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

Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay

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/152]. All terms and the MarESA methodology are outlined on the website (https://www.marlin.ac.uk)

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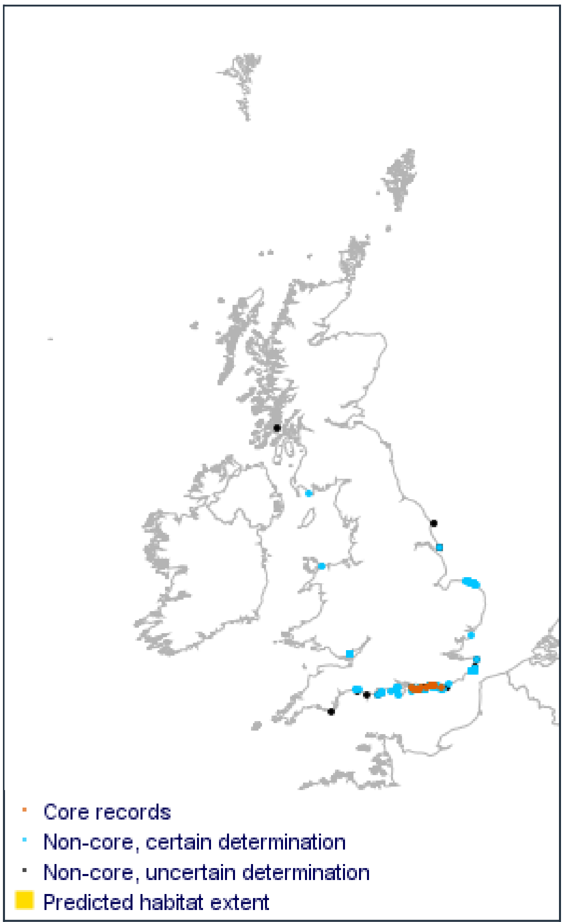
Piddocks with a sparse associated fauna in upward-facing circalittoral very soft chalk or clay.
Photographer: Roger Covey



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

Researched by Dr Heidi Tillin & Jacqueline Hill **Refereed by** Admin

Summary

UK and Ireland classification

EUNIS 2008	A4.231	Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
JNCC 2015	CR.MCR.SfR.Pid	Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
JNCC 2004	CR.MCR.SfR.Pid	Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
1997 Biotope	CR.MCR.SfR.Pid	Piddocks with a sparse associated fauna in upward-facing circalittoral very soft chalk or clay

Description

This biotope occurs on circalittoral soft rock, such as soft chalk or clay, most often in moderately exposed tide-swept conditions. As soft chalk and firm clay are often too soft for sessile filter-feeding animals to attach and thrive in large numbers, an extremely impoverished epifauna results on upward-facing surfaces, although vertical faces may be somewhat richer. The rock is sufficiently soft to be bored by bivalves. Species vary with location, but *Pholas dactylus* is the most widespread borer and may be abundant. Other species present may include the sponges *Dysidea fragilis* and*Suberites carnosus* and the polychaete *Bispira volutacornis*. Foliose red algae may be present on the harder, more stable areas of rock. Mobile fauna often include the crabs *Necora puber* and *Cancer pagurus* (Connor *et al*., 2004: JNCC).

Depth range

5-10 m, 10-20 m

Additional information

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Listed By

- none -

Further information sources

Search on:

G G JNCC

Habitat review

Ecology

Ecological and functional relationships

Ecological relationships within the biotope are not particularly complex and the main functional groups are those that are dependant on high levels of suspended particles, the suspension and deposit feeders.

- Although abundance of the key functional species, the common piddock *Pholas dactylus*, and the tube worm *Polydora ciliata* may be high, other fauna are relatively sparse so competition for space is not likely to be a factor structuring the biotope. In relatively unstable areas like soft chalk or clay, there is an opportunity for short-lived species to take up residence. These species, such as the sea-squirt *Molgula manhattensis*, settle out from the plankton at various times of the year and thrive where there is least competition from well established species.
- There are few species that prey on other members of the community although feeding by fish and predatory crabs probably occurs. The dahlia anemone *Urticina felina* is a passive carnivore, waiting to trap animals that stumble into its tentacles.
- Crabs, such as *Pisidia longicornis* are the predominant mobile species in the biotope, travelling through as they scavenge for food.
- The abundance of filter feeding organisms such as sponges, bryozoans and tunicates within the biotope indicates the importance of planktonic input to the benthic community. Piddocks and the tube worm *Polydora ciliata* contribute to the creation of a relatively high silt environment through burrowing activities.

Seasonal and longer term change

Some of the characterizing species in the biotope, such as piddocks, the sponge *Halichondria panicea* and the anemone *Urticina felina* have a longevity of several years and may not show great seasonal changes. Abundance of the polychaete *Polydora ciliata* is highly seasonal with numbers of individuals dropping off significantly in winter months before the reproductive period begins in the spring. Annual species in the biotope such as the hydroids *Tubularia indivisa* and *Nemertesia antennina* will increase and decrease through the seasons. Other species such as *Alcyonium digitatum* have seasonal stages, 'shutting up shop' during the winter months.

Habitat structure and complexity

Chalk or clay platforms are not particularly structurally complex habitats. However, piddock burrowing forms a generally uneven surface on a small scale (5-15 cm) creating habitats for other animals that inhabit vacant burrows and crevices in the rocks. Empty burrows are colonized by various animals, including sponges, anemones such as *Sagartia elegans*, bristleworms like *Spirobranchus triqueter*, crabs and bryozoan sea mats (Pinn *et al.*, in press). The empty shells protruding from the eroded surface are also an important settlement surface within this habitat. In addition to piddock borings, the top centimetre or so of the chalk is often riddled with large numbers of tiny U-shaped burrows of the bristleworm *Polydora ciliata* and in silty habitats may be associated with the amphipod *Jassa falcata*. Scattered on the chalk platforms, small rounded chalk pebbles and larger more angular cobbles on the surface may support sparse small hydroids on upper surfaces and occasional red algae. Where massive growths of the sponge *Halichondria* *panicea* occur, they may provide a significant habitat for other species especially amphipods.

Productivity

No algal species are listed as characterizing species in MCR.Pid, although some red algae may be present attached to cobbles, so primary production is not a major component of productivity. Specific information about the productivity of characterizing species or about the biotopes in general are not available. However, many of the species that are present are either suspension or deposit feeders so productivity of the biotope will be largely dependent on detrital input.

Recruitment processes

Most of the characterizing species in the biotope are sessile or sedentary suspension feeders. Recruitment of adults of these species to the biotope by immigration is unlikely. Consequently, recruitment must occur primarily through dispersive larval stages. Some species have larvae that can disperse widely and these may arrive from distant locations.

- *Pholas dactylus* usually spawns between May and September. The larvae are pelagic, with settlement and recruitment of juvenile piddocks occuring between November and February (Pinn *et al*., 2005).
- The spawning period for *Polydora ciliata* is from February until June in northern England. Larvae are substrate specific selecting rocks or sediment according to their physical properties settling preferentially on substrates covered with mud.
- Among sessile organisms, patterns fixed at settlement, though potentially altered by post settlement mortality, obviously cannot be influenced by dispersal of juveniles or adults.
- Some of the species in the biotope do not have pelagic larvae, but instead have direct development of larvae producing their offspring as 'miniature adults'.

Time for community to reach maturity

The time for biotope MCR.Pid to reach maturity is unknown. However, most characterizing species have a planktonic larva and so colonization should be fairly rapid. Colonization time by the key structuring species, *Pholas dactylus*, is unknown but it is expected that recruitment should be fairly rapid as the species has pelagic larvae and spawns for several months in the summer. *Polydora ciliata*, for example, can recolonize areas within a few months and is able to disperse over large distances. Also, although the recruitment of *Pholas dactylus* is annual, very few of the individuals get beyond their first year (Pinn *et al*., 2005). Some species, such as the sponge *Halichondria panicea*, are fast growing and mobile species within the biotope, predominantly crabs, can migrate into the area. The anemone *Urticina felina*, however, is noted as having poor dispersal (Sol-Cava *et al*., 1994) and being slow growing and living for several years (Chia & Spaulding, 1972). Therefore, although many species can colonize a suitable area fairly rapidly it is expected that the community as a whole would take longer to reach maturity, probably within five years. How

Additional information

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Preferences & Distribution

Habitat preferences

Depth Range	5-10 m, 10-20 m
Water clarity preferences	Data deficient
Limiting Nutrients	Data deficient
Salinity preferences	Full (30-40 psu)
Physiographic preferences	Open coast
Biological zone preferences	Circalittoral
Substratum/habitat preferences	Chalk, Clay
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.)
Wave exposure preferences	Moderately exposed
Other preferences	Data deficient

Additional Information

This biotope has a requirement for soft rock or firm clay substrata and is found on vertical faces.

Species composition

Species found especially in this biotope

Rare or scarce species associated with this biotope

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Additional information

Sensitivity review

Sensitivity characteristics of the habitat and relevant characteristic species

This biotope occurs in sublittoral very soft chalk or clay substrata, which have a restricted distribution around the UK. As the occurrence of piddock biotopes are highly dependent on the presence of suitable substratum, the sensitivity assessments specifically consider the sensitivity of the substratum to pressures, where appropriate. The piddock species *Pholas dactylus* is the most widespread borer and may be abundant (Connor *et al*., 2004) and is considered to be the key characterizing species. If the population were removed the biotope classification would change, therefore *Pholas dactylus* is considered to be the key characterizing species although other piddocks may occur in this biotope. Piddocks are also key structuring species within this biotope as their empty holes can provide habitats for other species (Pinn *et al*., 2008) and they are bioeroders, destabilising the substratum through burrowing allowing it to be more easily eroded by water flow and wave action (Pinn *et al*., 2005; Evans, 1968, Trudgill, 1983, Trudgill & Crabtree, 1987). Pinn *et al*. (2005) estimated that over the lifespan of a piddock (12 years), up to 41% of the shore could be eroded to a depth of 8.5 mm).

A 'sparse' fauna is associated with this biotope (Connor *et al*., 2004) as the substratum is too hard for sedimentary species and too soft for epifauna and flora to attach to. All the speciesassociated with this biotope are commonly found on many different shore types and are either mobile or rapid colonizers. Although these species contribute to the structure and function of the biotope they are not considered key species and are not specifically assessed.

Resilience and recovery rates of habitat

No direct information for recovery rates of piddocks to perturbations was found and limited information on population dynamics and relevant life history characteristics is available. Adult piddocks remain within permanent burrows and are therefore difficult to observe and sample without destroying the burrows which has limited the extent of observation and experimentation.

The burrows of *Pholas dactylus*, have a narrow entrance excavated by the juvenile after settlement on the substratum. As the individual grows and excavates deeper the burrow widens resulting in a conical burrow from which the adult cannot emerge. Recovery of impacted populations will therefore depend on recolonization by juveniles rather than adult migration. Although it should be noted that adults may be carried into new areas where they have bored into drift wood.

In piddocks the sexes are separate and fertilisation is external, with gametes released into the water column (Pinn *et al*., 2005 and references therein). Studies report that larval release occurs from April to September (e.g. Pelseneer, 1924; El-Maghraby, 1955; Purchon 1955; Duval 1962; Knight 1984). Knight (1984) reported that the resulting planktonic larval stage spends 45 days in the plankton. Pinn *et al*., (2005) observed newly settled individuals between November and February. Pinn *et al*. (2005) found the smallest sexually mature *Pholas dactylus* was a one year old measuring 27.4 mm.

Piddocks are relatively long-lived and *Pholas dactylus* lives to an estimated 14 years of age, based on annual growth lines (Pinn *et al*., 2005). Pinn *et al*., (2005) estimated age and growth rates for *Pholas dactylus* from chalk and clay sites in Southern England. She showed that *Pholas dactylus* live to at least an estimated 14 years of age and are slow growing. Jefferies (1865) reported that *Pholas dactylus* in the UK reached a maximum length of 150 mm, although 125 mm was a more usual size encountered, and a length to width ratio of 2.8. Turner (1954) reported that *Pholas dactylus* in the USA attained a maximum length of 130 mm.

Richter & Sarnthein (1976) studied the re-colonization of different sediments by various molluscs on suspended platforms in Kiel Bay, Germany. The platforms were suspended at 11, 15 and 19 m water depth, each containing three round containers filled with clay, sand, or gravel. Substratum type was found to be the most important factor for the piddock *Barnea candida*, although for all other species it was depth. This highlights the significance of the availability of a suitable substratum to the recovery of piddock species and suggests that larvae have some mechanisms for selection of suitable substratum.. Richter & Sarnthein (1976) found that within the two year study period the piddocks grew to represent up to 98% of molluscan fauna on clay platforms.

Although rare in the Romanian Black Sea, Micu (2007) reported the first observations of *Pholas dactylus* in 34 years at three locations illustrating the recovery potential of this species and ability for long-range dispersal to allow colonization or recolonization of suitable habitat. The vulnerability of piddocks to episodic events such as the deposition of sediments (Hebda, 2011) and storm damage of sediments (Micu, 2007) and the on-going chronic erosion of suitable sediments (Pinn *et al*., 2005) indicate that larval dispersal and recruitment of new juveniles from source populations is an effective recovery mechanism allowing persistence of piddocks in suitable habitats.

Resilience assessment. The sedentary nature of adult piddocks and their vulnerability to episodic events and chronic erosion suggest that piddocks have evolved effective strategies of larval dispersal and juvenile recruitment with some selectivity for suitable habitats. As recovery depends on recolonization and subsequent growth to adult size, resilience is assessed as 'Medium' (2-10 years) for all levels of resistance. The biotope is present in sublittoral clay and chalk habitats. These are formed in prehistoric periods and are therefore unlike sedimentary habitats which may be renewed by water transport of sediment particles. Following removal of the substratum no recovery of habitat is possible, although sub-surface layers of the same substratum type may be exposed. Resilience of the substratum following complete removal is therefore considered to be 'Very Low' (>25 years).

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: NR C: NR

Little direct evidence was found to assess the effects of increased temperature on piddocks and the assessment is based on distribution records and evidence for spawning in response to temperature changes. *Pholas dactylus* occurs in the Mediterranean and the East Atlantic, from Norway to Cape Verde Islands (Micu, 2007). There is some evidence that temperature influences the timing of reproduction in *Pholas dactylus*, which usually spawns between July and August. Increased summer temperatures in 1982 induced spawning in July on the south coast of England (Knight, 1984). Similar observations have been made for other piddock species. Spawning of the piddock *Petricolaria pholadiformis* is initiated by increasing water temperature (>18 °C) (Duval, 1963a), so elevated temperatures outside of usual seasons may disrupt normal spawning periods. The spawning of *Barnea candida* was also reported to be disrupted by changes in temperature (Duval, 1963b). Disruption from established spawning periods, caused by temperature changes, may be detrimental to the survival of recruits as other factors influencing their survival may not be optimal, and some mortality may result. Established populations may otherwise remain unaffected by elevated temperatures.

Sensitivity assessment. The global distribution of *Pholas dactylus* suggests that this species can tolerate warmer waters than currently experienced in the UK and may therefore be tolerant of a chronic increase in temperature. Short-term acute increases may, (depending on timing) interfere with spawning cues which appear to be temperature driven. The effects will depend on seasonality of occurrence and the species affected. Adult populations may be unaffected and, in such long-lived species, an unfavourable recruitment may be compensated for in a following year. Resistance to an acute change in temperature is therefore assessed as 'High' and recovery as 'High' (no impact to recover from) and the biotope is considered 'Not Sensitive'. It should be noted that the timing of acute changes may lead to greater impacts, temperature increases in the warmest months may exceed thermal tolerances whilst changes in colder periods may stress individuals acclimated to the lower temperatures.

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

Little direct evidence was found to assess the effects of increased temperature on piddocks and the assessment is based on distribution records and evidence for spawning in response to temperature changes. *Pholas dactylus* occurs in the Mediterranean and the East Atlantic, from Norway to Cape Verde Islands (Micu, 2007). *Pholas dactylus* spawning appears to be temperature dependent and so a long-term drop in temperature may cause *Pholas dactylus* to be replaced by piddocks tolerant of cooler water such as *Barnea candida* and *Zirfaea crispata* so the overall nature of the biotope is unlikely to change significantly.

Sensitivity assessment. The global distribution of *Pholas dactylus* suggests that this species can tolerate cooler waters than currently experienced in the UK and may therefore be tolerant of a chronic decrease in temperature. Short-term chronic increases may, (depending on timing) interfere with spawning cues which appear to be temperature driven. The effects will depend on seasonality of occurrence and the species affected. Adult populations may be unaffected and, in such long-lived species, an unfavourable recruitment may be compensated for in a following year. Resistance to an acute change in temperature is therefore assessed as 'High' and recovery as 'High' (no impact to recover from) and the biotope is considered 'Not Sensitive'. It should be noted that the timing of acute changes may lead to greater impacts, temperature increases in the warmest months may exceed thermal tolerances whilst changes in colder periods may stress individuals acclimated to the lower temperatures.

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

Sensitivity assessment. No evidence for the range of physiological tolerances to salinity changes were found for piddocks and sensitivity to this pressure is not assessed based on 'No evidence'.

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

No direct empirical evidence was found to assess this pressure for piddocks and the assessment is largely based on the reported distribution of the biotope which is recorded only from fully marine habitats (Connor *et al*., 2004). Biotopes found in the intertidal will naturally experience fluctuations in salinity where evaporation increases salinity and inputs of rainwater expose individuals to freshwater. Species found in the intertidal are therefore likely to have some form of behavioural or physiological adaptations to changes in salinity.

No information was found for the salinity tolerance of *Pholas dactylus*. *Barnea candida* is reported to extend in to estuarine environments in salinities down to 20 psu (Fish & Fish, 1996). *Petricolaria pholadiformis* is particularly common off the Essex and Thames estuary, e.g. the River Medway (Bamber, 1985) suggesting tolerance of brackish waters. Zenetos *et al*. (2009) suggest that at all sites where *Petricolaria pholadiformis* has been found there is some freshwater inflow into the sea. According to the literature, the species in its native range inhabits environments with salinities between 29 and 35ppt, while in the Baltic Sea it is reported from salinities 10-30 psu (Gollasch & Mecke, 1996, cited from Zenetos *et al*. 2009). According to Castagna & Chanley (1973, cited from Zenetos *et al*. 2009) the lower salinity tolerance of *Petricolaria pholadiformis* is 7.5-10 psu. It thus appears that reduced salinity facilitates its establishment (Zenetos *et al*., 2009). No information was found for the salinity tolerance of *Pholas dactylus*.

Mytilus edulis is found in a wide range of salinities from variable salinity areas (18-35 ppt) such as estuaries and intertidal areas, to areas of more constant salinity (30-35ppt) in the sublittoral (Connor *et al*., 2004). In addition, *Mytilus edulis* thrives in brackish lagoons and estuaries, although, this is probably due to the abundance of food in these environments rather than the salinity (Seed & Suchanek, 1992). *Mytilus edulis* was recorded to grow in a dwarf form in the Baltic sea where the average salinity was 6.5psu (Riisgård *et al*., 2013). *Mytilus edulis* exhibits a defined behavioural response to reducing salinity, initially only closing its siphons to maintain the salinity of the water in its mantle cavity, which allows some gaseous exchange and therefore maintains aerobic metabolism for longer. If the salinity continues to fall the valves close tightly (Davenport,1979; Rankin & Davenport, 1981). In the long-term (weeks) *Mytilus edulis* can acclimate to lower salinities (Almada-Villela, 1984; Seed & Suchanek 1992; Holt *et al*.1998). Almada-Villela (1984) reported that the growth rate of individuals exposed to only 13 psu reduced to almost zero but had recovered to over 80% of control animals within one month. Observed differences in growth are due to physiological and/or genetic adaptation to salinity.Decreased salinity has physiological effects on *Mytilus edulis*; decreasing the heart rate (Bahmet *et al*., 2005), reducing filtration rates (Riisgård *et al*., 2013), reducing growth rate (Gruffydd *et al*., 1984) and reducing the immune function (Bussell *et al*., 2008). Both Bahmet *et al*., (2005); Riisgård *et al*., (2013) noted that filtration and heart rates return to normal within a number of days acclimation or a return to the original salinity. However, Riisgard *et al*., (2013) did observe that mussels from an average of 17 psu found it harder to acclimate between the salinity extremes than those from an average of 6.5 psu. This observation may mean that mussels in a variable/ lower salinity environment are more able to tolerate change than those found at fully marine salinities.

Sensitivity assessment. A change in full to variable salinity (the pressure benchmark) may lead to changes in the composition of the piddock population with replacement of *Pholas dactylus* (if it is sensitive) by piddocks more tolerant of lower salinities particularly *Petricolaria pholadiformis*. *Mytilus edulis* is considered to be tolerant of a change in salinity at the pressure benchmark, based on evidence for salinity tolerances and recorded distribution. Based on reported distributions of the biotope and piddocks it is considered that the benchmark decrease in salinity would result in decreased abundance of *Pholas dactylus* in biotopes that were previously fully marine. As the biotope is sublittoral other piddock species more adapted to the intertidal may not be able to colonise the habitat to the same abundance. Resistance is therefore assessed as 'Low' and resilience (following return to full salinity) as 'Medium', the biotope is therefore considered to have ‘Medium’ sensitivity to this pressure.

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

Established adult piddocks are, to a large extent, protected from direct effects of increased water flow, owing to their environmental position within the substratum. Increases or decreases in flow rates may affect suspension feeding by altering the delivery of suspended particles or the efficiency of filter feeding. This biotope has been recorded from areas where tidal flows vary between 0.5 -1.5 m/s (Connor *et al*., 2004), suggesting that changes in flow rates (increase or decrease) within this range will not negatively impact the biotope. Adult piddocks may become exposed should physical erosion of the clay and chalk substratum occur at a greater rate than burrowing, and lost from the substratum. At higher densities bioerosion by piddocks may destabilise the substratum increasing vulnerability to erosion.

The most damaging effect of increased flow rate would be the erosion of the clay or soft chalk substratum as this could eventually lead to loss of the habitat. No evidence was found to assess the water velocities at which erosion of clay or chalk occurs. Some erosion will occur naturally and storm events and wave action may be more significant in loss and damage of substratum than surface water flow.

Sensitivity assessment. No direct evidence was found to assess this pressure at the benchmark. Based on the exposure of piddocks in this biotopes to water flows between 0.5 and 1.5 m/s (Connor *et al*., 2004), the biotope is considered to be unimpacted by changes within this range as long as these do not lead to increased erosion of the substratum. Resistance is therefore assessed as 'High' and resilience as 'High' (based on no impact to recover from), so that the biotope is considered to be ‘Not sensitive’.

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

Not relevant to sublittoral habitats.

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

No direct evidence was found to assess sensitivity to this pressure. The biotope typically occurs in moderately wave exposed locations (Connor *et al*., 2004). The piddocks are unlikely to be directly affected by changes in wave exposure, owing to their environmental position within the substratum, which protects them. On chalk and clay substrates, it is possible however, that wave action actively erodes the substratum at a faster rate than the piddocks can burrow leaving them exposed to predators or displaced. At higher densities bioerosion by piddocks may destabilise the substratum increasing vulnerability to erosion.

Potentially the most damaging effect of increased wave heights would be the erosion of the clay substratum as this could eventually lead to loss of the habitat. Increased erosion would lead to the loss of habitat and removal of piddocks. No evidence was found to link significant wave height to erosion. Some erosion will occur naturally and storm events may be more significant in loss and damage of clays than changes in wave height at the pressure benchmark. Micu (2007) for example observed numerous *Pholas dactylus* that had been washed out of the clay substratum or exposed due to storm damage to the clay in the Romanian Black Sea.

Sensitivity assessment. No direct evidence was found to assess this pressure at the benchmark. Based on the occurrence of this biotope in moderately wave exposed habitats the piddocks and algal mat are considered to have 'High' resistance to changes at the pressure benchmark where these do not lead to increased erosion of the substratum. Resilience is therefore assessed as 'High' and the biotope is considered to be 'Not sensitive', at the pressure benchmark.

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.

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.

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.

Radionuclide contamination	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 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	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

Specific information concerning oxygen consumption and reduced oxygen tolerances were not found for important characterizing species within the biotope. Cole *et al.* (1999) suggested possible adverse effects on marine species below 4 mg O_2/l and probable adverse effects below 2mg O_2/l. Duval (1963a) observed that conditions within the borings of *Petricolaria pholadiformis* were anaerobic and lined with a loose blue/black sludge. Similarly Knight (1984) observed Pholas dactylus exposed to low oxygen concentrations in burrows in areas of chalk bedrock, that were overlain with silt and were anoxic below the surface (Knight, 1984). Piddocks may therefore have some tolerance of this pressure at the benchmark, however, insufficient information has been recorded to develop an assessment.

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

This pressure relates to increased levels of nitrogen, phosphorus and silicon in the marine environment compared to background concentrations. The benchmark is set at compliance with WFD criteria for good status, based on nitrogen concentration (UKTAG, 2014). No evidence was found to assess the sensitivity of piddocks to this pressure. Nutrient enrichment that enhances productivity of phytoplankton may indirectly benefit the suspension feeding piddocks by increasing food supply.

Sensitivity assessment. The pressure benchmark is set at a level that is relatively protective and the biological assemblage is considered to be 'Not sensitive' at the pressure benchmark. Resistance and resilience are therefore assessed as 'High'.

Organic enrichment	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 evidence was found to assess this pressure.

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

This biotope is characterized by the clay or soft chalk substratum which supports populations of burrowing piddocks. A change to a sedimentary, rock or artificial substratum would result in the loss of piddocks significantly altering the character of the biotope. The biotope is therefore considered to have 'No' resistance to this pressure, recovery of the biological assemblage (following habitat restoration) is considered to be 'Medium' (2-10 years). The biotope is dependent on the presence of clay or soft chalk, when lost restoration would not be feasible and recovery is therefore categorised as 'Very low'. Sensitivity is therefore assessed as 'High', based on the lack of recovery of the substratum. Although no specific evidence is described confidence in this assessment is ‘High’, due to the incontrovertible nature of this pressure.

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 characterized by the clay or soft chalk substratum which supports populations of burrowing piddocks. A change to a sedimentary substratum would result in the loss of piddocks significantly altering the character of the biotope. The biotope is therefore considered to have 'No' resistance to this pressure, recovery of the biological assemblage (following habitat restoration) is considered to be 'Medium' (2-10 years) but see caveats in the recovery notes. The biotope is dependent on the presence of soft chalk or clayt, when lost restoration would not be feasible and recovery is therefore categorised as 'Very low'. Sensitivity is therefore assessed as 'High', based on the lack of recovery on chalk or clay substratum. Although no specific evidence is described confidence in this assessment is ‘High’, due to the incontrovertible nature of this pressure.

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

The removal of substratum to 30cm depth will remove the clay or chalk substratum, piddocks and the associated biological assemblage, in the impact footprint. Resistance is therefore assessed as ‘None’, recovery of the biological assemblage (fwhere suitable substratum remains) is considered to be 'Medium' (2-10 years). The biotope is dependent on the presence of clay or chalk substratum, when lost restoration would not be feasible and recovery is therefore categorised as 'Very low'. Sensitivity is therefore assessed as 'High', based on the lack of recovery of clay or chalk habitats. Although no specific evidence is described confidence in this assessment is ‘High’, due to the incontrovertible nature of this pressure.

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

Within this biotope the sparse epifauna could be damaged and removed by surface abrasion. Some species protruding from the surface may also be removed. Although the piddocks are afforded some protection from surface abrasion by living in their burrows, the clay or chalk is soft which leaves many individuals, especially those near the surface of the clay, vulnerable to damage and death through exposure of burrows and habitat damage. Micu (2007), for example, observed that after storms in the Romanian Black Sea, the round goby, *Neogobius melanostomus*, removed clay from damaged or exposed *Pholas dactylus* burrows to be able to remove and eat the piddocks.

The most significant impact may be on the substratum by removing or damaging surface layers resulting in the clay or chalk being more vulnerable to erosion. Natural erosion processes are, however, likely to be on-going within this habitat type. Where abundant the boring activities of piddocks also contribute significantly to bioerosion, which can make the substratum habitat more unstable and can result in increased rates of coastal erosion (Evans 1968a, Trudgill 1983, Trudgill & Crabtree, 1987). Pinn *et al*. (2005) estimated that over the lifespan of a piddock (12 years), up to 41% of the shore could be eroded to a depth of 8.5 mm. Surface erosion is therefore a natural part of the environmental processes the biotope experiences although rates could be enhanced by surface abrasion and disturbance.

Sensitivity assessment. Surface abrasion may remove epifauna and result in the loss of some piddocks and damage to habitat. Resistance is assessed as 'Medium' for piddocks and substratum. As the substratum cannot recover, resilience is assessed as 'Very Low' and sensitivity of the overall biotope is considered to be 'Medium'.

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

Penetration and disturbance below the surface of the substratum will damage and remove the dense algal mat and surface fauna and could damage and expose piddocks. Individuals in damaged burrows, or those that are removed from the substratum, are unlikely to be able to rebury and will be predated by fish and other mobile species (Micu, 2007).

The most significant impacst arising from this pressure may be the damage and removal of the chalk and clay substratum. Where abundant the boring activities of piddocks can make the substratum habitat more unstable and can exacerbate erosion (Evans 1968a, Trudgill 1983, Brookes & Stevens, 1985, Trudgill & Crabtree, 1987). Pinn *et al*. (2005) estimated that over the lifespan of a piddock (12 years), up to 41% of the shore could be eroded to a depth of 8.5 mm. Piddock burrowing can therefore make the substratum more vulnerable to damage and removal.

Sensitivity assessment. Sub-surface penetration and disturbance will remove and damage the sparse epifauna and result in the loss of piddocks and damage to the habitat. Resistance is therefore assessed as 'Low' for the piddocks and substratum. The piddocks are judged to have 'Medium' resilience (where suitable substratum remains) so that sensitivity of the piddocks is 'Medium'. As the substratum cannot recover, resilience is assessed as 'Very Low' and sensitivity of the overall biotope is considered to be 'High'.

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

No direct evidence was found to assess this pressure. Increased suspended particles will decrease light penetration, may enhance food supply (where these are organic in origin), or decrease feeding efficiency (where the particles are inorganic and require greater filtration efforts). Very high levels of silt may clog respiratory and feeding organs of some suspension feeders. Increased levels of particles may increase scour and deposition in the biotope depending on local hydrodynamic conditions, however, the piddocks are protected from scour within burrows and increased organic particles will provide a food subsidy.

Pholas dactylus occurs in habitats such as soft chalks where turbidity may be high (UK BAP, 2008) and is therefore unlikely to be affected by an increase in suspended sediments at the pressure benchmark. Piddocks, in common with other suspension feeding bivalves, have efficient mechanisms to remove inorganic particles via pseudofaeces. Experimental work on *Pholas* *dactylus* showed that large particles can either be rejected immediately in the pseudofaeces or passed very quickly through the gut (Knight, 1984). Increased suspended sediments may impose sub-lethal energetic costs on piddocks by reducing feeding efficiency and requiring the production of pseudofaeces with impacts on growth and reproduction.

A significant decrease in suspended organic particles may reduce food input to the biotope resulting in reduced growth and fecundity of *Pholas dactylus*. However, local primary productivity may be enhanced where suspended sediments decrease, increasing food supply.

Sensitivity assessment. No direct evidence was found to assess sensitivity to this pressure however, based on the occurrence of *Pholas dactylus* in turbid areas and evidence for the production of pseudofaeces by piddocks, resistance is assessed as 'High' and resilience as High (no impact to recover from). The biotope is therefore considered to be 'Not sensitive'.

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

The burrowing mechanisms of the piddocks *Pholas dactylus* and *Barnea candida* and other Pholads, mean that the burrows have a narrow entrance excavated by the juvenile. As the individual grows and excavates deeper the burrow widens resulting in a conical burrow from which the adult cannot emerge. Piddocks cannot therefore emerge from layers of deposited silt as other more mobile bivalves can.

No examples of direct empirical evidence or experiments on mortality rates have been found. Sometimes the substratum in which piddocks reside is covered by a thin layer of loose sandy material, through which the piddocks maintain contact with the surface via their siphons. *Pholas dactylus* is considered relatively tolerant of smothering by silt as it has been recorded from gently sloping chalk bedrock largely overlain by mud or silt 1-5cm deep, anoxic below the surface (Knight, 1984). *Pholas dactylus* has also been found living under layers of sand in Aberystwyth, Wales, (Knight, 1984) and in Eastbourne, with their siphons protruding at the surface (Pinn *et al*., 2008). It is likely that the piddocks would be able to extend their siphons through loose material, particularly where tidal movements and the oscillatory water movements produced by waves shift sediments. *Barnea candida* has also been found to survive being covered by shallow layers of sand in Merseyside (Wallace & Wallace, 1983). Wallace & Wallace (1983) were unsure as to how long the *Barnea candida* could survive smothering but noted that, on the coast of the Wirral, the piddocks have survived smothering after periods of rough weather. Where smothering is constant, survival can be more difficult. The redistribution of loose material following storms off Whitstable Street, in the Thames Estuary, is thought to be responsible for the suffocation of many *Petricolaria pholadiformis*. However, it was not known how deep the layer of 'loose material' was, nor how long it lasted for or what type of material it was made up of.

Indirect indications for the impacts of siltation are provided by studies of Witt (2004) on the impacts of harbour dredge disposal. *Petricola pholadiformis* was absent from the disposal area, and Witt (2004) cites reports by Essink (1996, not seen) that smothering of *Petricola pholadiformis* from siltation could lead to mortality within a few hours. Hebda (2011) also identified that sedimentation may be one of the key threats to *Barnea truncata* populations. At Agigea (Micu, 2007) reported that smothering of clay beds by sand and finer sediments had removed populations of *Pholas dactylus*. In this area sand banks up to 1m thick frequently shift position driven by storm events and currents (Micu, 2007). Similar smothering was described in the case of *Barnea candida* populations boring into clay beds (Gomoiu & Muller 1962, cited from Micu, 2007).

Sensitivity assessment. As piddocks are essentially sedentary and as siphons are relatively short, siltation from fine sediments that add to existing silt layers could be lethal. As the evidence suggests that *Pholas dactylus* is present under deposits up to the benchmark layer, resistance is assessed as 'Medium' where existing deposits are relatively thin. Effects may be mitigated where water currents and wave exposure rapidly removed the overburden and this will depend on local hydrodynamic conditions and the footprint of the deposit. Resilience is assessed as 'Medium' (2-10 years) for piddocks and sensitivity is therefore assessed as 'Medium'.

Smothering and siltation rate changes (heavy)	None Q: High A: High C: High	Medium Q: Medium A: Low C: Medium	Medium Q: Medium A: Low C: Medium

The burrowing mechanisms of the piddocks *Pholas dactylus* and *Barnea candida* and other Pholads, mean that the burrows have a narrow entrance excavated by the juvenile. As the individual grows and excavates deeper the burrow widens resulting in a conical burrow from which the adult cannot emerge. Piddocks cannot therefore emerge from layers of deposited silt as other more mobile bivalves can.

No examples of direct empirical evidence or experiments on mortality rates in response to siltation have been found for piddocks. Indirect indications for the impacts of siltation are provided by studies of Witt (2004) on the impacts of harbour dredge disposal. *Petricolaria pholadiformis* (as *Petricola pholadiformis* was absent from the disposal area, and Witt (2004) cites reports by Essink (1996, not seen) that smothering of *Petricola pholadiformis* from siltation could lead to mortality within a few hours. Hebda (2011) also identified that sedimentation may be one of the key threats to *Barnea truncata* populations. At Agigea (Micu, 2007) reported that smothering of clay beds by sand and finer sediments had removed populations of *Pholas dactylus*. In this area sand banks up to 1m thick frequently shift position driven by storm events and currents (Micu, 2007). Similar smothering was described in the case of *Barnea candida* populations boring into clay beds (Gomoiu & Muller 1962, cited from Micu, 2007).

Sensitivity assessment. As piddocks are essentially sedentary and as siphons are relatively short, siltation from fine could be lethal. Siltation at the pressure benchmark is considered to smother most or all of the piddocks and the surface fauna. Resistance to siltation is therefore assessed as 'None' although effects could be mitigated where water currents and wave exposure rapidly removed the overburden and this will depend on shore height and local hydrodynamic conditions. Resilience is assessed as 'Medium' (2-10 years) for piddocks and sensitivity is therefore assessed as 'Medium'.

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

No evidence.

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

Not relevant.

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

Pholas dactylus can perceive and react to light (Hecht, 1928) however there is no evidence that this pressure would impact the biotope.

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.

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

Pholas dactylus reacts quickly to changes in light intensity, after a couple of seconds, by withdrawing its siphon (Knight, 1984). This reaction is ultimately an adaptation to reduce the risk of predation by, for example, approaching birds (Knight, 1984). However, its visual acuity is probably very limited and it is unlikely to be sensitive to visual disturbance. Resistance and resilience are therefore assessed as 'High' by default.

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

The species characterizing this biotope, *Pholas dactylus* and other piddocks, are not farmed or translocated and therefore this pressure is '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 friable nature of the substratum which is subject to on-going erosion means this biotope supports only a sparse epifauna and flora. This biotope is therefore unlikely to be invaded by sessile invasive non-indigenous species. As the biotope occurs subtidally and turbidity levels are often high this biotope likely to be unsuitable for invasive non-indigenous algae.

The American piddock, *Petricolaria pholadiformis* is a non-native, boring piddock that was unintentionally introduced from America with the American oyster, *Crassostrea virginica*, not later than 1890 (Naylor, 1957). Rosenthal (1980) suggested that from the British Isles, the species has colonized several northern European countries by means of its pelagic larva and may also spread via driftwood, although it usually bores into clay, peat or soft rock shores. In Belgium and The Netherlands *Petricolaria pholadiformis* almost completely displaced the native piddock, *Barnea candida* (ICES, 1972). However, this has not been observed elsewhere, and later studies have found that *Barnea candida* is now more common than *Petricolaria pholadiformis* in Belgium (Wouters, 1993) and there is no documentary evidence to suggest that *Barnea candida* has been displaced in the British Isles (J. Light & I. Kileen pers. comm. to Eno et al., 1997). This species is also unlikely to displace *Pholas dactylus* which is more likely to occur subtidally.

Although not currently established in UK waters, the whelk *Rapana venosa*, may spread to habitats. This species has been observed predating on *Pholas dactylus* in the Romanian Black Sea by Micu (2007).

Sensitivity assessment. Based on the lack of records of invasive non-indigenous species in this biotope, and the unsuitability of the habitat for algae and other attached epifauna this biotope is considered to have 'High' resistance to this pressure and, by default 'High' resilience, this biotope is therefore considered to be 'Not sensitive'. This assessment may need revising in light of future invasions, e.g. the introduction of the whelk *Rapana venosa*.

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

No evidence.

Removal of target species	Low Q: Low A: NR C: NR	Medium Q: Low A: NR C: NR	Medium Q: Low A: Low C: Low

Piddocks may be removed as bait and across Europe they have traditionally been harvested for food, however high levels of habitat damage are associated with the removal of boring molluscs (Fanelli *et al*., 1994) and this practice has largely been banned. The most sensitive component of this biotope to targeted harvesting is the peat substratum which may be damaged and removed if piddocks were excavated from their burrows, this effect is considered through the physical damage pressures, abrasion and penetration and sub-surface damage.

Sensitivity assessment. Removal of piddocks will result in loss of targeted individuals and damage to the habitat. Resistance is assessed as 'Low' as piddocks are sedentary and burrow openings are readily detected. Piddocks are predicted to recover within 2-10 years so that resilience is considered to 'Medium' and sensitivity is 'Medium'.

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

The sparse epifauna and the substratum may be removed or damaged by activities targeting other species. These direct, physical impacts are assessed through the abrasion and penetration of the seabed pressures. It is unlikely that any targeted harvesting of other species occurs in this biotope or that it would unintentionally remove piddocks. Resistance of surface fauna and flora is assessed as 'Medium' and resilience as 'High' so that sensitivity is assessed as 'Low'.

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