Common shore crab (*Carcinus maenas*)

MarLIN – Marine Life Information Network
Biology and Sensitivity Key Information Review

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The Marine Life Information Network, Marine Biological Association of the United Kingdom.

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Two *Carcinus maenas* mating.
Photographer: Peter Barfield
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See online review for distribution map

Distribution data supplied by the Ocean Biogeographic Information System (OBIS). To interrogate UK data visit the NBN Atlas.

Researched by	Ken Neal & Paolo Pizzolla	**Refereed by**	This information is not refereed.
Authority	(Linnaeus, 1758)		
Other common names	-	**Synonyms**	-

Summary

Description

The shore crab has a shell (carapace) that is much broader than long (up to 8 cm across). The front of the carapace is serrated with five teeth on either side and three rounded lobes between the eyes. The first pair of legs (pereopods) have well developed pincers (chelae). Its colour is highly variable from dark green to orange and red. Variation in colour may be due to the stage of the life cycle or the habitat. Juveniles in particular display a wide range of mottled patterns.

Recorded distribution in Britain and Ireland

This ubiquitous crab is found on all shores of Britain and Ireland.

Global distribution

North Eastern Atlantic from northern Norway southwards to West Africa. It has been introduced to the USA, Sri Lanka, Red Sea, Madagascar, South Africa and Australia.

Habitat

Carcinus maenas is found on all types of shore, from high water to depths of 60 m in the sublittoral, but it is predominantly a shore and shallow water species. It tolerates a wide range of salinities and is especially abundant in estuaries and salt marshes.

Depth range
Intertidal down to 60 m.

Identifying features

- Shell (carapace) up to 8 cm wide.
- Front of carapace serrated with five teeth either side of the eyes.
- Three rounded lobes between the eyes.
- Variable in colour from dark green to orange or red.
- Females can distinguished from males by examining the vestigal abdomen on the underside of the crab. Males have a triangular abdomen, while in females, the abdomen is rounded and of equal breadth for most of its length.

Additional information
No text entered

Listed by

Further information sources

Search on:

NBN WoRMS

Biology review

Taxonomy

Family	Carcinidae
Genus	Carcinus
Authority	(Linnaeus, 1758)
Recent Synonyms	-

Biology

Typical abundance	High density
Male size range	1-86mm
Male size at maturity	25-30mm
Female size range	15-31mm
Female size at maturity	
Growth form	Articulate
Growth rate	See additional information
Body flexibility	None (less than 10 degrees)
Mobility	
Characteristic feeding method	
Diet/food source	Omnivore, Omnivore
Typically feeds on	Any animal or plant material (see additional information below).
Sociability	
Environmental position	Epibenthic
Dependency	No information found.
Supports	No information
Is the species harmful?	No

Biology information

General

Carcinus maenas is an easily identifiable crab of estuaries, sheltered rocky shores and offshore waters (Crothers, 1968). With increasing exposure on rocky shores, *Carcinus maenas* is replaced by other crab species such as the velvet swimming crab *Necora puber*, the bristly crab *Pilumnus hirtellus*, the edible crab *Cancer pagurus* and Montagu's crab *Xantho incisus*, and on increasingly exposed sandy areas by Pennant's swimming crab *Portumnus latipes*, the masked crab *Corystes cassivelaunus*, the harbour crab *Liocarcinus depurator* and the flying crab, *Liocarcinus holsatus* (Crothers, 1968).

Some large *Carcinus maenas* have red limbs and undersides rather than the usual green. This is thought to be related to the breeding period (Ditmmann & Villbrandt, 1999) and prolonged intermoult, and is caused by photodegradation of the green exoskeletal pigment. Red morphs of *Carcinus maenas* were found to have a thicker carapace for greater protection during intraspecific conflict for mates. However, the red morph was also found to have a higher metabolic demand and were less tolerant to changes in salinity and temperature compared to the green morph (Dittmann & Villbrandt, 1999). Green *Carcinus maenas* are mainly found sheltering under algae where their colour blends-in with the background. Red *Carcinus maenas* appear brown against a brown background in deep water and are mostly found in the shallow sublittoral where red light does not penetrate. Juvenile *Carcinus maenas* often have white patches on the carapace to breakup their outline against shell and gravel (Crothers, 1968). In the Wadden Sea and, probably colder, northern parts of Britain, *Carcinus maenas* migrates to subtidal areas and remains there until spring. During this time the crabs are inactive in shelters and do not feed (Dittmann & Villbrandt, 1999). Lack of prey in the winter also leads to starvation and inactivity (Scott-Fordsmand & Depledge, 1993).

Growth
Carcinus maenas increases its body size by 20-33% per moult (Klein Breteler, 1975) and takes about 10 moults to reach 20 mm carapace width (CW) in its first year, if conditions are favourable (Crothers,1967). *Carcinus maenas* may moult more than once per year after the first year if conditions are good but moulting rate slows once maturity is reached (Crothers, 1967) and is probably about once per year post maturity.

Diet
Carcinus maenas can be considered a true omnivore and consumes plants, algae, molluscs, arthropods (including their own species), annelids and carrion. Animal matter makes up the majority of the diet but some plant matter including algae and cord grass *Spartina* sp. is consumed. The diet of large *Carcinus maenas* mainly consists of molluscs and the common mussel *Mytilus edulis* is the most important of these. Smaller crabs (<30 mm CW) have more plant matter and arthropods in their diet. On rocky shores, juvenile *Carcinus maenas* were found to consume the barnacle *Semibalanus balanoides* whereas adults consume more gastropods (Rangley & Thomas, 1987) especially the dogwhelk *Nucella lapillus* and winkles *Littorina* sp. (Little & Kitching, 1996). *Semibalanus balanoides* is abundant and supports rapid growth (frequent moulting) in the early life stages of *Carcinus maenas* (Rangley & Thomas, 1987). Peak foraging occurs at night around high tide (Ropes, 1969). Predation rate is dependent on prey density (Walton *et al*., 2002) and temperature (Sanchez-Salazar *et al*., 1987).

Parasites
The most well known parasite of *Carcinus maenas* is the rhizocephalan barnacle *Sacculina carcini*. This parasite infects by larval settlement on the exoskeleton and subsequent infection into the haemocoel by injection through a chitin 'needle' at the base of a hair on one of the legs of the host. Any larvae that do not settle adjacent a hair base do not survive (Smith, 1907). *Sacculina carcini* castrates male and female *Carcinus maenas* and prevents moulting for the rest of the crabs life (Naylor, 2000; Thresher *et al*., 2000 and references therein). Infected crabs with sexually mature parasites carry a reproductive externae in the same way as females carry an egg-mass when they are berried. The externae is distinguishable from an egg-mass because it is smooth rather than granular (Naylor, 2000).

Carcinus maenas is the 1st host of the acanthocephalan helminth *Profilicollis botulus* which infects eider ducks (*Somateria mollissima*) by ingestion of infected crabs. Juvenile eider ducks suffer some mortality from heavy infections and crabs are infected by eggs of the parasite from duck faeces(Thompson, 1985).

Small *Carcinus maenas* (3-11 mm CW) can be attacked by the parasitoid platyhelminth *Fecampia erythrocephala*. This parasitoid is 8-12 mm long and replaces much of the digestive gland in the haemocoel. Infection is usually 1 worm per crab but may be as many as 4. Once the worm is mature it exits the crab, killing it in the process. Prevalence in natural populations is about 7% and Kuris *et* *al*., (2002) suggested *Fecampia erythrocephala* may be a useful biocontrol where introduced *Carcinus maenas* are a pest because it kills crabs before they can mature and breed.

Predators
Common shore crabs are eaten mainly by fish and birds (e.g. gulls, commorants, eider ducks) although it depends on the size of the crabs and on geographic location. For example, in some areas, predators of *Carcinus maenas* may include otters.

Habitat preferences

Physiographic preferences	Open coast, Strait / sound, Sea loch / Sea lough, Ria / Voe, Estuary, Isolated saline water (Lagoon), Enclosed coast / Embayment
Biological zone preferences	Lower circalittoral, Lower eulittoral, Lower infralittoral, Mid eulittoral, Sublittoral fringe, Upper circalittoral, Upper eulittoral, Upper infralittoral
Substratum / habitat preferences	No preference
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Extremely sheltered, Sheltered, Ultra sheltered, Very sheltered
Salinity preferences	Full (30-40 psu), Low (<18 psu), Reduced (18-30 psu), Variable (18-40 psu)
Depth range	Intertidal down to 60 m.
Other preferences	None found
Migration Pattern	

Habitat Information

No text entered

Life history

Adult characteristics

Reproductive type	Gonochoristic (dioecious)
Reproductive frequency	Annual protracted
Fecundity (number of eggs)	100,000-1,000,000
Generation time	1-2 years
Age at maturity	1-2 years
Season	See additional information
Life span	5-10 years

Larval characteristics

Larval/propagule type	-

Larval/juvenile development	Planktotrophic
Duration of larval stage	1-2 months
Larval dispersal potential	Greater than 10 km
Larval settlement period	Insufficient information

Life history information

Duration of reproductive season is related to geographical location. Egg-bearing females can be found year-round in the south of England, between January and April/May in the Bristol Channel and Wash area and only in spring in northern Scotland (Ingle, 1980). In areas where there is a defined reproductive season, females aggregate at 'hotspots' and males compete for copulatory opportunities (van der Meeren, 1994). Males preferentially select females with a carapace width 10 mm smaller than their own but are not size selective below this threshold and do not select females on the basis of imminence of moult (Reid *et al.*, 1994). Males 65 mm carapace width or more are large enough to dominate competitive interactions and often mate with several females. However, males of this size only make up approximately 5% of the population (van der Meeren, 1994). Unmated males will try to displace males in precopula (a male carrying a female beneath its body held by one of the legs, prior to the female moulting) and always loses out to a male that has a carapace width 9 mm or larger than its own. Males that are similar size are likely to win intrasex conflicts 50% of the time (Reid *et al.*, 1994).
After moulting the 'soft' female is turned over by the male and copulation ensues through modified pleopods on the much reduced abdomen. As with most crabs, the female bears the fertilized eggs in a mass held between the abdomen and underside of the carapace. Females are berried for up to 4 months, depending on temperature, before the eggs hatch in spring/summer. Females in estuaries migrate to the mouth of the estuary to release larvae at night on ebb tides into fully saline water (Queiroga, 1996). At the southern limit of its range, larvae are released in winter when water temperatures are cooler (Sprung, 2001). *Carcinus maenas* was reported to breed only at temperatures below 18°C (Crothers, 1967). The maximum fecundity recorded was 185,000 eggs (Crothers, 1967).

Sensitivity review

This MarLIN sensitivity assessment has been superseded by the MarESA approach to sensitivity assessment. MarLIN assessments used an approach that has now been modified to reflect the most recent conservation imperatives and terminology and are due to be updated by 2016/17.

Physical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Substratum Loss	Low	High	Low	Low

Carcinus maenas displays very little preference for substratum, inhabiting everything from mudflats to bedrock. Therefore, it is unlikely to be affected by the loss of a particular substratum although its foraging success may be decreased and an intolerance of low has been recorded.

	Intolerance	Recoverability	Sensitivity	Confidence
Smothering	Tolerant	Not relevant	Not sensitive	Low

Carcinus maenas is an extremely mobile organism and is capable of burrowing into sediment with its legs for shelter or when searching for prey such as the cockle *Cerastoderma edule* or the clam *Mya arenaria*. Therefore, it is unlikely to be significantly perturbed by a layer of sediment and tolerant has been recorded. Recruitment may be affected however, as mortality of post-settlement *Carcinus maenas* on sand flats is 80-90% (Moksnes *et al*., 1998). Therefore, if a large area of previously complex habitat was covered in sediment, post-settlement mortality would be much higher than before the deposition of the sediment.

	Intolerance	Recoverability	Sensitivity	Confidence
Increase in suspended sediment	Tolerant	Not relevant	Not sensitive	Low

Carcinus maenas shows very little habitat preference and are found in clear rocky shore waters all the way through to turbid estuarine waters. Therefore, they are unlikely to be affected by an increase in suspended sediment.

	Intolerance	Recoverability	Sensitivity	Confidence
Decrease in suspended sediment	Tolerant	Not relevant	Not sensitive	Low

Carcinus maenas shows very little habitat preference and are found in clear rocky shore waters all the way through to turbid estuarine waters. Therefore, they are unlikely to be affected by a decrease in suspended sediment.

	Intolerance	Recoverability	Sensitivity	Confidence
Dessication	Tolerant	Not relevant	Not sensitive	High

Young crabs have been reported to survive for 10 days in moist air (Crothers, 1968) and can probably survive dry air for some time as well. Therefore, tolerant at the benchmark level has been recorded.

	Intolerance	Recoverability	Sensitivity	Confidence
Increase in emergence regime	Low	Very high	Very Low	High

The activity rhythms of adult *Carcinus maenas* are entrained by salinity, hydrostatic pressure and temperature, and are therefore unaffected behaviourally by an increase in emergence. Juvenile crabs are entrained to some extent by periodicity of inundation and emergence (Reid *et al*., 1992), and may become active before immersion by the tide and become more vulnerable to predation by birds. Physiologically, *Carcinus maenas* is exceptionally tolerant (e.g. Ameyaw-Akumfi & Naylor, 1987; Crothers, 1968; Hill *et al*., 1991; Naylor, 2000) and will probably survive an extra hour of emergence until it can re-entrain to the new tidal cycle and migrate downshore to a suitable habitat. First and second instar *Carcinus maenas* live in the high intertidal and have finely tuned endogenous rhythms to ensure moulting occurs during inundation on spring tides (Zeng *et al*., 1999). A sudden increase in emergence coupled with these rhythms, which persist for 8 days in constant conditions (Zeng *et al*., 1999), could lead to moulting becoming dislocated from inundation on spring tides. However, mortality of *Carcinus maenas* due to an increase in emergence is unlikely and an intolerance of low has been recorded.

Decrease in emergence regime	Tolerant*	Not relevant	Not sensitive*	Low

A decrease in emergence would allow *Carcinus maenas* to forage for longer and increase its food intake, especially on mussel or cockle beds. This would increase its growth rate and fecundity (Klein Breteler, 1975). Predation by fish, cephalopods and other crustaceans would probably increase but this would probably be tempered by reduced predation from birds, and tolerant has been recorded.

Increase in water flow rate	Low	Very high	Very Low	Moderate

Carcinus maenas is replaced in high energy sand areas by *Portumnus latipes*, *Corystes cassivelaunus*, *Liocarcinus depurator* and*Liocarcinus holsatus* (Crothers, 1968), and so is likely to migrate away from an area where water flow rate increases. Mortality is likely to be low so a an intolerance of low has been recorded.

Decrease in water flow rate	Tolerant	Not relevant	Not sensitive	Low

Carcinus maenas can be found in salt marsh creeks and rockpools where water flow can be very low or non-existent and therefore a decrease in water flow is unlikely to affect *Carcinus maenas* and tolerant has been recorded.

Increase in temperature	Tolerant*	Not relevant	Not sensitive*	High

At the benchmark level, *Carcinus maenas* is unlikely to be harmed by an increase in temperature as it can survive at least 23°C at the southern limit of its range in the Mediterranean Sea (Sprung, 2001). However, the adults will not breed over 18°C (Crothers, 1967) so summer breeding may be affected by a chronic increase. However, an increase in temperature also increases moulting rate (Klein Breteler, 1975), feeding rate (Sanchez-Salar *et al*., 1987) and salinity tolerance (Crothers, 1967) and therefore is likely to be of benefit to a population. Therefore, tolerant* has been recorded.

Decrease in temperature	Tolerant	Not relevant	Not sensitive	High

Carcinus maenas can tolerate a temperature range of at least 5 -26°C (Truchot, 1973) and therefore is unlikely to suffer mortality from a decrease in temperature at the benchmark level. Since increased temperature increases feeding rate (Sanchez-Salar *et al*., 1987) and moulting rate (Klein Breteler, 1975) it follows that a decrease in temperature would slow down feeding rate and growth rate. This is only a perturbation, however, and there would probably not be any mortality at the benchmark level and therefore tolerant has been recorded. However, in the severe winter of 1962-63, when water temperatures around the British coast fell to -1.5°C, large numbers of adult *Carcinus maenas* were caught in dredges and washed up upon the shore. Juveniles seemed to be unaffected (Crisp, 1964).

Increase in turbidity	Not relevant	Not relevant	Not relevant	Low

Carcinus maenas is not reliant on clear water for any part of its adult life and so is unlikely to be affected by an increase in turbidity. One consequence may be increased productivity of filter-feeding prey items such as the mussel *Mytilus edulis* or the cockle *Cerastoderma edule* and therefore improved feeding for *Carcinus maenas* .

Decrease in turbidity	Not relevant	Not relevant	Not relevant	Low

Carcinus maenas is not reliant on clear water for any part of its adult life and so is unlikely to be affected by a decrease in turbidity.

Increase in wave exposure Intermediate High Low Moderate

Carcinus maenas is typical of sheltered shores (Crothers, 1968) and estuaries (Ingle, 1997) and an increase in wave exposure may force *Carcinus maenas* out of areas where it is at the limit of its tolerance. An intolerance of intermediate has been recorded since some crabs are likely to be washed out of refuges by large waves and killed by further wave action or consumption by predators.

Decrease in wave exposure Tolerant* Not relevant Not sensitive* Moderate

Carcinus maenas is typical of sheltered shores (Crothers, 1968) and estuaries (Ingle, 1997) and a decrease in wave exposure is likely to increase the available habitat for *Carcinus maenas* and tolerant* has been recorded.

Noise Tolerant Not relevant Not sensitive High

Carcinus maenas is unlikely to be affected by noise at the benchmark level.

Visual Presence Tolerant Not relevant Not sensitive High

Carcinus maenas may adjust its behaviour in response to the presence of machinery or people, it will often adopt a defensive posture upon the approach of a person but mortality or emigration is unlikely and tolerant has been recorded.

Abrasion & physical disturbance Low High Low Low

During the construction of the "EUROPIPE" gas pipeline in the Wadden Sea, *Carcinus maenas* abundance was affected by construction activities across the route of tidal migration: crabs were most likely scared away and unable to migrate upshore than killed. The difference in *Carcinus maenas* abundance compared to pre-construction levels lasted only a few months (van Bernem, 1999). Physical disturbance will probably cause short term effects with rapid recovery due to the mobility and fecundity of *Carcinus maenas*.

Displacement Tolerant Not relevant Not sensitive High

Translocated crabs quickly orient to concealment (Bliss, 1983) and are easily kept in captivity at high density. Therefore, they are tolerant of displacement as long as there is suitable refuge in the new area.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	Intermediate	High	Low	High

Cypermethrin is an insecticide used to treat salmon for fish lice. At the concentration used on fish farms (5 µg/l) half the exposed *Carcinus maenas* died within 96 hours. However, most of the crabs displayed sublethal effects of stiffened limbs, outstretched chelae and unresponsiveness to visual or mechanical stimuli after 5 hours in cypermethrin treated water (Gowland, 2002). In the wild, this would make active crabs vulnerable to predation.
Exposure to sublethal concentrations of the oil dispersant BP1100WD caused increased locomotory activity, cardiac output and respiratory rate for the first 24 hours of exposure and prevented feeding for the entire six weeks of the trial (Depledge, 1984). Exposure to dispersant will probably affect moulting and reproduction because they both have high energy requirements that are unlikely to be met after a period of dispersant-induced starvation.

A solution of 200 ng/l of DDT (a concentration that may be found in the aquatic environment) inhibited Na K ATPase and Mg ATPase in the gills of *Carcinus maenas* and decreased the crabs' ability to osmoregulate. This effect was cumulative and increased with exposure time (Jowett *et al*., 1981) and would probably decrease the ability of *Carcinus maenas* to survive low salinity environments. Exposure to synthetic chemicals is likely to cause high mortality in *Carcinus maenas* populations and an intermediate intolerance has been recorded.

Heavy metal contamination	Low	Very high	Very Low	High

Carcinus maenas is very tolerant of zinc pollution and was found to have loadings from 2087-3859 µg Zn per 10 g dry weight of crab; 60-80% of which was deposited in the exoskeleton (Chan & Rainbow, 1993) and was presumably lost at moulting. Even at very high concentrations, zinc does not cause significant mortality but it is not without metabolic effects. *Carcinus maenas* exposed to hypoxia (1.5 mg O_2/l) and zinc pollution (0.25 mg/ l) switched to anaerobic respiration sooner than those exposed to hypoxia only (Johnson, 1987). In low salinity, in addition to zinc contamination and hypoxia, osmoregulation was interrupted by zinc but the experimental *Carcinus maenas* survived 96 hours in these conditions and then fully recovered in clean normoxic water (Johnson, 1988).
Johnson (1988) also conducted experiments under the same conditions described above with copper, with similar results. Copper contamination can be lethal or cause severe sublethal effects. As described above, 0.25 mg/l caused some perturbation but not mortality of *Carcinus maenas* (Johnson, 1987; 1988), 0.5 mg/l caused gill damage including vacuolisation and necrosis of gill cells and reducing blood oxygen levels, and 2 mg/l caused 50% mortality in five days (Nonnotte *et al*., 1993). Low salinity caused synergistic effects with copper, a 10 ppm copper solution caused a 50-60% reduction in Na K ATPase (needed for ionic regulation) activity in 10 psu water and some mortality as a result (Hansen *et al*., 1992).

Carcinus maenas starves immediately before moulting and the breakdown of energy stores and catabolism of body tissue releases bound metals and increases the total body concentration even though no more metal has been absorbed (Scott-Fordsmand & Depledge, 1993). This may affect metal toxicity and *Carcinus maenas* may be more vulnerable to metal pollution just before and just after moulting. Low salinity also increases the uptake of cadmium (by up to twice as much) from solution and during long exposures whole body levels of cadmium can be 6-18 times higher than that of the surrounding water (Bjerregaard & Depledge, 1994: Wright, 1977). Nevertheless, *Carcinus maenas* tolerated a body loading of 33.7 mg Cd per kg wet weight and cleared half of the cadmium from its body in 11 days in clean water (Wright, 1977). This is presumably due to the excretion of metallothioneins.

Carcinus maenas is also tolerant of selenium, an essential micronutrient, but toxic at high concentrations (as are many other metals including copper and zinc). As with most metals, selenium is concentrated in the hepatopancreas and bound with metallothionein. It was found at 4.5 ppm in sampled *Carcinus maenas* (Zatta *et al*., 1985). Interestingly, selenium binds with other metals and forms metal-selenides that are less toxic than the metal or selenium alone (Zatta *et al*., 1985).

In contrast to other metals, arsenic is found at the highest concentrations in the gill tissue of *Carcinus maenas* this may be due to absorption at this site or elimination. Gill arsenic concentrations were found to be 179-483 µg per g dry weight and *Carcinus maenas* is assumed to be tolerant to arsenic pollution (Anderson & Depledge, 1994).

Mercury is by far the most toxic metal to *Carcinus maenas*, 0.05 mg/l caused an increase in locomotory activity and disrupted endogenous rhythms with possible ecological implications (Depledge, 1984a). A 10 hour exposure to 1 mg Hg/l caused 100% mortality within 48 hours (Depledge, 1984a).

Overall, *Carcinus maenas* is very tolerant of metal contamination although mortality may occur at high concentrations of mercury. However, heavy metal contamination causes a wide range of metabolic effects and, therefore, an intolerance of low has been recorded.

Hydrocarbon contamination	High	High	Moderate	High

*Carcinus maenas*populations were extinguished on some shores by oiling from the *Torrey Canyon* oil spill (Smith, 1968) and many were killed by effluent discharged into saltmarsh creeks from a Milford Haven refinery (Baker, 1976).
Sublethal concentrations of the water soluble fraction of oil caused increased locomotory activity, cardiac output and respiratory rate for the first 24 hours of exposure. Feeding was inhibited for at least 8 days. A combination of oil and dispersant had synergistic effects and inhibited feeding for longer than either oil or dispersant alone (Depledge, 1984b). An intolerance of high has been recorded.

Radionuclide contamination	Tolerant	Not relevant		Moderate

Carcinus maenas accumulates antimony^{124} from its food (Weers & Louwrier, 1981) and uranium from water (Chassard-Bouchaud, 1983). Both are concentrated in the hepatopancreas and seem to cause little harm to *Carcinus maenas* even though concentrations of uranium can be 100 times higher in contaminated individuals compared to uncontaminated ones. *Carcinus maenas* is capable at least of detoxifying itself of uranium by moulting and voiding spherocrystals in which the uranium is bound (Chassard-Bouchaud, 1983). However, no evidence of adverse effects of radionuclides on *Carcinus maenas* was found and tolerant has been recorded.

Changes in nutrient levels	Tolerant	Not relevant	Not sensitive	Moderate

Carcinus maenas is probably tolerant of nutrient input as it is tolerant of hypoxia that is often associated with organic enrichment. In addition, *Carcinus maenas* preys on species that can benefit from organic inputs, especially bivalve molluscs. *Carcinus maenas* normally excretes ammonium through the gills but in response to increased ammonium concentration, *Carcinus maenas* increases urea production and consequently has to increase gill permeability to take up more water for urine production. This in turn means that the affected *Carcinus maenas* has to increase energy expenditure on active ion transport, especially in low salinities (Spaargaren, 1990). Therefore, high energy demands may exclude *Carcinus maenas* from areas of organic enrichment in low salinity waters. The megalopae of *Carcinus maenas* select filamentous algae for settlement to avoid predation from cannibalistic juveniles (Moksnes *et al*., 1998; Moksnes, 2002). Eutrophication has been shown to cause algal mats to form on estuarine mudflats which may increase recruit survivorship. Therefore, tolerant has been recorded.

Increase in salinity	Tolerant	Not relevant	Not sensitive	High

Carcinus maenas can tolerate salinities from 4-40 psu (Crothers, 1968; Ameyaw-Akumfi & Naylor, 1987) and has a preference for 27-40 psu, exhibiting halokinesis (non-directional movement in response to salinity) in a salinity gradient (Ameyaw-Akumfi & Naylor, 1987). *Carcinus maenas* is more tolerant of hypoxia (Legeay & Massabuau, 2000) and heavy metal accumulation (Bjerregard & Depledge, 1994) in higher salinities. Therefore, *Carcinus maenas* is likely to be tolerant of an increase in salinity at the benchmark level.

Decrease in salinity	Tolerant	Not relevant	Not sensitive	High

Carcinus maenas remains in estuaries throughout each tidal cycle (as opposed to migrating in and out with the flood and ebb tides) and experiences from full salinity to almost freshwater twice daily (Ameyaw-Akumfi & Naylor, 1987). Therefore, it is very tolerant of a decrease in salinity. However, decreasing salinity decreases the tolerance of *Carcinus maenas* to hypoxia and heavy metal accumulation, presumably due to increased energetic demands. Because of the increased energetic demands in low salinity, berried females and parasitized *Carcinus maenas* avoid brackish water (Crothers, 1968). Overall, *Carcinus maenas* is probably tolerant of a decrease in salinity at the benchmark level.

Changes in oxygenation	Tolerant	Not relevant	Not sensitive	High

Carcinus maenas can survive up to 18 hours in complete anoxia by switching to anaerobic respiration and building up lactate. The crabs become inactive in anoxia and metabolic rate drops to <20% of that in normoxic conditions. *Carcinus maenas* is probably tolerant of hypoxia and is regularly subject to hypoxic conditions in rock pools, especially at night (Brante & Hughes, 2001). Exposure to 1.5 mg O_2/l, about a quarter of normoxic oxygen levels, for 24 hours had little effect on metabolism (Johnson, 1987) and 1 mg O_2/l increased the time taken to glean and consume the flesh of mussels but had no other effect (Brante & Hughes, 2001). Oxygen consumption doubles after feeding but *Carcinus maenas* can still survive long periods of hypoxia (Legeay & Massabuau, 2000). Hypoxia and low salinity in combination can cause some perturbation in *Carcinus maenas*. Exposure to 27 psu and 1.5 mg O_2/l for 96 hours had no effect on crabs but when the salinity was reduced to 13 psu, osmoregulation was interrupted but none of the crabs died (Johnson, 1988). However, *Carcinus maenas* in salinities less than 10 psu in approximately 1.5 mg O_2 l^{-1} switched to anaerobic respiration and there was 50% mortality within 24 hours (Legeay & Massabuau, 2000). The tolerance of *Carcinus maenas* to hypoxia does vary with season and is highest in the spring and summer during intermoult and lowest in winter just before the main moulting period (Legeay & Massabuau, 2000). Tolerant has been recorded because *Carcinus maenas* is unaffected by hypoxia (and even anoxia) in all but the most extreme conditions.

Biological Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Introduction of microbial pathogens/parasites	Intermediate	High	Low	High

Carcinus maenas can contract bacterial haemolymph infections through wounds which cause death or prolong intermoult and are caused by a variety of bacteria including species of *Vibrio*, *Bacillus* and *Aerococcus* (Bliss, 1983). On very rare occasions, *Carcinus maenas* may become infected by *Anophrys maggii*, which consumes blood cells and causes death by anaemia and secondary bacterial infection (Bliss, 1983). *Carcinus maenas* is parasitized by *Proficollis botulus*, *Fecampia erythrocephalus* and *Sacculina carcini* (see adult general biology). Some mortality in *Carcinus maenas* populations is caused by microbial and parasitic infections and an intolerance of intermediate has been recorded.

Introduction of non-native species	Low	Very high	Very Low	Low

The Chesapeake Bay Swimming Crab, *Callinectes sapidus*, was introduced to southeast England from America (Ingle, 1980; 1997). It has a similar diet to *Carcinus maenas* and the two species may compete for food (Ropes, 1989).

Extraction of this species	Intermediate	High	Low	Low

Carcinus maenas is sometimes sold at fish markets in France and Portugal and soft crabs (known as 'peelers') are used as fishing bait but although there is some mortality, neither are at a sufficient magnitude to significantly affect *Carcinus maenas* populations.

Extraction of other species	Tolerant	Not relevant	Not sensitive	Not relevant

Carcinus maenas consumes such a wide range of food items that the extraction of one food type (e.g. mussels *Mytilus edulis*) would cause *Carcinus maenas* to switch to a different food type. Therefore, it is probably tolerant of extraction of its prey species.

Additional information

Recoverability
If a population of *Carcinus maenas* was completely wiped out by a catastrophic event, for example an oil spill, recovery is likely to be rapid as fecundity is high (up to 185,000 eggs) and reproduction is frequent (Crothers, 1968). The dispersal potential of larvae is high, and *Carcinus maenas* larvae have been found to colonize new areas at a rate of 1.9-8.7 km per year (Thresher *et al.*, 2003 and references therein). Hence, the recolonization of defaunated areas is likely to be rapid. In addition, adults are very mobile and have been reported as travelling up to 15 km along a coast in 6 months (Thresher *et al.*, 2003 and references therein). *Carcinus maenas* reaches maturity within 2 years (Crothers, 1967; Moksnes *et al.*, 1998 and references therein) and a population of newly settled individuals are likely to grow rapidly and become self perpetuating within a few years.

Importance review

Policy/legislation

- no data -

Status

National (GB) importance	-	**Global red list (IUCN) category**	-

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

Carcinus maenas is a major predator of shellfish and is a pest in mariculture. In the UK, France and USA, metal mesh fences are used to protect mariculture of the blue mussel, *Mytilus edulis*, the oyster *Ostrea edulis* and the hard-shell clam *Mercenaria mercenaria* from predation by *Carcinus maenas*. *Mytilus edulis* does not reach a size refuge from *Carcinus maenas* predation until a shell length of 4 cm (approximate age of 1.5 years). Mussel 2-2.5 cm shell length seed stocks are surrounded by fences until they reach 4 cm shell length, when the fences are removed and the mussels continue to grow for another year until harvest size at 5.5 cm. Before fences were used, mortality of mussel seed stocks was 85% by harvest size. Fences reduced mortality to 15%. *Carcinus maenas* could completely destroy a 4m^2 area of seed mussels in 7 days, leaving only broken shells. *Carcinus maenas* is too abundant and mobile to be trapped to prevent mariculture damage (Davies *et al*., 1980).

Carcinus maenas also causes significant damage to mariculture of the stepped clam *Katelysia scalarina*, in Australia (Walton *et al*., 2002) and has been blamed for much for the decline in sand gaper *Mya arenaria* landings in New England, USA (Ropes, 1969). *Carcinus maenas* also preys upon the common cockle *Cerastoderma edule*, preferring individuals <1.5 cm shell length and large male *Carcinus maenas* can consume up to 40 cockles daily in the summer months (Sanchez-Salar *et al*., 1987).

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