MarLIN
Marine Information Network
Information on the species and habitats around the coasts and sea of the British Isles

Echinogammarus incertae sedis planicrurus in mid shore well-sorted gravel or coarse sand

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

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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/151]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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Gravel and sand shore.
Photographer: Paul Brazier
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Biotope distribution data provided by EMODnet Seabed Habitats (www.emodnet-seabedhabitats.eu)

Researched by Dr Heidi Tillin & Georgina Budd **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A2.112	*Pectenogammarus planicrurus* in mid shore well-sorted gravel or coarse sand
JNCC 2015	LS.LCS.Sh.Ech	*Echinogammarus incertae sedis planicrurus* in mid shore well-sorted gravel or coarse sand
JNCC 2004	LS.LCS.Sh.Pec	*Pectenogammarus planicrurus* in mid shore well-sorted gravel or coarse sand
1997 Biotope	LS.LGS.Sh.Pec	*Pectenogammarus planicrurus* in mid shore well-sorted gravel or coarse sand

Description

Shores of well-sorted gravel with a predominant particle size of 4.0 mm but ranging between 3 and 6 mm support dense populations of the amphipod *Echinogammarus incertae sedis planicrurus*.

Material finer than 2 mm reduces the ability of the amphipod to survive. The amphipod is tolerant of variable salinity, although a preference for a specific salinity regime has not been determined. As this habitat is regularly under-surveyed, its distribution is unclear. The biotope is often associated with the lee side (wind or tide) of obstacles such as rock outcrops and groynes; this may be due to the deposition of algal debris, shelter from wave action or degree of sorting due to localised tidal flow around the obstacle (most likely a combination of the first and last influence) (JNCC, 2015).

Depth range

Upper shore, Mid shore

Additional information

No text entered.

Listed By

- none -

Further information sources

Search on:

G G JNCC

Habitat review

Ecology

Ecological and functional relationships

- Species diversity is influenced by habitat stability and sediment type. The apparent harshness of the coarse sand/gravel beach environment belies the rich rewards for an organism capable of withstanding the rigours. There is an almost complete lack of competing species, a relative absence of predators (although the predatory isopod *Eurydice pulchra* may frequent the biotope as part of the surf plankton and prey upon *Echinogammarus incertae sedis planicrurus* (Naylor, 1972), and an abundant supply of food in the form of macroalgae and other organic debris (Bell, 1995).
- A critical relationship exists between the size of interstitial spaces in the substratum through which the species can pass and the size of *Echinogammarus incertae sedis planicrurus* (Morgan, 1970). Selection experiments carried out with particles retained by 6.35, 3.35, 2.06 and 1.4 mm sieves revealed a clear preference for the 3.35 mm grade of particles. Further experiments showed that the passage of *Echinogammarus incertae sedis planicrurus* was impaired by particles of the grade 2.06 mm, below which mortalities occurred. Following further work, Bell (1992) concluded that particle size was more important in determining the nature of the population of *Echinogammarus incertae sedis planicrurus* than any other aspect of shore location, such as shore level (within tidal limits) and depth within the substratum. Bell (1992) consequently stated substratum preferences to be an important factor driving the population dynamics of the species, causing size-dependent migration between different grades of gravel. Short distance migration was suggested to be one reason why *Echinogammarus incertae sedis planicrurus* enters the surf plankton (Morgan, 1968; Fincham, 1970; Bell, 1992).

Seasonal and longer term change

Episodes of substratum instability would be expected particularly during the winter owing to storm generated wave action. In the calmer conditions that follow storm events, considerable quantities of macroalgal detritus are deposited on the gravel beach. Other macrofaunal species not especially found in the biotope may appear and exploit the food resource, these include archianellids of the genus *Protodrilus*, idoteid isopods and a variety of gammaridean amphipods, e.g. *Atylus swammerdami* and *Gammarus salinus* (Bell, 1995).

Habitat structure and complexity

Where coarse sand and gravel beaches originate from relict glacial deposits, the particles are smooth and of a similar size, whilst very coarse particle beaches derived from the erosion of cliffs are more mixed and angular in shape. Coarse particle beaches are also likely to be found in wave exposed conditions where they are continually disturbed by plunging breakers. The beach is inherently unstable and the moving particles crush and grind against each other so that the surfaces are devoid of life other than microscopic species. The gaps between the particles are large so that on the ebbing tide water drains freely away because the capillary forces which hold on to the water are weak. It is in this interstitial space that the amphipod *Echinogammarus incertae sedis planicrurus* lives. An important process along many coasts is the along-shore displacement of sediment or 'longshore drift'. As a coastal protection measure, barriers to longshore drift, 'groynes', are placed at right angles to the shore in the lee of which subsidiary currents are created

which create a degree of substrate sorting and macroalgal debris deposited. *Echinogammarus incertae sedis planicrurus* may be particularly abundant behind such obstructions to the current.

Productivity

Very coarse sandy beaches are extremely unstable places, consequently macrophyte species do not become established owing to the lack of a stable substratum. In most situations, diatoms are the primary producers of the depositing shore, and are confined to the illuminated sediment surface layers. The phytoplankton of the sea also become a temporary part of the shore ecosystem when the tide is in and primary producers from other environments appear on the shore. These are invariably macroalgae that have become detached from rocky substrata and have been washed up, eventually they decompose on the beach and contribute to the energy budget of the shore system. Consequently most productivity on the depositing sandy shore may be categorised as secondary, derived from detritus and allochthonous organic matter, which is utilized by the fauna.

Recruitment processes

The amphipod *Echinogammarus incertae sedis planicrurus*, is the only species that is a permanent resident of the biotope and restricted to breeding within it. Other species, *Eurydice pulchra* and *Gammarus salinus*, may also be recorded in the biotope but are not faithful to it (see *MarLIN* reviews). On the west coast of Wales, *Echinogammarus incertae sedis planicrurus* is an iteroparous breeder, with a semi-annual life history pattern (i.e. young produced early in the year mature and reproduce within the same year) and multiple overlapping generations (Bell, 1992). Females reach sexual maturity when body length is between 3-6 mm, and fecundity is related to female body size, ranging from 2 eggs per brood in small females to 14 per brood in large females. Mean brood size is 6.74 eggs (Bell & Fish, 1996). During the summer, the population turnover of *Echinogammarus incertae sedis planicrurus* is high; a female might typically live for four weeks whilst those that survive and overwinter may live as long as eight months (Bell, 1992). For populations to persist in the harsh gravel/coarse sand beach, the species requires a high reproductive output at the population level, thus small brood sizes (brood sizes are typically larger in other species of intertidal amphipod) are compensated for by an early maturation and optimisation of reproductive trade offs, such as those between fecundity, egg size and parental female survival (Bell & Fish, 1996).

Time for community to reach maturity

Beaches are dynamic environments, even when they are neither gaining nor losing sediment they are subject to short-term changes in response to wave regimes and weather conditions. Beach profiles show alteration as beach-face sands are re-cycled and decline as the component sand grains are reduced in calibre by attrition and weathering. As a consequence of the dynamic nature of the habitat the faunal component of the biotope is very sparse and low in species richness. Therefore, the community might be considered 'mature' only a few days or weeks after the last storm event, as the mobile species displaced from the biotope and those from adjacent area colonize the substratum via the surf plankton.

Additional information

No text entered.

Preferences & Distribution

Habitat preferences

Depth Range	Upper shore, Mid shore
Water clarity preferences	Field Unresearched
Limiting Nutrients	Field unresearched
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Physiographic preferences	Enclosed coast / Embayment, Open coast
Biological zone preferences	Eulittoral
Substratum/habitat preferences	Coarse clean sand, Gravel / shingle
Tidal strength preferences	No information
Wave exposure preferences	Moderately exposed
Other preferences	Gravel/shingle substratum

Additional Information

The habitat is under-surveyed, so may be more widespread than records suggest.

Species composition

Species found especially in this biotope

- *Pectenogammarus planicrurus*

Rare or scarce species associated with this biotope

- *Pectenogammarus planicrurus*

Additional information

No text entered.

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

The biotope description and characterizing species is taken from JNCC (2015). This biotope occurs on shores of well-sorted gravel and is characterized by dense populations of the amphipod *Echinogammarus incertae sedis planicrurus* (syn. *Pectenogammarus planicrurus*; Costello & Bellan-Santini, 2004). The biotope is typically found in the lee of obstacles such as rock and artificial structures such as groynes (JNCC, 2015). As physical factors such as sediment type are key to structuring the biotope the sensitivity assessments consider these, where relevant, within the assessments as well as evidence for the sensitivity of the dominant amphipod.

Resilience and recovery rates of habitat

The amphipod *Echinogammarus incertae sedis planicrurus* (syn. *Pectenogammarus planicrurus*) is the only species that is a permanent resident of the biotope and restricted to breeding within it. On the west coast of Wales, *Echinogammarus incertae sedis planicrurus* is an iteroparous breeder, with a semi-annual life history pattern (i.e. young produced early in the year mature and reproduce within the same year) and multiple overlapping generations (Bell, 1992). Females reach sexual maturity when body length is between 3-6 mm, and fecundity is related to female body size, ranging from 2 eggs per brood in small females to 14 per brood in large females. Mean brood size is 6.74 eggs (Bell & Fish, 1996). During the summer, the population turnover of *Echinogammarus incertae sedis planicrurus* is high; a female might typically live for four weeks whilst those that survive and overwinter may live as long as eight months (Bell, 1992). For populations to persist in the harsh gravel/coarse sand beach, the species requires a high reproductive output at the population level, thus small brood sizes (brood sizes are typically larger in other species of intertidal amphipod) are compensated for by an early maturation and optimisation of reproductive trade-offs, such as those between fecundity, egg size and parental female survival (Bell & Fish, 1996).

In order to survive in the harsh gravel/coarse sand habitat the species has a high reproductive output at the population level (Bell, 1995) so, assuming that a proportion of the population survived in the locality, recovery might be reasonably expected to occur within a year following a return to prior conditions and good sorting of the beach substratum. However, the reported distribution of *Echinogammarus incertae sedis planicrurus* (as *Pectenogammarus planicrurus*) is patchy, as is the occurrence of coarse sand/gravel, and populations are consequently isolated. No information was found concerning the exchange of *Echinogammarus incertae sedis planicrurus* between populations. Consequently, if a population was completely removed recovery may take considerably longer.

Amphipods are mobile and may migrate over sediments so that immigration by adults may support rapid recovery. *Echinogammarus incertae sedis planicrurus* (as *Pectenogammarus planicrurus*) was also found within the surf over sand at Port Erin (Isle of Man) and was described as a tidal immigrant by Fincham (1970). Dispersal via the water column may therefore also allow rapid repopulation where there is some connectivity between biotopes within an area. Amphipods may also raft on drift algae (Brown & Bell, 2001), allowing recolonization of depopulated habitats.

Resilience assessment. As a consequence of the dynamic nature of the habitat the faunal component of the biotope is very sparse and low in species richness. Therefore, the community might be considered recovered after only a few days or weeks after the last storm event, as the mobile species displaced from the biotope and those from adjacent area colonize the substratum

via the surf plankton. Resilience is therefore assessed as 'High' based on the high reproductive output of *Echinogammarus incertae sedis planicrurus* and the rapid recovery of a typical habitat, resilience is assessed as 'High' for any level of disturbance (resistance is 'None', 'Low' or 'Medium', except for pressures that may lead to significant habitat impacts that are either long-lasting or permanent.

NB: The resilience and the ability to recover from human induced pressures is a combination of the environmental conditions of the site, the frequency (repeated disturbances versus a one-off event) and the intensity of the disturbance. Recovery of impacted populations will always be mediated by stochastic events and processes acting over different scales including, but not limited to, local habitat conditions, further impacts and processes such as larval-supply and recruitment between populations. Full recovery is defined as the return to the state of the habitat that existed prior to impact. This does not necessarily mean that every component species has returned to its prior condition, abundance or extent but that the relevant functional components are present and the habitat is structurally and functionally recognizable as the initial habitat of interest. It should be noted that the recovery rates are only indicative of the recovery potential.

Hydrological Pressures

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

Intertidal species are exposed to extremes of high and low air temperatures during periods of emersion. They must also be able to cope with sharp temperature fluctuations over a short period of time during the tidal cycle. In winter air temperatures are colder than the sea, conversely in summer air temperatures are much warmer than the sea. Species that occur in the intertidal are therefore generally adapted to tolerate a range of temperatures, with the width of the thermal niche positively correlated with the height of the shore that the animal usually occurs at (Davenport & Davenport, 2005).

No empirical evidence was found to assess the tolerant of *Echinogammarus incertae sedis planicrurus* to temperature increases. Bell (1995) summarised the distribution of *Echinogammarus incertae sedis planicrurus* (as *Pectenogammarus planicrurus*) based on previous studies. Both Stock (1982) and Lincoln (1979) identified *Echinogammarus incertae sedis planicrurus* as a southern species and described its distribution as a 'west-Mediterranean Lusitanian type' and 'Mediterranean type' respectively. The south and west coasts of Britain and Ireland form the northern limit of distribution. Populations in different areas are likely to have acclimated to the prevailing conditions and so the distributions are interpreted cautiously and confidence in this assessment is 'Low'. During the summer, the population turnover of *Echinogammarus incertae sedis planicrurus* is high; a female might typically live for four weeks whilst those that survive and overwinter may live as long as eight months (Bell, 1992) and changes in temperature may result in increased reproductive outoput during warmer periods.

Sensitivity assessment. *Echinogammarus incertae sedis planicrurus* has a southern distribution and can be found on the upper shore where they are likely to experience wide temperature fluctuations during the tidal cycle. The sediments are coarse and porous so that little protection may be gained from sediment buffering. Acute temperature increases (5°C for one month) may exceed tolerances in the summer months or in the winter a sudden increase in temperature may

also affect cold acclimated individuals. Exposure to warmer waters during the tidal cycle will, however, be brief (particularly for upper shore populations) and animals may migrate either downwards within sediments or up the shore to avoid unfavourable conditions. Resistance to both an acute and chronic increase in temperature (2°C for one year) is therefore assessed as 'High' and resilience as 'High' so that the biotope is assessed as 'Not sensitive'.

Temperature decrease (local)	Low Q: Low A: NR C: NR	High Q: High A: High C: High	Low Q: Low A: Low C: Low

Records of *Echinogammarus incertae sedis planicrurus* have not been reported to the north of the British Isles. Bell (1995) suggested that the northerly limit to the distribution of *Echinogammarus incertae sedis planicrurus* (as *Pectenogammarus planicrurus*) is defined by the lowest temperature at which its semi-annual life history of producing small broods with early maturation is possible. A chronic decrease of 2°C may, therefore, affect the viability of the species. Furthermore, in the intertidal acute decreases in temperature, e.g. during a severe winter, may cause freezing of the species within the substratum.

Amphipods are mobile and can escape local unfavourable conditions by migrating into sediments or by moving within the habitat. The species may, therefore, be able to escape from colder waters during tidal emersion by migrating up the shore (as long as sediments are not frozen). During the summer, the population turnover of *Echinogammarus incertae sedis planicrurus* is high; a female might typically live for four weeks whilst those that survive and overwinter may live as long as eight months (Bell, 1992). decreases in temperature may, therefore, reduce reproductive outputs and population size.

Sensitivity assessment. *Echinogammarus incertae sedis planicrurus* is considered sensitive to both a chronic and acute decrease in temperature, which may affect reproduction and population viability. Resistance is, therefore, assessed as 'Low' as the population may decrease in response to both pressure benchmarks. Resilience is assessed as 'High' as populations are likely to recover by *in-situ* reproduction (assuming some individuals survive) within two years following exposure, given the absence of competitors and predators in the habitat. The biotope is, therefore, judged to have low sensitivity to this pressure.

Salinity increase (local)	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

This biotope is found in full salinity (30-35 ppt) habitats (JNCC, 2015), a change at the pressure benchmark, therefore, is assessed as a change to hypersaline conditions. No evidence was found to assess salinity tolerances of the key characterizing species *Echinogammarus incertae sedis planicrurus*. In its habitat, the species is unlikely to encounter hypersaline water (e.g. as a consequence of evaporation of 'pooled' surface water) as the coarse sand/gravel substratum is permeable and free draining.

Sensitivity assessment. 'No evidence' was found on which to base an assessment.

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

This biotope is found in full salinity (30-35 ppt) habitats (JNCC, 2015), and the key characterizing species *Echinogammarus incertae sedis planicrurus* can withstand variable salinity (JNCC, 2015). Experimental evidence suggests that *Echinogammarus incertae sedis planicrurus* can withstand immersion in water of reduced salinity (20 psu) for 36 hours and freshwater for >18 hours (Morgan, 1970). Gravel sediments inhabited by *Echinogammarus incertae sedis planicrurus* are often associated with brackish waters and freshwater inputs (Stock, 1982; Bell, 1995). Thus it is likely that the important characterizing species of the biotope would survive periodic tidal flushing of the sediment with brackish or freshwater. As a mobile species, it would also probably move from conditions which it found intolerable.

Sensitivity assessment. Based on salinity tolerance of the key characterizing species *Echinogammarus incertae sedis planicrurus* biotope resistance is assessed as 'High' and resilience as 'High' (by default) so that the biotope is assessed as 'Not sensitive'.

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

A typical feature of this habitat is its occurrence in the lee of obstacles such as rocky outcrops and groynes (JNCC, 2015) where it receives some protection from water flows. The gravel habitat is non-cohesive and changes in water flow may increase or decrease movement of particles. Gravel shores are typically unstable and a decrease in water flow and/or wave exposure may lead to deposition of finer particles altering the sedimentary habitat and the associated biological assemblage. Increased water flow may increase instability and abrasion within sediments as the particles are moved, the shore profile may also change.

Sensitivity assessment. It should be noted that substrate coupled with wave action, rather than water flow, are likely to be key factors structuring the biotope. At the benchmark level, the change in water flow may result in some changes in sediment stability but these are not considered to significantly alter the biotope. Resistance is therefore assessed as 'High' and resilience as 'High' (by default) so that the biotope is assessed as 'Not sensitive'.

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

This biotope is found on the mid and upper shore (JNCC, 2015). The coarse particles that characterize this biotope are free-draining and an increase in emergence could lead to desiccation On sandy shores (as in rocky shores) zonation of species occurs in relation to tidal height, talitrid amphipods tend to occur higher on the shore where sediments dry out at low tide while lower down the shore suspension feeding bivalves are more abundant in the damper sediments (McLachlan *et al.*, 1995).

Echinogammarus incertae sedis planicrurus lives interstitially within the coarse sand/gravel and is probably sufficiently mobile within it to avoid adverse effects of a change in emergence regime. For instance, it can burrow deeper to avoid dryer surface layers. Some lateral migration is also possible to avoid unsuitable conditions. A change in emergence is likely to alter habitat suitability for examples of this biotope at the upper and lower shore height range. Biotopes at the upper end may be replaced by supralittoral strandline communities such as those dominated by macroalgal debris and talitrid amphipods if emergence increases, conversely decreased emergence may reduce habitat suitability for mid-shore biotopes and may lead to increased predation by fish

during periods when the biotope is submerged (this may be compensated by reduced bird predation).

Sensitivity assessment. Overall resistance is assessed as 'Medium' as substratum rather than timing and duration of emergence is a key factor structuring the biotope changes in emergence may, however, lead to decreased habitat suitability for upper and lower shore examples. Resilience is assessed as 'High' based on migration from adjacent populations and biotope sensitivity is assessed as 'Low'.

	Resistance	Resilience	Sensitivity
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

This biotope is found in habitats that are estimated to be moderately exposed to wave action (JNCC, 2015). A typical feature of this habitat is its occurrence in the lee of obstacles such as rocky outcrops and groynes (JNCC, 2015) where it receives some protection from wave action. Wave exposure is an important physical factor determining the composition of the substratum and its stability which in turn changes suitability for the associated biological assemblage. Changes in wave exposure in the long-term result in changes in particle size and sorting and associated sediment properties and beach profile (Little, 2000).Where wave action is lower beaches tend to contain coarser sediments and to have steeper profiles and to dry out faster, whereas beaches exposed to higher levels of wave action consist of finer particles and are flatter (Little, 2000).

Sensitivity assessment. At the pressure benchmark, the biotope is considered to be unaffected, resistance is assessed as 'High' and resilience as 'High' (by default) so that the biotope is assessed as 'Not sensitive'.

Chemical Pressures

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

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

No information concerning heavy metals and specific effects on *Echinogammarus incertae sedis planicrurus* was found. For most metals, toxicity to crustaceans increases with decreased salinity and elevated temperature, therefore marine species living within their normal salinity range may be less susceptible to heavy metal pollution than those living in salinities near the lower limit of their salinity tolerance (McLusky *et al.*, 1986).

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

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

Echinogammarus incertae sedis planicrurus is likely to have a high intolerance to hydrocarbon pollution. Oil penetrates deep in to coarse sand/gravel substratum. For example, the largest

amount and least weathered oil arising from the *Exxon Valdez* oil tanker spill in Prince William Sound, Alaska was found eight years after the incident on gravel beaches at a depth between 25 and 50 cm (Hayes & Michel, 1999). Moderate wave exposure and unstable substratum characteristic of the biotope probably aid the penetration of oil in to the sediment. The smothering effect of oil is likely to cause mortality of *Echinogammarus incertae sedis planicrurus* in advance of toxic effects. Oil would coat the substratum particles, lessening the interstitial voids through which the amphipod moves and to which it would probably stick.

Small amounts of oil that can persist for decades in the intertidal zone of coarse-sediment beaches have been documented in a few well-studied cases (Owens *et al.*, 2008). Oil that survives attenuation over the short-term (weeks to months) will persist until there is a change in the environmental conditions, as might occur where there is a seasonal storm-wave climate or as a beach undergoes long-term (erosional) changes. Oil residues can persist on the beach surface as tar mats, asphalt-like pavements, or as veneers on sediment particles or hard surfaces. Subsurface oil residues can persist in similar forms or as fill or partial fill of the pore spaces between coarse-sediment particles. Oil penetrates until it reaches fine-grained sediment, the water table, bedrock, or other penetration-limiting layers. Amounts of persistent oil are very small fractions of the volumes that were originally stranded and these protected residues can continue to biodegrade as they become thinner and more discontinuous.

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

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

No information concerning synthetic chemical and specific effects on the important characterizing species *Echinogammarus incertae sedis planicrurus* was found. However, areas of the intertidal adjacent to industrialised and urbanised estuaries and coastlines may receive effluent discharges which contain a variety of synthetic contaminants. Bioaccumulation of conservative contaminants may occur within the infauna, but in coarse sand/gravel beaches contaminants are unlikely to accumulate owing to a relative absence of organic matter.

Radionuclide contamination	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.

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

This pressure is **Not assessed**.

De-oxygenation	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

In its intertidal habitat, *Echinogammarus incertae sedis planicrurus* is inundated by the tide and subject to emergence that the species respires in both air and water. Within the interstitial environment of clean (low organic matter), coarse sand/gravel oxygen is unlikely to become

limiting. The coarseness of the particles, bestows a high permeability, so that water percolates rapidly through and owing to the relative lack of organic matter, little oxygen is utilized for oxidization or respiration by micro-organisms (bacteria populations in sediments with a mean diameter greater than 0.2 mm typically support fewer bacteria (Dale, 1974). Sediments are, therefore, re-oxygenated during the ebb tide when sediments are exposed to air. Oxygen depletion tends to be a severe problem at all states of the tide on much finer grained beaches which support larger populations of bacteria (Hayward, 1994). At the benchmark level (a reduced dissolved oxygen concentration of 2 mg/l for 1 week) the characteristics of the sedimentary habitat make conditions of limiting oxygen unlikely. The important characterizing species *Echinogammarus incertae sedis planicrurus*, is also sufficiently mobile to migrate up-shore and avoid conditions that it finds inhospitable.

Sensitivity assessment. Biotope resistance is assessed as 'High', resilience is assessed as 'High' by default and the biotope is considered to be 'Not sensitive'.

Nutrient enrichment	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

The community is unlikely to be directly affected by an increase in the concentration of dissolved nutrients in the water column, as the food resource that the community utilizes is in the form of macroalgal debris. This pressure is therefore considered 'Not relevant'.

Organic enrichment	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: High A: High C: High

The biotope occurs in coarse sediments where wave action leads to particle sorting and fine sediments and organic matter are likely to be either flushed through the sediment owing to its porosity or re-suspended and removed. An input of organic matter at the pressure benchmark is therefore unlikely to alter the habitat type. Organic detritus may be used by *Echinogammarus incertae sedis planicrurus* as food (Bell, 1995) and thus this species may benefit from some input.

Sensitivity assessment. Biotope sensitivity is assessed as 'High' and resilience as 'High', so that the biotope is assessed as 'Not sensitive'.

Physical Pressures

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

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

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

The biotope is characterized by the sedimentary habitat (JNCC, 2015), a change to an artificial or rock substratum would alter the character of the biotope leading to reclassification and the loss of the sedimentary community including the characterizing oligochaetes that live buried within the sediment.

Sensitivity assessment. Based on the loss of the biotope, resistance is assessed as 'None', recovery is assessed as 'Very low' (as the change at the pressure benchmark is permanent and sensitivity is assessed as 'High'.

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

This biotope is found in gravel and very coarse sands (JNCC, 2015), a change between these sediment types would not alter habitat suitability for the key characterizing species or the habitat classification. However, the biotope would be sensitive to a change to fine sands or sediments with high-levels of fine sediments, as these impair the burrowing ability of the key characterizing species *Echinogammarus incertae sedis planicrurus* (as *Pectenogammarus planicrurus*) (Morgan, 1970).

Sensitivity assessment. A change to a fine sediment would result in the biotope becoming unsuitable for the key characterizing species, which would be lost, with a change in biotope classification. Resistance is therefore assessed as 'None' and recovery as 'Very low' as a change at the pressure benchmark is permanent. Sensitivity is, therefore assessed as 'High'.

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

The amphipod *Echinogammarus incertae sedis planicrurus* lives interstitially in the spaces between coarse sand/gravel particles. It is mobile within the substratum but would be removed along with the substratum if this was extracted to a depth of 30cm.

Sensitivity assessment. Removal of the sediment to 30 cm would remove the key characterizing species and its habitat. Resistance is therefore assessed as 'None'. Resilience is assessed as 'High' if adjacent populations are present to support recolonization through adult migration and reproduction, so that sensitivity is assessed as 'Low'. However, if populations were removed over a wide area recovery could be prolonged and is assessed as 'Medium', so that sensitivity s assessed as 'Medium'. The less precautionary assessment is considered more representative but the caveats outlined in the resilience section should be considered and this assessment may underestimate sensitivity.

Abrasion/disturbance of the surface of the substratum or seabed	Low Q: High A: Low C: High	High Q: High A: Low C: High	Low Q: High A: Low C: High

No evidence was found for abrasion impacts on the key characterizing species *Echinogammarus*

incertae sedis planicrurus. However, a number of studies have assessed the effects of trampling on other intertidal amphipods and these assessments are used as a proxy.

Comparisons between shores with low and high levels of trampling found that the amphipod *Bathyporeia pelagica* is sensitive to human trampling (Reyes-Martínez *et al*., 2015). Changes in abundance of talitrid amphipods on urban beaches subject to high levels of recreational use was also observed by Bessa *et al*. (2014), this study compared abundances between samples taken ten years apart and thus the trends observed were not directly attributable to trampling vs beach cleaning or other pressures although they illustrate a general trend in density patterns as recreational use increases. Ugolini *et al*. (2008) carried out a controlled trampling experiment on Talitrus saltator. Plastic cylinders of 110 cm diameter (area 0.95 m^2) were placed in the sand and all individuals trapped and counted, and 400 steps were made in a cylinder in 15 minutes after the amphipods had reburied. The trampling rate was based on observed number of beach users and therefore represents a realistic level of exposure. Alive sandhoppers were counted at the end of the experiment and 24 hours after. Trampling significantly reduced abundance of the amphipods and after 24 hours the percentage of surviving amphipods dropped to almost zero, while survival rates of control (untrampled) amphipods were unaffected. Abrasion and compaction can therefore kill buried amphipods within sediments.

Sensitivity assessment. The trampling experiment (Ugolini *et al*., 2008) represents a high intensity of abrasion with multiple steps on the sediment within a short time period. The experiment, does however, demonstrate that amphipods are sensitive to abrasion and compaction of the sediment and these results are observed by comparisons between heavily and lightly used areas (Reyes-Martínez *et al*., 2015; Bessa *et al*., 2014). Resistance to a single abrasion event is therefore assessed as 'Low' based on the characterizing species *Echinogammarus incertae sedis planicrurus*. Resilience is assessed as 'High', based on migration from adjacent populations and in-situ reproduction by surviving amphipods. Sensitivity is therefore assessed as 'Low'. This assessment may underestimate sensitivity to high-levels of abrasion (repeated events within a short period).

Penetration or disturbance of the substratum subsurface

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

No evidence was found for penetration and disturbance impacts on the key characterizing species *Echinogammarus incertae sedis planicrurus*. Based on the abrasion assessment, penetration and abrasion is considered likely to result in high-levels of mortality. Resistance is therefore assessed as 'None;' and resilience as 'High' so that sensitivity is assessed as 'Medium'. Resilience may be lower where the pressure affects an entire population in areas with low population connectivity so that recovery is prolonged.

Changes in suspended solids (water clarity)

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

Echinogammarus incertae sedis planicrurus lives in the interstitial spaces within coarse sand/gravel and is unlikely to be directly affected by an increased concentration of suspended matter in the water column. The species feeds on macroalgal debris and other detritus and may be capable of feeding on suspended particles (J.D. Fish & L. Rickard, personal communication to M.C. Bell and

cited in Bell, 1995).

Sensitivity assessment. Increased organic solids in suspension may provide food to the key characterizing species *Echinogammarus incertae sedis planicrurus*. Increased inorganic suspended solids may increase abrasion but it is likely that *Echinogammarus incertae sedis planicrurus* would withdraw into burrows or avoid areas of unsuitable conditions during tidal emersion and would be largely unaffected. Biotope resistance is assessed as 'Medium' as some effects on feeding and other behaviours may occur, resilience is assessed as 'High', following a return to usual conditions and sensitivity is assessed as 'Low'. Indirect effects such as deposition and sediment change that may result as a result from increased suspended solids in the long-term are assessed separately. Indirect reduction of macroalgal productivity in adjacent impacted habitats resulting in reduced supply of macroalgae debris is possible but not assessed.

Smothering and siltation rate changes (light)

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

As this biotope occurs in sheltered areas in the lee of obstacles (JNCC, 2015) a deposit of fine sediment may remain in-situ rather than being rapidly removed by wave action. If the deposited fine sediments are cohesive this can also prolong removal times .Deposited fine sediments may also become incorporated within coarse sands and gravels, reducing interstitial spaces and altering the sediment type. *Echinogammarus incertae sedis planicrurus* is likely to be highly intolerant of smothering by 5 cm of fine sediment. There is a critical relationship between the size of interstitial spaces in the substratum through which the species can pass and the size of *Echinogammarus incertae sedis planicrurus* (Morgan, 1970). In selection experiments, the species demonstrated a clear preference for a sediment grades between 3-6 mm in diameter. Its passage through finer grades of substratum (<3 mm) was impaired and mortalities occurred as a consequence of suffocation (Morgan, 1970). Similarly, Maurer *et al*. (1981) found that the amphipod *Parahaustorius longimerus* which occurs intertidally in clean, well-sorted sands and is an active, effective burrower was able to regain the surface after being buried by sand far more easily than when buried under silt/clay mixtures.

Sensitivity assessment. A deposit of 5 cm fine sediment will prevent burrowing by *Echinogammarus incertae sedis planicrurus*, individuals within the sediment will not be able to reach the surface to feed and will suffocated, while individuals stranded on the surface will not be able to retreat into sediment and will become vulnerable to predation by birds. Resistance is therefore assessed as 'None'. Resilience is assessed as 'High' if adjacent populations are present to support recolonization through adult migration and reproduction, so that sensitivity is assessed as 'Low'. However, if populations were removed over a wide area recovery could be prolonged and is assessed as 'Medium', so that sensitivity s assessed as 'Medium'. The less precautionary assessment is considered more representative but the caveats outlined in the resilience section should be considered and this assessment may underestimate sensitivity.

Smothering and siltation rate changes (heavy)

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

As this biotope occurs in sheltered areas in the lee of obstacles (JNCC, 2015), a deposit of fine sediment may remain in-situ rather than being rapidly removed by wave action. If the deposited fine sediments are cohesive this can also prolong removal times. Deposited fine sediments may also become incorporated within coarse sands and gravels, reducing interstitial spaces and altering

the sediment type. *Echinogammarus incertae sedis planicrurus* is likely to be highly intolerant of smothering by 30 cm of fine sediment. There is a critical relationship between the size of interstitial spaces in the substratum through which the species can pass and the size *of Echinogammarus incertae sedis planicrurus* (Morgan, 1970). In selection experiments, the species demonstrated a clear preference for a sediment grades between 3-6 mm in diameter. Its passage through finer grades of substratum (<3 mm) was impaired and mortalities occurred as a consequence of suffocation. Similarly, Maurer *et al*. (1981) found that the amphipod *Parahaustorius longimerus* which occurs intertidally in clean, well-sorted sands and is an active, effective burrower was able to regain the surface after being buried by sand far more easily than when buried under silt/clay mixtures.

Sensitivity assessment. A deposit of 30 cm fine sediment will prevent burrowing by *Echinogammarus incertae sedis planicrurus*, individuals within the sediment will not be able to reach the surface to feed and will suffocated, while individuals stranded on the surface will not be able to retreat into sediment and will become vulnerable to predation by birds. Resistance is therefore assessed as 'None'. Resilience is assessed as 'High' if adjacent populations are present to support recolonization through adult migration and reproduction, so that sensitivity is assessed as 'Low'. However, if populations were removed over a wide area recovery could be prolonged and is assessed as 'Medium', so that sensitivity s assessed as 'Medium'. The less precautionary assessment is considered more representative but the caveats outlined in the resilience section should be considered and this assessment may underestimate sensitivity.

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. No evidence was found for *Echinogammarus incertae sedis planicrurus*, however, the talitrid *Orchestia gammarellus* ingests microplastics in the size range 20-200 µm (Thompson *et al*., 2004).

Electromagnetic changes	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

No information was found on orientation using geomagnetic fields by *Echinogammarus incertae sedis planicrurus*. However, for some amphipods there is evidence for geomagnetic orientation being inhibited or disrupted by the presence of electromagnetic fields or by changing magnetic fields. Arendse & Barendregt (1981) manipulated magnetic fields to alter orientation of the talitrid amphipod *Orchestia cavimana*. Deep-water amphipods *Gondogenia arctica* have been shown to be sensitive to even weak electromagnetic fields which cancel magnetic orientation (Tomanova & Vacha, 2016). Loss of orientation was observed at a radiofrequency electromagnetic field of 2 nT (0.002 µT) (Tomanova & Vacha, 2016).

No assessment was made of the sensitivity of *Echinogammarus incertae sedis planicrurus* due to the lack of evidence for this species.

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

No evidence was found to assess this pressure.

Introduction of light or shading	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

No specific evidence was found to assess sensitivity of *Pectenogamarus planicrurus* to this pressure. However, it is noted that orientation by light has been well studied for other intertidal amphipods (particularly the strandline dwelling species, *Talitrus saltator*). Intertidal amphipods orientate themselves by a range of factors that include (but are not limited to) visual cues based on solar or astronomic cues and the geomagnetic field (Scapini *et al*., 2014). Activity patterns are also linked to internal biological clocks that respond to diel, tidal, lunar and seasonal cycles, so that animals are active during the most suitable time of day or night (Scapini *et al*., 2014). The introduction of light or an increase in shading could therefore alter behavioural patterns and navigation. As responses may be species specific or vary according to local factors or individual needs such as feeding, mating, it is not possible to provide a simple assessment for this species. Some sensitivity is however likely if incident light levels were altered. This will depend, however, on the footprint and intensity of impact. Fanini *et al*., (2014) found no difference in abundance of *Talitrus saltator* between Greek beaches that frequently hosts small scale beach-parties with lights at night and those that were not used in this way.

Barrier to species movement	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

As the amphipods that characterize this biotope have benthic dispersal strategies (via brooding), water transport is not a key method of dispersal over wide distances, as it is for some marine invertebrates that produce pelagic larvae. The biotope (based on the biological assemblage) is therefore considered to have 'High' resistance to the presence of barriers that lead to a reduction in tidal excursion, resilience is assessed as 'High' (by default) and the biotope is considered to be 'not sensitive'.

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

Not relevant' to seabed habitats. NB. Collision by grounding vessels is addressed under 'surface abrasion.

Visual disturbance	High Q: Low A: NR C: NR	High Q: High A: Low C: Medium	Not sensitive Q: Low A: Low C: Low

No specific evidence for *Echinogammarus incertae sedis planicrurus* was found. Intertidal amphipods such as talitrids have eyes (eyelessness is more commonly associated with deep-sea species, Thurston & Bett, 1993). Visual perception by talitrids is used to detect predators and orientate using landscape and other cues (Hartwick, 1976). it is likely that the amphipods could detect movement and would react by burrowing or escaping. This disturbance may interrupt feeding and other behaviour but may not lead to lethal effects. Biotope resistance based on *Echinogammarus incertae sedis planicrurus* is assessed as **'High'** and resilience as **'High'**, so that the biotope is assessed as **'Not sensitive'**.

Biological Pressures

	Resistance	Resilience	Sensitivity
Genetic modification & translocation of indigenous species	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR	Not relevant (NR) Q: NR A: NR C: NR

Key characterizing species within this biotope are not cultivated or translocated. This pressure is, therefore considered 'Not relevant' to this biotope.

Introduction or spread of invasive non-indigenous species	High Q: Low A: NR C: NR	High Q: High A: High C: High	Not sensitive Q: Low A: Low C: Low

The sediments characterizing this biotope are coarse, mobile and free-draining, this limits establishment of marine and coastal invasive non-indigenous species as the habitat conditions are unsuitable for most species, as exemplified by the low species richness characterizing this biotope. This biotope is therefore considered ot have 'High' resistance to this pressure and high resilience (by default), so that it is assessed as 'Not sensitive' to this pressure.

Invasion of rivers and freshwaters by invasive non-indigenous amphipods has been documented, but no potential invasive species were identified for the habitat this biotope occurs in.

Introduction of microbial pathogens	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR	No evidence (NEv) Q: NR A: NR C: NR

Amphipods may be infected by a number of parasites or pathogens that alter population numbers through changes in host condition, growth, behaviour and reproduction (Green Extabe & Ford, 2014). Infection by acanthocephalan larvae, for example, may alter behaviour and responses of gammarid amphipods (Bethel & Holmes, 1977). The amphipod *Orchestia gammarellus* is host to the parasitic protist *Marteilia* sp. which has a feminizing effect on populations, with higher rations of females and intersex males in infected, estuarine populations (Ginsburger-Vogel & Desportes, 1979).

No evidence was found for pathogen/parasite outbreaks that may result in mass-mortalities in *Echinogammarus incertae sedis planicrurus* and this pressure is not assessed.

Removal of target species	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

No species within the biotope are targeted by commercial or recreational fishers or harvesters. This pressure is therefore considered 'Not relevant'.

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

The loss of the key characterizing species through unintentional removal would alter the character of the biotope and may lead to reclassification to a similar, species-poor biotope such as

LS.LSa.MoSa.BarSa. The ecosystem services such as secondary production and food for higher trophic levels such as birds provided by the amphipods would be lost.

Sensitivity assessment. Biotope resistance to loss of the characterizing species is assessed as 'Low' as the burrowing lifestyle and mobility of *Echinogammarus incertae sedis planicrurus* means that a proportion of the population may escape removal. Resilience is assessed as 'High' based on *in-situ* recovery and migration from adjacent populations: sensitivity is therefore assessed as 'Low'.

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