical disturbance (Jenkins & Kaiser, 1998). Hydroids are likely to be detached or damaged by bottom trawling or dredging (Holt *et al.*, 1995). Veale *et al.* (2000) reported that the abundance, biomass, and production of epifaunal assemblages decreased with increasing fishing effort. Hydroid and bryozoan matrices were reported to be greatly reduced in fished areas (Jennings & Kaiser, 1998). Mobile gears also result in modification of the substratum, including removal of shell debris, cobbles and rocks, and the movement of boulders (Bullimore, 1985; Jennings & Kaiser, 1998) on which many of the species in this community depend. The removal of rocks or boulders to which species are attached results in substratum loss (see above). For example, Magorrian & Service (1998) reported that queen scallop

trawling flattened horse mussel beds and removed emergent epifauna in Strangford Lough. They suggested that the emergent epifauna such as *Alcyonium digitatum*, a frequent component of this biotope, were more sensitive than the horse mussels themselves and reflected early signs of damage. Species with fragile tests such as *Echinus esculentus* and the brittlestar *Ophiocomina nigra* and edible crabs *Cancer pagurus* were reported to suffer badly from the impact of a passing scallop dredge (Bradshaw *et al.*, 2000). But brittlestars such as *Ophiothrix fragilis* probably have good powers of regeneration and infaunal species such as *Amphiura filiformis* may avoid the effects of a passing beam trawl. Scavengers such as *Asterias rubens* and *Buccinum undatum* were reported to be fairly robust to encounters with trawls (Kaiser & Spencer, 1995) may benefit in the short-term, feeding on species damaged or killed by passing dredges. However, Veale *et al.* (2000) did not detect any net benefit at the population level. Greathead *et al.* (2011) were not able to conclude if the variation in *Cerianthus* abundance in the Fladden Grounds was due to miscounting, its patchy distribution, or fishing activity.

Ocnus species are the most important characterizing species within the biotope, and may be damaged by physical disturbance due to an anchor or passing fishing gear. But they probably have good powers of regeneration (given their fissiparous habit) and would survive if the damage were not too severe. However, they may be displaced due to physical abrasion as the stones and shell they occupy are moved, rolled, or removed from the habitat.

Sensitivity assessment. Overall, physical disturbance by an anchor or mobile fishing gear is likely to remove a significant proportion of the epifauna within the community and attract scavengers to the community in the short-term. Therefore, a resistance of **Low** is suggested. Resilience is probably **Medium** so that sensitivity is assessed as **Medium**.

Penetration or disturbance of the substratum subsurface	Low	Medium	Medium
	Q: High A: Medium C: Medium	Q: Low A: NR C: NR	Q: Low A: Low C: Low

Sensitivity assessment. Based on the evidence present under abrasion above physical disturbance by mobile fishing gear is likely to remove a significant proportion of the epifauna within the community and attract scavengers to the community in the short-term. Therefore, a resistance of **Low** is suggested. Resilience is probably **Medium** so that sensitivity is assessed as **Medium**.

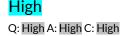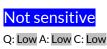| **Changes in suspended solids (water clarity)**	High	High	Not sensitive
	Q: Low A: NR C: NR	Q: High A: High C: High	Q: Low A: Low C: Low

The biotope occurs in sheltered areas, in fine sediments, subject to high suspended sediment loads. The effect of increased deposition of fine silt is uncertain but it is possible that feeding structures may become clogged. However, *Ocnus planci* (as *Cucumaria planci*) maintained a high filtration efficiency even at food concentrations (suspension densities) three times average natural levels (Ölsher & Fedra, 1977). Burrowing species are unlikely to be affected and suspension feeding species are likely to experience, and hence tolerate, periodic re-suspension of suspended sediment due to wave or current surges, storms or digging by predators. Therefore, they are likely to tolerate an increase in suspended sediment for a month, although feeding efficiency of some species, especially epifaunal suspension feeders, may be impaired. Therefore, a resistance of **High** is suggested. Hence, resilience is **High** and the biotope is assessed as **Not sensitive** at the benchmark level.

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

Deposition of a 5 cm layer of sediment is unlikely to disturb burrowing infaunal species. Kukert & Smith (1992) noted that deposition of 5-6 cm of sediment resulted in a 32% reduction in macrofaunal abundance in less than 1 month but that deposit feeders had returned to background levels within 3 months, while scavengers and carnivores took longer. Suspension feeding epifauna are likely to be the least resistant. Species that project above the sediment surface, such as sea pens and *Sabella pavonina* are probably tall enough to avoid the effects, while burrowing species such as *Myxicola infundibulum*, *Chaetopterus variopedatus*, *Cerianthus lloydii* and *Amphiura filiformis* could probably burrow up through the sediment. For example, in normal accretion, *Cerianthus lloydii* keeps pace with the accretion and, as a result, develops burrows much larger than the animal itself (Schäfer, 1972; Bromley, 2012). Schäfer (1972) reported that an increase in depositional rate led to an avoidance behaviour in *Cerianthus lloydii*. The organism ceases tube building activity and instead the animal bunches its tentacles and intrudes its way up to the new surface, where it establishes a new burrow. However, no information on the depth of material through which is can burrow was given

Other epifauna e.g. hydroids, tubeworms, ascidians are fixed to the substratum, the brittlestar *Ophiothrix fragilis* and smaller sea urchins are unable to burrow effectively and would probably be smothered, potentially succumbing due to clogged respiratory apparatus and temporary anoxia.

At up to 15 cm in length, *Ocnus planci* may be large enough to avoid the effects of smothering but *Ocnus brunneus* is a small species. However, holothurians are generally burrowing species and it is probably able to regain the sediment surface rapidly. Raised areas of sediment may even provide this species with a new feeding perch.

Sensitvity assessment. *Ocnus* and most of the species typical of mud communities would probably survive smothering by 5 cm of sediment. However, some epifaunal species, and juveniles of several species may be affected adversely, resulting in a short-term decrease in species richness. Therefore, a resistance of **High** is suggested. Hence, resilience is **High** and the biotope is assessed as **Not sensitive** at the benchmark level.

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

Deposition of 30 cm of fine sediment is likely to smother the entire community. In the sheltered low energy environment this biotope occurs, the sediment is likely to remain. Therefore, the effect on the community will depend on the ability of the species to burrow through the deposited sediment. Small brittlestars and hydroids or ascidians affixed to stones and shell will be unable to burrow, while large burrowing species such as *Chaetopterus variopedatus* and *Cerianthus lloydii* may be able to regain the surface. For example, in normal accretion, *Cerianthus lloydii* keeps pace with the accretion and, as a result, develops burrows much larger than the animal itself (Schäfer, 1972; Bromley, 2012). Schäfer (1972) reported that an increase in depositional rate led to an avoidance behaviour in *Cerianthus lloydii*. The organism ceases tube building activity and instead the animal bunches its tentacles and intrudes its way up to the new surface, where it establishes a new burrow. However, no information on the depth of material through which is can burrow was given.

At up to 15 cm in length, *Ocnus planci* may be large enough to avoid the effects of smothering but

Ocnus brunneus is a small species. However, holothurians are generally burrowing species and it is probably able to regain the sediment surface rapidly. Raised areas of sediment may even provide this species with a new feeding perch. But the stones and shell typical of the biotope would also be smothered and lost and with them the epifaunal perches they provide. As a result, the aggregations of *Ocnus* spp. that typify this biotope may also be lost, although the reason for their aggregation is unknown.

Sensitivity assessment. Smothering by 30 cm of sediment is likely to result in the loss of smaller species and epifauna while larger burrowing species may survive. Therefore, a resistance of **Medium** is suggested to represent the loss of some of the *Ocnus* population and other epifauna. The resilience is probably **High** so that sensitivity is assessed as **Low**.

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

Not assessed.

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

No evidence was found.

Underwater noise changes	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Some of the characterizing species associated with this biotope, in particular, the epifauna, may respond to sound vibrations. Feeding will resume once the disturbing factor has passed. Therefore, this pressure is probably **Not relevant** in this biotope.

Introduction of light or shading	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

Epifaunal suspension feeders that feed on passing seston such as phytoplankton and a variety of marine organic particulates dominate the biotope. Most of the productivity is probably secondary and not directly dependent on the availability of light , especially in the deeper examples of the biotope. Therefore, this biotope is probably **Not sensitive** to changes in light (resistance and resilience are **High**).

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

Not relevant – this pressure is considered applicable to mobile species, e.g. fish and marine mammals rather than seabed habitats. Physical and hydrographic barriers may limit the dispersal of seed or propagules. But seed or propagule dispersal is not considered under the pressure definition and benchmark.

Death or injury by collision	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

Not relevant to seabed habitats.

Visual disturbance	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

Most species within the biotope are burrowing and have no or poor visual perception and are unlikely to be affected by visual disturbance such as shading. Epifauna such as crabs have well developed visual acuity and are likely to respond to movement in order to avoid predators. However, it is unlikely that the species will be affected by visual disturbance at the benchmark level.

🐚 Biological Pressures

	Resistance	Resilience	Sensitivity
Genetic modification & translocation of indigenous species	No evidence (NEv)	Not relevant (NR)	No evidence (NEv)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

No evidence of genetic modification, breeding, or translocation was found.

Introduction or spread of invasive non-indigenous species	No evidence (NEv)	Not relevant (NR)	No evidence (NEv)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

Sternapsis scutata is a non-native polychaete that has extended its range in inshore muddy sediments in the south west of the UK (Shelley *et al*., 2008). However, in mesocosm experiments, little effect on biological functioning was detected after the introduction of the polychaete and a doubling of its biomass (Shelley *et al*., 2008). No direct evidence on the effect of non-native species on mud communities was found. However, this assessment should be revisited in the light of new evidence.

Introduction of microbial pathogens	High	High	Not sensitive
	Q: Low A: NR C: NR	Q: High A: High C: High	Q: Low A: Low C: Low

The gastropod snail *Melanella alba* parasites holothurians, probably by sucking their fluids (Graham, 1988) and has been recorded in this biotope (Connor *et al*., 2004). Any parasite is likely to reduce the viability of the host species, so a resistance of **High** has been recorded. Therefore, resilience is also **High** and the biotope is assessed as **Not sensitive**.

Removal of target species	Not relevant (NR)	Not relevant (NR)	Not relevant (NR)
	Q: NR A: NR C: NR	Q: NR A: NR C: NR	Q: NR A: NR C: NR

None of the characterizing species within this biotope are currently directly targeted in the UK

and, hence, this pressure is considered to be **Not relevant**.

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

The physical effects of fisheries or dredging activities are addressed under abrasion, penetration and extraction pressures above. No clear biological relationships between the important characteristic species were found. Therefore, removal of any one species may not affect other members of the community adversely. However, is the important characterizing species were removed as by-catch, the character of the biotope would change. A significant decline in the abundance of either *Ocnus planci* would result in loss of the biotope as recognised by the habitat classification. Therefore, a resistance of **Medium** is recorded, albeit at Low confidence. As resilience is probably **High**, sensitivity is assessed as **Low**.

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