Brown shrimp (*Crangon crangon*)

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

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Crangon crangon **on shell fragments and gravel (from above).**
Photographer: John Rundle

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	**Refereed by**	This information is not refereed.
Authority	(Linnaeus, 1758)		
Other common names	-	**Synonyms**	*Crangon vulgaris* (Linnaeus, 1758)

Summary

Description

The brown shimp, *Crangon crangon* is a long thin animal, mottled brown in colour, narrowing from a wide anterior end to a fanned tail. It is up to 8.5 cm in length and can be distinguished from most other shrimps and prawns by the short blunt-ended rostrum between the eyes. The colour can be varied by chromatophores depending on the colour of the substratum. It is somewhat dorsoventrally flattened compared to most other shrimps and prawns. The main antennae are almost as long as the body.

Recorded distribution in Britain and Ireland

Found on sandy and muddy bottoms around all British and Irish coasts.

Global distribution

Found from the Finnish coast South into the Baltic and into the Mediterranean.

Habitat

Crangon crangon is found on sandy and muddy ground, showing a preference for grain sizes between 125 and 710 µm and is often buried with only the eyes and antennae above the sediment surface (Pinn & Ansell, 1993).

Depth range
Intertidal to 150 metres

Identifying features

- 1st thoracic limb subchelate.
- Rostrum short, about half length of the eye.
- Paddle -shaped appendages held in front of eyes (scaphocerites) about half as wide as long.
- Telson with two pairs of lateral spines.
- Sixth dorsal segment smooth on dorsal side

Additional information
Crangon crangon can be confused with *Crangon allmani*, but *Crangon allmani* has a longitudinal ridge on the sixth abdominal segment. *Crangon crangon* has very high productivity and is an important food source for many birds, fish and crustaceans. It is commercially exploited for human consumption in northern Europe.

Listed by

Further information sources

Search on:

NBN WoRMS

Biology review

Taxonomy

Order	Decapoda	Crabs, shrimps, prawns, crayfish and lobsters
Family	Crangonidae	
Genus	Crangon	
Authority	(Linnaeus, 1758)	
Recent Synonyms	Crangon vulgaris (Linnaeus, 1758)	

Biology

Typical abundance	Moderate density
Male size range	5-55mm
Male size at maturity	30mm
Female size range	5-85mm
Female size at maturity	
Growth form	Articulate
Growth rate	14mm/month
Body flexibility	High (greater than 45 degrees)
Mobility	
Characteristic feeding method	
Diet/food source	Omnivore, Planktotroph
Typically feeds on	A wide variety of animal and plant material.
Sociability	
Environmental position	Epibenthic
Dependency	No information found.
Supports	No information
Is the species harmful?	No

Biology information

Crangon crangon is the most commonly encountered shrimp of sandy bays and estuaries, reaching densities of 60 per m^2 during summer peaks (Beukema, 1992). *Crangon crangon* buries itself in sand to avoid predators and to ambush prey. It prefers sediment of 125-710 µm grain size (Pinn & Ansell, 1993). Burial takes 9-10 seconds and is achieved by rapid beating of the abdominal limbs (pleopods) followed by violent shuffling and completed by the antennae sweeping sand over the back to leave only the eyes and antennae above the sediment surface (Pinn & Ansell, 1993). Onset of foraging activity of *Crangon crangon* is light controlled, and occurs at night (Addison *et al*., 2003) except in very turbid areas such as the Bristol Channel (Lloyd & Yonge, 1947).

Population dynamics

The maximum age of *Crangon crangon* was reported as 3.3 years with the large majority (70-90%) of the population in the 1st year class, 10-20% in the 2nd year class and the rest in their 3rd year (Oh *et al*., 1999). Relative abundance of males changes with season and can vary between 6-82% in the Solway Firth (Abbott & Perkins, 1977). Juvenile *Crangon crangon* recruit to the benthos in May -

July to exploit the annual calanoid copepod bloom that is the main food of the early benthic stages (Boddeke *et al*., 1986). Small post-settlement *Crangon crangon* migrate to inshore nursery areas for better foraging and predation protection, remaining in these areas for 2-3 weeks before heading back offshore (Cattrijsse *et al*., 1997). Adults migrate offshore November to March to avoid low salinity water (Boddeke, 1989; Henderson & Holmes, 1987).

Growth

Crangon crangon moults frequently: every 13-30 days at 12°C (Lloyd & Yonge, 1947), every 8-9 days at 16-18°C (Price & Uglow, 1979), and increases in size by 1-3 mm with each moult (Lloyd & Yonge, 1947). Various authors have reported growth rates. For example, Boddeke *et al.* (1986) reported growth from a ripe egg to 54 mm adult length in 4 months but then growth slows, possibly due to the onset of maturity and the diversion of energy to gamete production, and growth from 54-68 mm takes a further 2 months. Juvenile *Crangon crangon* using tidal flats in the Wadden Sea as a nursery area have very rapid growth, reaching 25 mm in their first month (Beukema, 1992).

Feeding

Crangon crangon will consume just about any animal material including polychaetes, fish, molluscs and small arthropods (Dolmer *et al*., 2001; Henderson & Holmes, 1987; Kamermans & Huitema, 1994; Oh *et al*., 1999) but will also consume algae especially *Ulva lactuca* and *Ulva intestinalis* (Oh *et al*., 2001). In the Irish Sea, the mysid shrimp *Schistomysis spiritus* and amphipods (*Gammarus* sp.) made up 26-63% and 11-42% of gut contents respectively (Oh *et al*., 2001).

Predation

Crangon crangon is consumed by seabirds especially gulls (*Larus* sp.), terns (*Sterna* sp.) (Walter & Becker, 1997), and redshank *Tringa tortanus* (Holthuijzen, 1979) and *Tringa erythropus* (Goss-Custard *et al*., 1977). *Crangon crangon* is an important food source for gadoids and pleuronectids, pogge *Agonus cataphractus*, gurnards, sea snails *Liparis liparis* (ICES, 1996), gobies *Pomatoschistus microps* and juvenile bass *Dicentrarchus labrax* (Cattrijsse *et al*., 1997).

Habitat preferences

Physiographic preferences	Open coast, Offshore seabed, Strait / sound, Sea loch / Sea lough, Ria / Voe, Estuary, Isolated saline water (Lagoon), Enclosed coast / Embayment
Biological zone preferences	Circalittoral offshore, Lower circalittoral, Lower eulittoral, Lower infralittoral, Mid eulittoral, Sublittoral fringe, Upper circalittoral, Upper infralittoral
Substratum / habitat preferences	Fine clean sand, Mud, Muddy sand, Sandy mud
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Weak < 1 knot (<0.5 m/sec.)
Wave exposure preferences	Exposed, Extremely sheltered, Moderately exposed, Sheltered, Ultra sheltered, Very exposed, Very sheltered
Salinity preferences	Full (30-40 psu), Low (<18 psu), Reduced (18-30 psu), Variable (18-40 psu)
Depth range	Intertidal to 150 metres
Other preferences	No text entered

Migration Pattern

Habitat Information

Six distinct populations of *Crangon crangon* have been identified around the English and Welsh coasts.

- Northern North Sea from Spurn Head northwards.
- Southern North Sea from Spurn Head to Dungeness including the Dutch and Belgian coasts.
- English Channel from Dungeness West to Start Point and the north coast of France.
- South West Britain, the Atlantic coast of Devon, Cornwall and Wales to the northern areas of Cardigan Bay.
- A Bristol Channel population that has its eastern limit between Nash Point and Porlock Bay.
- Irish Sea north from northern areas of Cardigan Bay.

All populations are kept distinct by fronts of water masses preventing larval mixing (Henderson *et al*., 1990).

Life history

Adult characteristics

Reproductive type	See additional information
Reproductive frequency	Biannual protracted
Fecundity (number of eggs)	1,000-10,000
Generation time	<1 year
Age at maturity	Less than 1 year
Season	Not relevant
Life span	2-5 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Planktotrophic
Duration of larval stage	1-6 months
Larval dispersal potential	Greater than 10 km
Larval settlement period	Insufficient information

Life history information

There is some disagreement in the literature concerning the reproductive type of *Crangon crangon*. Boddeke (1989) proposed that *Crangon crangon* was a protandrous hermaphrodite with mature males 30-55 mm long and females >44 mm long. Males mate once and then change into to females, taking 2 months to do so. Other authors, e.g. Lloyd & Yonge (1947), stated that *Crangon crangon* was gonochoric but males were smaller and had a shorter lifespan than females. It was reported from the Solway Firth that the abundance of males varied between 6 and 82% of the adult population over the course of a year (Abbott & Perkins, 1977). This could be due to differential mortality of males and females or due to males changing sex.

Similar to lobsters and crabs, female *Crangon crangon* carry their eggs glued to the abdominal appendages (the pleopods) for a period of 4-13 weeks, depending on temperature (Boddeke, 1989). Egg-bearing (berried) females can be found for 46 weeks of the year but there are two peaks in numbers of berried females in the southern North Sea (Boddeke, 1989) and one in the Irish Sea (Oh *et al*., 1999).

Peak reproductive periods occur between April and September, when females carry up to 4,500 small 'summer' eggs approximately 370 μm across. The number of berried females decreases sharply in September but then increases again in October/November as females produce up to 2,800 larger 'winter' eggs approximately 430 μm across (Boddeke, 1982; 1989).

Onset of maturity may be temperature dependent. Maturity was reported to occur in the second year of life in the Solway Firth (Abbott & Perkins, 1977). Maturity probably occurs in the first year of life in southerly areas (Gelin *et al*., 2000; ICES, 2001) considering that mature males are >30 mm in length and mature females >44 mm in length (Boddeke, 1989) and that growth can be from ripe egg to 54 mm body length in the first 4 months (Boddeke *et al*., 1986), and up to 25 mm in the first month (Beukema, 1992).

Male *Crangon crangon* do not have copulatory organs. Instead, packets of sperm (spermatophores) are deposited adjacent to the genital openings of the female (Lloyd & Yonge, 1947). Copulation and spawning occur within 48 hours of mating (Abbott & Perkins, 1977), and egg extrusion takes between 4 and 8 minutes. The eggs are attached to the pleopods after copulation with secretions from a cement gland, which takes a further 30 minutes (Lloyd & Yonge, 1947).

The larvae that hatch from summer eggs are 2.14 mm long, while those from winter eggs are larger at 2.44 mm in length (Boddeke, 1982), presumably to improve survivorship at a time of year when planktonic productivity is low.

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	High	Very high	Low	Low

Crangon crangon is found on sandy and muddy ground, showing a preference for grain sizes between 125 and 710 µm (Pinn & Ansell, 1993). *Crangon crangon* buries itself to ambush prey and to avoid predation (Pinn & Ansell, 1993). It feeds mainly on benthic infauna and 0-group flatfish and if the substratum was removed, most of the *Crangon crangon* would be removed with it. Those individuals that escaped would have greatly increased predation from demersal fish e.g. gadoids and would have greatly decreased foraging success and mortality would probably be high. *Crangon crangon* needs areas with fine silt bottoms as nursery grounds for juveniles and land reclamation in the Wadden Sea has been stated as a threat to recruitment (Boddeke, 1982). Therefore, an intolerance of high and a recoverability of very high have been recorded.

Smothering	Intermediate	Very high	Low	Low

The effect of smothering on *Crangon crangon* is probably dependent on the nature of the deposited material. *Crangon crangon* is a very motile organism and therefore should be able to avoid burial but will probably be adversely affected if the deposited material is anything other than sand or mud as it will not be able to forage or escape predation by burying. *Crangon crangon* needs areas with fine silt bottoms as nursery grounds for juveniles and land reclamation in the Wadden Sea has been stated as a threat to recruitment (Boddeke, 1982). To account for a worst-case scenario an intolerance of intermediate has been recorded. A recoverability of very high has been recorded

Increase in suspended sediment	Tolerant	Not relevant	Not sensitive	Moderate

Crangon crangon inhabits areas with extremely high quantities of suspended sediment (Addison *et al*., 2003; Lloyd & Yonge, 1947) and, therefore, is likely to be tolerant of an increase in suspended sediment.

Decrease in suspended sediment	Tolerant	Not relevant	Not sensitive	Moderate

Crangon crangon is found in very clear and very turbid waters (Addison *et al*., 2003) and is likely to be tolerant of a decrease in suspended sediment.

Dessication	High	Very high	Low	Low

Despite the fact that *Crangon crangon* is found intertidally, it is not adapted for exposure to air, instead seeking refuge in intertidal pools at low tide. Adults are mostly subtidal but juveniles move into intertidal areas with the flood tide to feed and are carried back out to sea on the ebb (Cattrijsse *et al*., 1997; Lloyd & Yonge, 1947). An intolerance of high has been recorded to account for any individuals that may become stranded, which will probably die from water loss very quickly. For recoverability see below.

Increase in emergence regime	Not relevant	Not relevant	Not relevant	Not relevant

Crangon crangon is rarely stranded on sand exposed to the air, burying into the sand just below the low water mark. It has endogenous circatidal rhythms of activity and shows peak emergence around high tide so that it is carried upshore no further than mean tide level to forage and is carried back downshore on the ebb tide (Al-Adhub & Naylor, 1975). Activity is suppressed by light (Addison *et al.*, 2003; Al-Adhub & Naylor, 1975) so a change in emergence regime would not affect timing of emergence during the day when *Crangon crangon* is most vulnerable to predation. *Crangon crangon* does occur in the intertidal but due to the reasons stated above is not subject to emersion and not relevant has been recorded.

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Increase in water flow rate Low Immediate Not sensitive Moderate

Crangon crangon has a preference for strong tidal currents (Henderson *et al.*, 1990) but is less common where current speeds exceed 1.5 knots (Hostens, 2000) even though these speeds probably do not displace standing or walking individuals (Huddart & Arthur, 1971). An increase in the water flow rate at the benchmark level would probably lead to a population of *Crangon crangon* being swept away by the flow. However, since *Crangon crangon* uses tidal currents to make annual migrations (Boddeke, 1975) and can move more than 12 km in a week (Huddart & Arthur, 1971) there probably would not be any mortality as a result but some perturbation, and an intolerance of low has been recorded.

Decrease in water flow rate Tolerant Not relevant Not sensitive Moderate

Crangon crangon relies on currents to move up and down sandy shores for foraging (Al-Adhub & Naylor, 1975) and to perform seasonal migrations (Boddeke, 1975) but also occurs in lagoons (Gelin *et al.*, 2000) with negligible water flow. Therefore *Crangon crangon* is unlikely to be affected by a decrease in water flow rate at the benchmark level and tolerant has been recorded.

Increase in temperature Tolerant Not relevant Not sensitive High

Crangon crangon can survive 6-30°C (Abbott & Perkins, 1977; Jeffery & Revill, 2002; Lloyd & Yonge, 1947) and is likely to be tolerant of an increase in temperature at the benchmark level. However, elevated temperatures (20°C +) may cause increased vulnerability to synthetic chemicals (Drewa, 1988; McLeese & Metcalf, 1979), oxygen depletion (Hagerman & Szaniawska, 1986; Sedgwick, 1981), organic enrichment (Costello *et al.*, 1993) and hydrocarbons (Palgan *et al.*, 1988). (see chemical factors below).

Decrease in temperature Tolerant Not relevant Not sensitive High

Crangon crangon can survive 6-30°C (Abbott & Perkins, 1977; Jeffery & Revill, 2002; Lloyd & Yonge, 1947) and is likely to be tolerant of a decrease in temperature at the benchmark level, especially as the populations migrate offshore in winter (Boddeke, 1989; Henderson & Holmes, 1987). However, sublethal effects of decreased temperature include less frequent moulting and a decreased ability to escape from e.g. trawls (Jeffery & Revill, 2002). After ice winters in the Wadden Sea, *Crangon crangon* abundances are very high as its main predators are excluded by the low temperatures (ICES, 1996). *Crangon crangon* does not seem to be affected by a decrease in temperature and in some cases can benefit and tolerant has been recorded.

Increase in turbidity Tolerant* Not relevant Not sensitive* Moderate

Crangon crangon is found in areas of extremely high turbidity (Addison *et al*., 2003; Lloyd & Yonge, 1947). In clear water in The Wash, *Crangon crangon* is only active at night to avoid predation (Addison *et al*., 2003) but in the very turbid waters of the Bristol Channel, *Crangon crangon* is active day and night (Lloyd & Yonge, 1947). Therefore an increase in turbidity is likely to be of benefit to *Crangon crangon* by increasing foraging time and tolerant* has been recorded.

Decrease in turbidity Tolerant Not relevant Not sensitive Moderate

Crangon crangon occurs in varying turbidity from clear water to extremely high turbidity (Addison *et al*., 2003) and therefore is likely to be tolerant of a decrease in turbidity.

Increase in wave exposure Tolerant Not relevant Not sensitive Moderate

Densities of *Crangon crangon* reached 394 per 100m on the Belgian coast and seemed to be unaffected by wind speed and wave height (Beyst *et al*., 2001). Therefore tolerant has been recorded.

Decrease in wave exposure Tolerant Not relevant Not sensitive Moderate

Crangon crangon occurs in lagoons (Gelin *et al*., 2000) and estuaries where wave exposures are very low. Therefore a decrease in wave exposure is unlikely to adversely affect the population and tolerant has been recorded.

Noise Tolerant Not relevant Not sensitive Low

Crangon crangon has highly sensitive antennae and is probably able to detect vibrations in the water. However, at the benchmark level the limit of response to noise is probably that *Crangon crangon* will bury itself for a short time but suffer no other perturbation and tolerant has been recorded.

Visual Presence Low Immediate Not sensitive Low

Crangon crangon has compound eyes and probably has good visual acuity. The presence of large, unnatural objects is likely to cause them to remain inactive as a predator avoidance response and although mortality is unlikely, it may affect population dynamics especially if the disturbance occurs during the main summer breeding season. Emergence behaviour of *Crangon crangon* is controlled by light, with most activity occurring at night (Addison *et al*., 2003; Al-Adhub & Naylor, 1975). Therefore, the presence of lights due to human activity will impact on the rhythmical behaviour of *Crangon crangon* and probably reduce its foraging success. Neither of the scenarios described above are likely to cause mortality but will probably reduce the viability of the population and an intolerance of low has been recorded.

Abrasion & physical disturbance Low Very high Very Low High

Crangon crangon suffers exoskeleton damage when it is trawled or dredged. Such damage allows infection of the exoskeleton by chitin digesting bacteria that cause black spot disease (Nottage, 1982). Although mortality from black spot disease is very low (Dyrynda, 1998; Nottage, 1982) prey perception and motility might be affected and therefore an intolerance of low has been recorded.

Displacement Tolerant Not relevant Not sensitive High

Lancaster & Frid (2002) reported that 99% of undersized shrimp discarded from a trawl catch are alive when returned to the sea and that 92% were alive 24 hours later. Most of the mortality resulted from seabirds consuming discards before they could swim down out of reach. *Crangon crangon* uses tidal currents to make annual migrations (Boddeke, 1975) and can move more than 12 km in a week (Huddart & Arthur, 1971). Therefore, if a *Crangon crangon* population was displaced by less traumatic means than trawling and release, it is unlikely that they would be significantly perturbed and tolerant has been recorded.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	Intermediate	Very high	Low	High

In the 1980s the amount of detergents polluting water bodies increased, reaching extremes of 40 mg/l but more commonly around 5 mg/l. A 5 mg/l concentration of the surfactant alkylobenzene sulphonate (ABS) caused 100% mortality of *Crangon crangon* in 18 days at 15°C and in 15 days at 20°C in normoxic conditions (8.6-9.3 mg O_2 l). Hypoxia (4.4-5.3 mg O_2 l) increased surfactant toxicity and halved the time taken to reach total mortality (Drewa, 1988). ABS caused vacuolization of hepatopancreas cells (presumably as an attempt to detoxify the chemical) and a total cessation of cell proliferation at 5 mg/l (Zbytniewski & Drewa, 1988). Even if *Crangon crangon* was not exposed to ABS for long enough to cause mortality, it probably suffers serious physiological effects.

Ivermectin is used in fish farms to treat salmon for fish lice. In solution, it had no effect on *Crangon septemspinosa*, a North American relative of *Crangon crangon*, but when presented in fish food (used to treat salmon prophylactically), Ivermectin caused 50% mortality in 96 hours at only 8.5 µg ivermectin per g of fish food (Burridge & Haya, 1993). *Crangon crangon* beneath fish cages are likely to suffer high mortality if they feed upon waste food impregnated with Ivermectin.

Some polychlorobiphenyls (PCBs) are toxic to *Crangon crangon* but only at concentrations far higher than normally found in the sea. PCB15 caused 50% mortality at 500 µg/l but concentrations of PCB in nature are rarely higher than 1.7 µg/l (general levels for the North Sea are 5 ng/l) and only 9% of PCB in nature is PCB15 (Smith & Johnston, 1992). Therefore *Crangon crangon* is unlikely to be killed directly by PCBs, however, a concentration of 0.5 µg/l of PCB15 caused an approximately 40% drop in haemocyte numbers making *Crangon crangon* more susceptible to bacterial infection (Smith & Johnston, 1992).

Modern oil dispersants are less toxic than those used for e.g. the *Torrey Canyon* oil spill but they are not without their effects. The dispersant 'SOLO' caused a 50% reduction in arylsulphatase activity, which is the enzyme responsible for post-moult exoskeleton hardening (Drewa *et al*., 1978). The dispersants Tween 80, BP1100X and Slickgone LT2 did not cause mortality at a concentration of 10 ppm but decreased food consumption and ability to detect food by *Crangon crangon*. The exposed *Crangon crangon* recovered their appetite after 4 hours in clean seawater (Evans *et al*., 1977).

Creosote is lethal to *Crangon crangon* at 0.13 mg/l at 10°C and at 0.11 mg/l at 20°C (McLeese & Metcalfe, 1979). Abele-Oeschger *et al.* (1997) reported a 26% reduction in aerobic metabolic rate in 0.68 mg/l of hydrogen peroxide but did not report a lethal concentration.

Crangon crangon has been shown to be intolerant of a wide variety of synthetic chemicals at varying concentrations but long time periods or high concentrations are needed to cause 100% mortality and intermediate has been recorded to represent the conditions that *Crangon crangon* is likely to be subject to in nature. *Crangon crangon* is also very sensitive to sulphide pollution (see oxygenation below).

Heavy metal contamination	Intermediate	Very high	Low	High

- Andersen *et al*, (1984) measured metal concentrations in wild *Crangon crangon* from the Seine Bay estuary and found 5.25 mg mercury, 2.35 mg cadmium, 121.5 mg copper, 316 mg zinc and 247 mg iron per kg dry weight of tissue.
- In the Bristol Channel, cadmium, zinc and copper were found at levels of 1.4-15.4, 29-136 and 76-107 mg per kg dry weight respectively (Culshaw *et al.*, 2002).
- Price (1979) investigated the toxicity of metals in solution and found that toxicity was temperature dependent with higher temperatures increasing toxicity. In 96 hour exposures, copper caused 50% mortality at 21 mg/l at 5°C, 9.5 mg/l at 10°C, 6 mg/l at 15°C and 4.5 mg/l at 20°C. Zinc is much less toxic to *Crangon crangon* and caused 50% mortality at 56, 19, 12 and 10 mg/l at 5, 10, 15 and 20°C respectively. Cadmium was the most toxic of the metals tested by Price (1979) and caused 50% mortality at 2.54, 0.65, 0.4 and 0.3 mg/l at 5, 10, 15 and 20°C respectively.
- *Crangon crangon* exposed to very low concentrations of metals, 0.005 mg/l cadmium, 0.75 mg/l copper and 5.5 mg/l zinc, for 42 days suffered 40-60% mortality at 5-20°C (Price, 1979).
- *Crangon crangon* is tolerant of arsenate, which becomes toxic at 25 mg/l but takes over 7 days to cause 50% mortality at 50 mg/l in small *Crangon crangon* and more than 14 days in larger specimens (Madsen, 1992). *Crangon crangon* did not accumulate arsenic from seawater but it was rapidly accumulated from food, especially organic forms such as arsenobetaine, which reached levels 40 times those of control animals in a 16 day exposure (Hunter *et al.*, 1998).

Several authors have reported sublethal effects of heavy metals.

- Johnson (1988) reported a reduction in osmoregulatory ability at 25% oxygen saturation and 0.25 mg/l of copper or zinc.
- A reduction in osmoregulatory ability at 0.5 mg/l zinc was reported by Rasmussen *et al.* (1995).
- Copper, cadmium and zinc at around 1 mg/l caused increased heart beat and gill ventilation but an escape response (emergence from the sediment and rapid tail flicking) was not observed until a metal concentration of 20 mg/l (Price & Uglow, 1980).
- Very low concentrations of cadmium damaged mitochondria and inhibited the transportation of salts, enzyme activity and protein synthesis in the gill epithelium (Papathanassiou, 1985).
- *Crangon crangon* is a strong bioaccumulator of cadmium and does not have an efficient method of excretion (Culshaw *et al.*, 2002).

High levels of metal pollution cause significant mortalities of *Crangon crangon* and an intolerance of intermediate has been recorded. As important, however, is the fact that *Crangon crangon* accumulates high levels of toxic metals that will be concentrated by consumers, including humans.

Hydrocarbon contamination	High	Very high	Low	High

Crangon crangon exposed to light diesel fuel oil, heavy fuel oil and crude oil were found to be most susceptible to light diesel fuel oil. In brackish (7 psu) water at 20°C, light diesel fuel oil caused 50% mortality in 96 hours at 10 ppm, heavy fuel oil had the same effect at 20 ppm and crude at 25 ppm. Long term exposures to 5 ppm of all 3 oil types at 15°C caused total mortality in 9 days (Palgan *et al.*, 1988). After the *Sea Empress* oil spill, *Crangon crangon* 3 km from the wreck were found to be lethargic and failed to exhibit a normal escape response (Rutt *et al*., 1998). Different hydrocarbons have different toxicities in short exposures but all are very toxic if *Crangon crangon* is exposed for many days. Therefore an intolerance of high has been recorded.

Radionuclide contamination Not relevant Not relevant

Crangon crangon accumulates ^{60}cobalt and ^{65}zinc from liquid radioactive waste but most is lost at ecdysis as they are concentrated in the exoskeleton (van Weers, 1975). No information on the toxicity of radionuclides has been found and there is insufficient information to assess an intolerance.

Changes in nutrient levels Intermediate Very high Low Moderate

Phospho-gypsum, a by-product of the fertilizer industry, caused total mortality of *Crangon crangon* in 24 hours in a 1% solution. Long term exposures in 0.25% and 0.5% phospho-gypsum caused less mortality but reduced haemolymph protein with consequences for oxygen transport and immunity (Zbytniewski & Pautsch, 1973).
Adult *Crangon crangon* exposed to 1% sewage sludge in seawater at 10°C for 96 hours suffered 50% mortality. Sediments consisting of more than 6% sewage sludge were avoided by *Crangon crangon* but they would bury in sediments containing 1.6% sewage sludge (Costello *et al*., 1993).
However, nutrient inputs can be of benefit to *Crangon crangon*. In the Wadden Sea, phosphate enrichment from riverine industrial inputs was cut by a factor of 3 between 1981 and 1991. This caused a decrease in primary and secondary (calanoid copepod) production and a drop in *Crangon crangon* abundance from 4,000-6,000/1000m to <2000/1000m (Boddeke, 1996) showing that the enrichment was of benefit to *Crangon crangon*.
The sandy bottoms of the North Sea have a poor infauna and in these areas the main recruitment of *Crangon crangon* in May-July coincides with the calanoid copepod bloom, which is an important food source for 10-20 mm *Crangon crangon*. In the Hook of Holland, where nitrogen in seawater (as nitrate and ammonium) increased 5-fold from 1945-75, recruitment of *Crangon crangon* occurred April-October since the eutrophication generated a rich benthic infauna for small post-settlement *Crangon crangon* to exploit (Boddeke *et al*., 1986). Mortality from nutrient enrichment is likely to be very localized at point sources and have little impact on *Crangon crangon* populations whereas widespread dilute inputs are likely to be of benefit but intermediate has been recorded to account for the worst case scenario.

Increase in salinity Tolerant Not relevant Not sensitive High

Crangon crangon can tolerate salinities of 7-40 psu and can survive extremes if previously acclimated to the high or low end of its tolerance. For example, individuals acclimated to 40 psu survived 50 psu for 38 hours in comparison 16 hours by those previously acclimated to 7 psu (McLusky *et al*., 1982). Therefore tolerant has been recorded.

Decrease in salinity Low Very high Very Low High

Crangon crangon can tolerate salinities of 7-40 psu (Mclusky *et al*., 1982) and can survive fresh water for up to 8 hours (Lloyd & Yonge, 1947). Nevertheless, prolonged decreases in salinity are not without their effects and *Crangon crangon* migrate offshore in winter to avoid low salinities (Henderson & Holmes, 1987). At 25 psu female *Crangon crangon* become berried as normal but at 15 psu egg attachment to the abdominal appendages (pleoplods) is delayed and there is a complete failure of spawning at 5 psu (Gelin *et al*., 2001). Decreased salinity also increases the susceptibility of *Crangon crangon* to hypoxia (Johnson, 1988; Sedgwick, 1981). Low salinity is unlikely to cause mortality of adult *Crangon crangon* but may affect the viability of a population and an intolerance of low has been recorded.

Changes in oxygenation Low Very high High

Crangon crangon can maintain its use of oxygen independent of dissolved oxygen down to 2 mg/l and does not commence anaerobic respiration until 0.9 mg/l (Hagerman & Szaniawska, 1989). Sedgwick (1981) reported 99% survival at 27 psu and 20°C in 1.7 mg O_2/l and 99% mortality at 0.9 mg O_2/l. However, hypoxia tolerance in *Crangon crangon* is temperature and salinity dependent. At 20°C, buried *Crangon crangon* emerge from the sand at 4-5 mg O_2/l but remain buried until 2 mg O_2/l at 9°C (Hagerman & Szaniawska, 1986). Tolerance to very low oxygen is salinity dependent. An oxygen concentration of 1 mg O_2/l at 10 psu incurred 50% mortality in 4.5 hours but at 20 psu 50% mortality occurred after 6 hours. Very low mortalities occurred at either salinity at 2 mg O_2/l (Hagerman & Szaniawska, 1986). At the benchmark level, *Crangon crangon* is unlikely to suffer mortality from prolonged hypoxia but there are physiological perturbations and low has been recorded. Despite a high tolerance to hypoxia, *Crangon crangon* is surprisingly intolerant of anoxia when it is considered that it shares a habitat with organisms such as the green shore crab *Carcinus maenas* which can tolerate anoxia for up to 18 hours. In anoxic conditions at 30 psu and 18°C 50% mortality occurred in 2.5 hours. In combination with 17 µg sulphide (H_2S)/l, anoxia caused 75% mortality in 1.5 hours (Hagerman & Vismann, 1995). *Crangon crangon* is intolerant of H_2S in the presence of oxygen. At 3.4 µg/l it emerged from the sand and began to swim, at 6.8 µg/l panic ensued and rapid tail flicking was exhibited in an attempt to escape the pollution. At 13.6 µg/l H_2S, *Crangon crangon* is paralysed (Vismann, 1996).

Biological Pressures

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

Black spot shell disease, caused by chitin digesting bacteria, is common in *Crangon crangon* with an incidence of 13% in the Solway Firth (Nottage, 1982), up to 87% in Poole Harbour (Dyrynda, 1998) and 58% in the Elbe and Weser estuaries (Knust, 1990). Incidence increases with age: only 4.4% of 25 mm *Crangon crangon* were infected but 34.6% of 60 mm were infected (Knust, 1990). High incidences of black spot disease are believed to be related to damage by fishing gear and pollution, especially heavy metals (Knust, 1990; Nottage, 1982). Infected *Crangon crangon* have black lesions on the limbs, scaphocerites and antennae that make the exoskeleton very brittle leading to breakages. Mortality due to black spot disease is very low but infected individuals may have reduced prey perception and motility (Dyrynda, 1998) and an intolerance of low has been recorded.

Introduction of non-native species Not relevant

No information was found on the effects of non-native species on *Crangon crangon*.

Extraction of this species Intermediate Very high Low High

There are important fisheries for *Crangon crangon* around the British Isles (Addison et al., 2003; Henderson *et al*., 1990; Lancaster & Frid, 2002; Lloyd & Yonge, 1947) and on the coasts of the Netherlands, Germany and Belgium (Boddeke, 1989) with landings reaching a peak in 1997 at nearly 29,000 t (ICES, 2001). The high fecundity, prolonged breeding, rapid growth and maturity of *Crangon crangon* has meant that stocks have barely been affected (ICES, 2001). *Crangon crangon* are marketable when the carapace length is 9 mm or more (Lancaster & Frid, 2002) and fishing mortality amongst this population is high and an intolerance of intermediate has been recorded to account for this. Since most of the *Crangon crangon* that reproduce and contribute to the commercial catch are less than 1 year old (ICES, 2001), the turnover and hence recoverability is rapid.

Extraction of other species	Tolerant*	Not relevant	Not sensitive*	High

Crangon crangon densities increased in the tracks of blue mussel dredges for 7 days after dredging. This was presumed to be due to the dredge exposing large numbers of polychaetes upon which the *Crangon crangon* were feeding (Dolmer *et al*., 2001). Therefore tolerant* has been recorded.

Additional information

Recoverability

Crangon crangon is a common food item for a wide range of species including crustacea, fish, birds and mammals and therefore is pre-adapted to constant high mortality. Fishing mortality in the North Sea is estimated at 6.5-11.5% but natural mortality could be 3 times as much (Boddeke, 1982). *Crangon crangon* has rapid growth, early maturity, high fecundity and a prolonged reproductive season, all of which allow populations to recover from mass mortalities very quickly. Boddeke (1989) reported 12-fold population increase in 7 months. When the Wadden Sea was invaded by a huge shoal of juvenile whiting *Merlangius merlangus* in 1990, the *Crangon crangon* population was virtually wiped out but recovery was complete within a year (Berghahn, 1996).

Importance review

Policy/legislation

- no data -

Status

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

Non-native

Native	-		
Origin	-	**Date Arrived**	-

Importance information

Crangon crangon has been fished for human consumption for a very long time. There is reference in the Doomsday Book to a brown shrimp fishery in the Severn Estuary (Lloyd & Yonge, 1947). *Crangon crangon* is fished in the Severn Estuary by putts, essentially fixed net funnels that catch the shrimps as they are carried up the estuary on the flood tide (Lloyd & Yonge, 1947). Since the 1950s there has been a burgeoning trawl fishery for *Crangon crangon* in the southern North Sea (ICES, 1996). *Crangon crangon* landings were 5,000 t for all of Europe in 1950 (ICES, 1996) and peaked in 1997 at nearly 29,000 t and a value of ▯80 million (ICES, 2001). In the southern North Sea, the *Crangon crangon* fishery is the 4th most valuable (Addison *et al*., 2003). In Britain, there are fisheries for *Crangon crangon* in The Wash with landings reaching 1,600 t worth £2.5 million in 2001 (Addison *et al*., 2003). *Crangon crangon* is also fished in Morecambe Bay (Henderson *et al*., 1990), the Solway Firth (Lancaster & Frid, 2002) and in the Bristol Channel (Lloyd & Yonge, 1947). *Crangon crangon* is generally caught in a beam trawl and approximately half of those caught are below marketable size. The shrimps are sorted on deck by a riddle so that 89% of the undersized *Crangon crangon* are returned to the sea alive, with some subsequent predation by seabirds on the surface. The 11% of undersized shrimps not successfully sorted by the riddle are cooked on deck with the marketable catch. It is estimated that there is a 20-23% mortality of undersized *Crangon crangon* entering a beam trawl (Lancaster & Frid, 2002).

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