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

Common starfish (*Asterias rubens*)

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

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Common starfish *Asterias rubens*. A damaged small individual regrowing its arms is in the foreground.
Photographer: Sue Scott
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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	Georgina Budd	**Refereed by**	Prof. David Nichols
Authority	Linnaeus, 1758		
Other common names	-	**Synonyms**	-

Summary

Description

Asterias rubens is the most common and familiar starfish in the north-east Atlantic region. *Asterias rubens* may grow up to 52 cm in diameter, but commonly 10-30 cm. *Asterias rubens* is variable in colour, though usually orange, pale brown or violet. Deep-water specimens are pale. It has five tapering arms, broad at the base that are often slightly turned up at the tip when active.

Recorded distribution in Britain and Ireland

Found on all British and Irish coasts, especially amongst beds of mussels and barnacles.

Global distribution

Abundant throughout the north-east Atlantic, from Arctic Norway, along Atlantic coasts to Senegal, and only found occasionally in the Mediterranean (Mortensen, 1927)

Habitat

Asterias rubens occurs in varying abundance upon a variety of substrata that include coarse and shelly gravel and rock. Reported abundances vary between 2-31 *Asterias rubens* per m^2 on fine sand and 324-809 specimens on algal carpets (Anger *et al.*, 1977).

Depth range

Intertidal to depths of 650 m.

Identifying features

- Disc small, five arms (rarely 4-8).
- Body wall very flexible with numerous groups of papulae in soft areas.
- Major spines on the upper surface often in one or more longitudinal rows, sometimes surrounded by bundles of straight and crossed pedicellariae.
- Ventro-lateral spines just outside adambulacrals, in oblique rows.
- Straight pedicellariae on lower surface in ambulacral grooves and attached to furrow spines.

Additional information

- *Asterias rubens* is considered to be conspecific with *Asterias vulgaris* from the eastern seaboard of the United States of America and Canada (Coe, 1912).
- The size of *Asterias rubens* varies markedly with food availability and hence size is not necessarily a good indicator of age.

Listed by

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Biology review

Taxonomy

Phylum	Echinodermata	Starfish, brittlestars, sea urchins & sea cucumbers
Class	Asteroidea	Starfish
Order	Forcipulatida	
Family	Asteriidae	
Genus	Asterias	
Authority	Linnaeus, 1758	
Recent Synonyms	-	

Biology

Typical abundance	Low density
Male size range	(Diameter) 10-50cm
Male size at maturity	(Diameter) 50mm
Female size range	(Diameter) 50mm
Female size at maturity	
Growth form	Radial
Growth rate	0.2-1cm/month
Body flexibility	High (greater than 45 degrees)
Mobility	
Characteristic feeding method	
Diet/food source	
Typically feeds on	Bivalves, polychaetes, small crustaceans, other echinoderms and carrion.
Sociability	
Environmental position	Epibenthic
Dependency	Independent.
Supports	Host The caprellid amphipod *Pariambus typicus*, which is often found attached to the spines and a semiparasitic copepod *Scottomyzon gibbosum*. The male gonads may be parasitised by the ciliate *Orchitophrya stellarum*.
Is the species harmful?	No

Biology information

Growth rate

There is considerable irregularity in the growth rate of starfish, especially during their first year.

1. Vevers (1949) observed that with an abundant food supply, juvenile specimens of *Asterias rubens* could increase their radius at a monthly rate of slightly more than 10 mm in summer and autumn, and slightly less than 5 mm per month in winter.
2. Orton & Frazer (1930) recorded an increase in diameter of 2.5 mm per month on average,

and 5.0 mm per month maximum in *Asterias rubens*.

3. Nichols & Barker (1984 b) followed the growth of annual cohorts in a population of *Asterias rubens* on an intertidal reef in Torbay, South Devon, UK, for three years. Growth was most rapid in the year following settlement and during the warmer months of the year. The average increase in starfish diameter over the first year was 28.5 mm, and over the second, 13.0 mm. The mean monthly increase in diameter over the three year period of the study was 2.2 mm. Starfish on the reef became sexually mature in their second year after attaining a diameter of 5 cm.

Under conditions of poor food supply the growth of *Asterias rubens* is limited and specimens may decline in size (Hancock, 1958). Vevers (1949) reported a specimen of *Asterias rubens* shrinking in radius from 6 cm to 3.8 cm after starvation for 5 months.
Thus the plasticity of the growth rate of *Asterias rubens* causes difficulties when studying the population dynamics of this species, especially as individuals cannot be aged by inspection of growth rings in any skeletal component of the body (Barker & Nichols, 1983).

Feeding
Asterias rubens preys upon a wide range of living organisms and carrion that include molluscs, polychaete worms and other echinoderms. Occasionally, small crustaceans are caught on the suction discs of the tube feet. *Asterias rubens* preys upon bivalve molluscs by forcing the bivalve's shell open with its tube-feet, the tips of which attach to the bivalve shell by suction. Once a tiny gap (<0.1 mm) is established between the valves of the prey species shell, the starfish everts its stomach lobes into the bivalve and commences digestion.

Detailed experimental studies (Castilla & Crisp, 1970, 1973; Castilla,1972) have established that *Asterias rubens* has a well developed olfactory sense with adaptive preferences and avoidances. *Asterias rubens* demonstrates positive rheotaxis (purposeful movement of a motile organism in to a water current), which is enhanced in the presence of living prey such as *Mytilus edulis* (Castilla, 1972) and reversed in the presence of a predator *Crossaster papposus* (Castilla, 1972b).

Other species of the benthic fauna, including prey species *Marthasterias glacialis*, *Buccinum undatum*and several species of ophiuroids, demonstrate avoidance reactions in the presence of the predatory starfish *Asterias rubens* (Feder & Arvidssen 1967; Russell, 1984). These species can detect *Asterias rubens* owing to the release of a surface-active saponin from its body surface (Mackie *et al.* 1968).

Habitat preferences

Physiographic preferences	Open coast, Offshore seabed, Strait / sound, Enclosed coast / Embayment
Biological zone preferences	Circalittoral offshore, Lower circalittoral, Lower eulittoral, Lower infralittoral, Sublittoral fringe, Upper circalittoral, Upper infralittoral
Substratum / habitat preferences	Bedrock, Coarse clean sand, Gravel / shingle
Tidal strength preferences	Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Strong 3 to 6 knots (1.5-3 m/sec.)
Wave exposure preferences	Exposed, Moderately exposed, Sheltered, Very sheltered
Salinity preferences	Full (30-40 psu), Variable (18-40 psu)
Depth range	Intertidal to depths of 650 m.

Other preferences	No text entered
Migration Pattern	Non-migratory / resident

Habitat Information

Aggregation of starfish
In shallow coastal waters *Asterias rubens* sometimes occurs in dense aggregations of up to 100 specimens per m□ (Table VII, Sloan, 1980). Dare (1982) reported an aggregation of *Asterias rubens* in Morecambe Bay, UK. The aggregation occupied 2.5 ha (1600 x 15 m) at its peak and contained at least 2.4 $\times 10^{6}$ starfish of 6 cm mean arm radius. Feeding concentrations within the aggregation commonly attained 300-400 starfish per m□ representing a wet weight biomass of approximately 12-16 kg m□. It was estimated that the aggregation cleared a zone that contained 3500-4000 tonnes of *Mytilus edulis* within 3 months (June-August).

Factors causing the aggregations of *Asterias rubens* are unclear but suggestions have been made that calm weather, amenable temperature and feeding conditions act together to give rise occasionally to aggregations. The occurrence of the phenomenon is dependent upon a large population of *Asterias rubens* larvae prior to the aggregation, which itself would be a function of good larval recruitment and growth conditions. Thus the irregularity of aggregations of *Asterias rubens* may be due to the need of a complex set of environmental variables to occur in the correct sequence over a number of seasons before an aggregation can occur. In addition, concurrent good mussel recruitment may also be required because an abundant prey source is a necessary focal point for the starfish (Sloan, 1980).

Life history

Adult characteristics

Reproductive type	Gonochoristic (dioecious)
Reproductive frequency	Annual episodic
Fecundity (number of eggs)	>1,000,000
Generation time	1-2 years
Age at maturity	1 year
Season	February - April
Life span	5-10 years

Larval characteristics

Larval/propagule type	-
Larval/juvenile development	Planktotrophic
Duration of larval stage	See additional information
Larval dispersal potential	Greater than 10 km
Larval settlement period	See additional information

Life history information

Longevity
According to Schäfer (1972), the lifespan of *Asterias rubens* is 7-8 years, which is in agreement with interpretation of size frequency histograms for French populations (Guillou, 1983).

Reproduction
Asterias rubens is dioecious. The female produces small eggs that are released into the sea and fertilized externally to develop as planktotrophic larvae. It has been estimated that a female starfish of 140 mm diameter can spawn 2.5 million eggs (Fish & Fish, 1996).
Nutrient reserves in the pyloric caeca are an important source of energy for the process of gametogenesis and therefore food supply in the summer preceding spawning (when nutrients are deposited in the pyloric caeca) is an important factor determining fecundity (Jangoux & van Impe, 1977; Oudejans *et al.*, 1979) (see adult distribution, additional information).
Larval settling time
Asterias rubens undergoes a complicated and protracted metamorphosis in the pelagic zone (see larval general biology). Advanced brachiolaria larvae reach a form when they are ready to settle around 87 days after fertilization, but some specimens have been observed, under laboratory conditions, to remain in the plankton for > 100 days without losing the ability to settle eventually and complete metamorphosis (see larval general biology & distribution) (Barker & Nichols, 1983).
Gonad parasitisation
In free spawning echinoderms the factors affecting larval production and survival ultimately control their reproductive success. Male *Asterias rubens* and *Asterias vulgaris* are liable to gonad parasitisation by the ciliate parasite *Orchitophrya stellarum* (Vevers, 1951; Bouland & Claereboudt, 1994). *Orchitophrya stellarum* causes complete atrophy of the testes leading to castration. The occurrence of the parasite is strictly seasonal and is only found between January and May when the hosts' testes are ripening or ripe. All that remains after the parasitic infection are the thick shrunken sheaths of the original testis tubules (Vevers, 1951). Infected males also show very weak carotenoid pigmentation and a general flabbiness of the body lacking the fresh turgid appearance of a healthy specimen (Nichols & Barker, 1984).
In a parasitized population of *Asterias vulgaris* from Canada, Bouland & Claereboudt (1994) observed a lower abundance of males, which were small in size and had a reduced gonadal index (gonadal mass/body wall mass) in comparison with the females. These observations implied an overall drop in spermatozoa production at the population level, thus parasitism of the male testes has implications for recruitment. In a turbulent flow as found in most benthic habitats, the success of fertilization is limited by the concentration of gametes. With fewer spawning males in the population, the fertilization rate will drop rapidly leading to a virtual sterilisation. The contribution of a parasitised population to the species reproductive effort would be negligible since the same number of planktonic predators and other adverse factors would be acting upon a reduced number of gametes.
A population of *Asterias rubens* on the Outer Grounds of the Eddystone, English Channel, was found to have >20% of males parasitised with *Orchitophrya stellarum* in March 1947. Although the evidence was speculative, a reduction in the population of *Asterias rubens* in the locality was subsequently observed in 1948, 1949 and 1950 as compared to 1947 (Vevers, 1951).

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	High	Moderate	Low

Asterias rubens is benthic and although able to migrate by crawling up to a distance of 150-200 m per month or 5-7 m daily (Dare, 1982), it is not considered sufficiently mobile to avoid the physical removal of the substratum to which it is attached and a high intolerance rank is given. Recoverability, see additional information.

	Intolerance	Recoverability	Sensitivity	Confidence
Smothering	Low	Very high	Very Low	Low

Asterias rubens is a mobile species with a high degree of body flexibility. It may be found upon sandy substrata that can be stirred up by gales e.g. Schäfer (1972) reported the smothering of *Asterias rubens* and *Astropecten irregularis* in the North Sea by sand stirred up by gales. However, the benchmark for this factor is smothering by sediment up to a depth of 5 cm and it is likely that *Asterias rubens* would have little difficulty in crawling out from beneath 5 cm of sediment and an intolerance rank of low is given. However, *Asterias rubens* is likely to have a higher intolerance if smothered by impermeable or viscous material such as oil. Uptake of oxygen is through the tube feet and across the body wall, so smothering by viscous material is likely to cause death by suffocation.

	Intolerance	Recoverability	Sensitivity	Confidence
Increase in suspended sediment	Low	High	Low	Moderate

Asterias rubens appears able to flourish in naturally turbid conditions, such as the north-east coast of England (P.G. Moore, personal observation) and River Crouch (Mistakidis, 1951 in Moore, 1977). Greve & Kinne (1971) noted that *Asterias rubens* would cleanse itself of adhering mud particles by secreting mucus (Moore, 1977). However, Zafiriou *et al.*, (1972) suggested that the behaviour of starfish may be modified by variations in suspended material. They found an apparent lessening in intensity of approach response of *Asterias rubens* to soluble oyster homogenate in turbid water. The disruption of feeding activity has implications for recruitment. Nutrient reserves in the pyloric caeca are an important source of energy for the process of gametogenesis and therefore the acquisition of food in the summer preceding spawning is an important factor in determining fecundity and consequently species viability. In light of this evidence a low intolerance is given.

Decrease in suspended sediment

	Intolerance	Recoverability	Sensitivity	Confidence
Dessication	High	High	Moderate	Low

Asterias rubens has a large surface area : volume ratio and is relatively soft bodied so if stranded and continually exposed to air and sunshine for one hour would be prone to desiccation. Large numbers of dead starfish have been recorded after displacement and stranding upon the shore presumably from desiccation (see wave exposure) However, when migrating inshore to feed *Asterias rubens* seeks the damp underside of substrata which offer a degree of protection from direct sunlight and drying wind.

Increase in emergence regime Tolerant Not relevant Not sensitive Low

Asterias rubens is sufficiently mobile e.g. having the ability to move inshore to feed with the tide and retreating seawards with the tide, to avoid adverse factors such as desiccation, associated with a change in the emergence regime of a coastal area. The food resources of *Asterias rubens* generally extend lower down the shore than the intertidal so the acquisition of food is unlikely to be a problem.

Decrease in emergence regime

Increase in water flow rate Intermediate High Low Low

An increased water flow rate scours the substrata over which it flows and can cause displacement of epibenthic species such as *Asterias rubens*. Thorpe & Spencer (2000) described a mass stranding of *Asterias rubens* on the Isle of Man (see wave exposure) and increased water flow rates would probably be a contributing factor in causing the stranding of this species. Smaller starfish appear to be more prone to displacement during storm conditions (Thorpe & Spencer, 2000) and starfish in shallower coastal waters are likely to experience the highest bottom water velocities so an intermediate intolerance is recorded. Recoverability, see additional information below.

Decrease in water flow rate

Increase in temperature High High Moderate Moderate

The geographic range of *Asterias rubens* illustrates that the species is tolerant of a range of temperatures and probably becomes locally adapted. The following observations of the response of *Asterias rubens* to changes in temperature have been reported:

1. The response of *Asterias rubens* to prolonged exposure to unusually high temperatures is arm shedding (autotomy) then death (Schäfer, 1972).
2. Starfish have also been found dead in isolated rock pools during prolonged emersion in calm hot weather, the suspected cause of death being increased water temperature (references in Lawrence, 1995).
3. Feeding activity of *Asterias rubens* may also be disrupted by temperature changes. Feeding activity of *Asterias rubens* declines during cold winters and hot summers. For instance, Anger *et al.* (1977), described how turbulence within the water column caused destruction of a thermocline and allowed the temperature of the bottom water to increase to 16-18°C causing a decrease in the feeding activity of *Asterias rubens*. The disruption of feeding activity has implications for recruitment. Nutrient reserves in the pyloric caeca are an important source of energy for the process of gametogenesis and therefore the acquisition of food in the summer preceding spawning is an important factor in determining fecundity (Jangoux & Van Impe, 1977; Oudejans *et al.* 1979).

Recoverability, see additional information below.

Decrease in temperature Low High Low Moderate

The geographic range of *Asterias rubens* illustrates that the species is tolerant of a range of temperatures and probably becomes locally adapted.
Asterias rubens was reported to be unaffected by the severe winter of 1962-1963 in Britain when anomalously low temperatures persisted for two months (Crisp, 1964).

Increase in turbidity Low Very high Very Low Low

*Asterias rubens*is likely to have poor visual perception and consequently is probably tolerant of changes in turbidity. *Asterias rubens* is carnivorous and not directly dependent on phytoplankton, which have a requirement for light. However, many of its prey species are e.g. *Mytilus edulis*. Thus an increase in turbidity may consequently reduce the availability and nutritional value of its food resource. Food availability is one of the main factors controlling growth and fecundity in *Asterias rubens* as nutrient reserves stored in the pyloric caeca are drawn upon for gametogenesis (Jangoux & Van Impe, 1977; Oudejans *et al.* 1979). Recovery may be very rapid once food availability increases.

Decrease in turbidity

Increase in wave exposure	Intermediate	High	Low	Moderate

Severe storms produce wave scour that can displace and strand populations of *Asterias rubens*. Storms can generate strong water motion to considerable depths and affect offshore populations (Lawrence, 1995). Thorpe & Spencer (2000) described a mass stranding of *Asterias rubens* upon the northern shore of the Isle of Man. In total between 6000 and 10,000 particularly small (5-10 cm in diameter) starfish were washed up on shore. Very few larger (15-25 cm in diameter) starfish were found. The stranding coincided with a major spring tide (9.3 m at Liverpool) and a period of prolonged north easterly and easterly winds up to Force 5 blowing on to the exposed shore, so that a large swell developed. It is thought that the combination of those factors created turbulence in the shallow inshore area and caused displacement of the smaller starfish; once displaced they were unable to reattach to the substratum and were swept ashore. In light of this evidence it is likely that smaller specimens of *Asterias rubens* will be more intolerant of increased wave exposure than larger specimens at the benchmark level. Recoverability, see additional information.

Decrease in wave exposure	Low	High	Low	Low

Decreased wave exposure is unlikely to have an effect on *Asterias rubens* except in enclosed areas where deoxygenation might occur in unmixed waters.

Noise	Tolerant	Not relevant	Not sensitive	Not relevant

There is little known about the effects of underwater sound on marine invertebrates.

Visual Presence	Tolerant	Not relevant	Not sensitive	Not relevant

Asterias rubens does not have the visual acuity to perceive objects not normally found in the marine environment and is considered not sensitive to this factor.

Abrasion & physical disturbance	Intermediate	High	Low	Moderate

Asterias rubens are likely to be damaged by physical abrasion, especially removal of arms or damage to superficial tissue. However, starfish exhibit good powers of regeneration and the remaining starfish and even detached arms are likely to survive. For example, *Asterias rubens* can regenerate an arm within 1-2 years (Emson & Wilkie, 1980). An intolerance of low is suggested. Although individuals can survive loss of one or more arms, the viability of a population with a high index of arm damage (see importance, demersal fishing impacts) may be reduced as nutritional resources stored in the pyloric caeca are used for repair and growth at the expense of gametogenesis.

Displacement	Low	Immediate	Not sensitive	Moderate

Anchorage in starfish is by suckered tube feet. The effectiveness of the tube feet attaching the individual to the substratum is primarily a function of the number of tube feet (Lawrence, 1987). Thus smaller starfish may be more susceptible to displacement e.g. by waves or water flow in storm conditions, than larger specimens. *Asterias rubens* demonstrates a rapid (< 15 seconds) 'self-righting' behaviour if displaced and left upturned upon the substratum by twisting two alternate arms in order to bring its tube feet back onto surfaces for attachment (Russell-Hunter, 1979). Thus intolerance of *Asterias rubens* to displacement at the benchmark level is considered to be low as it is able to 'self-right' itself and reattach to suitable substrata immediately.

Chemical Pressures

	Intolerance	Recoverability	Sensitivity	Confidence
Synthetic compound contamination	Intermediate	High	Low	Low

Little documentation concerning the biological effects of synthetic chemicals on echinoderms in coastal areas exists, but starfish are known to concentrate synthetic chemicals. Knickemeyer *et al.* (1992) found that differences in adsorption and accumulation of polychlorinated biphenyl cogeners in starfish could be explained by the pattern of chlorine substitution. Pentachloro- to heptachloro- biphenyls with adjacent substituted carbons and those with 2,4,5-chlorine substitution were bioaccumulated. Distinct seasonal changes in organochlorine contamination could also be attributed to lipid content fluctuation accompanying reproduction and food availability. Limited evidence exists of the biological effects of synthetic chemical exposure but Besten, *et al.* (1989) reported that exposure of *Asterias rubens* to polychlorinated biphenyls (PCBs) resulted in production of defective offspring and an intolerance of intermediate is recorded as the viability of the species was affected.

	Intolerance	Recoverability	Sensitivity	Confidence
Heavy metal contamination	Intermediate	High	Low	High

Temara *et al.*, (1997) found that heavy metals are selectively distributed among body components of *Asterias rubens*: Hg concentrations were significantly higher in the pyloric caeca (0.15 µmg Hg g^{-1} dry weight) and the gonads (0.12 µmg Hg g^{-1}); Zn, Cd, Fe and Cu were high in the pyloric caeca, whilst Pb was significantly more concentrated in the skeleton (8.73 µmg Pb g^{-1} dry weight). The affinity of Pb for calcite is high and Pb is readily adsorbed to the skeleton of echinoderms. In starfish toxic effects of Pb could come directly from its incorporation into the skeleton or could influence other metabolic pathways and exert an indirect deleterious effect on the species (Temara, *et al.*, 1997). For instance, Pb adsorption occurs actively on the growing parts of the skeleton, where it could reduce skeletogenesis as Pb is one of the most effective inhibitors of calcite dissolution/precipitation kinetics (Morse, 1986).
Heavy metals have also been reported to effect gametogenesis and early larval development in the starfish *Asterias rubens*. For example, Besten *et al.*, (1991) examined the effects of cadmium on the gametogenesis in females of *Asteria rubens*, after short term exposure (5 weeks) to 200 µmg Cd l^{-1} and long term (7 months) exposure to 25 µmg Cd l^{-1} under semi-natural conditions. It became evident that a short term exposure to 200 µmg Cd l^{-1} affected gametogensis by reducing ovary growth. The early phase of gametogenesis was also found to be more susceptible to Cd exposure as experiments starting in February has less effect on ovary growth than those commencing in December. The long term exposure of female *Asterias rubens* to 25 µmg Cd l^{-1} caused a delay in ovary growth which was evident after 5 months. The oocytes from cadmium exposed females have also been shown to produce defective offspring (Besten, *et al.*, 1989). The aberrations were shown to occur at relatively low exposure levels, and the Cd concentrations found within the body of experimentally (long term) exposed *Asterias rubens* could also be found within specimens fed with mussels from polluted sites, such as the Dutch Western Scheldt. Consequently, Besten, *et al.*, (1991) concluded that cadmium pollution poses a considerable threat to populations of *Asterias rubens* in terms of recruitment

success.

LC_{50}concentrations exceeding 0.1 mg Cu l^{-1}, 1 mg Zn l^{-1} and 10 mg Cr l^{-1} for a duration between 4 -14 days of exposure have been reported for echinoderm species (Table 5.12, Crompton, 1997).

Hydrocarbon contamination High High Moderate High

Asterias rubens is intolerant of hydrocarbon pollution:

1. Bokn *et al*., (1993) examined of the long term effects of the water-accommodated fraction (WAF) of diesel oil on rocky shore populations. Two doses (average hydrocarbon concentration in diesel oil equivalents; *High*: = 129.4 µmg l^{-1}, and *Low* = 30.1 µmg l^{-1}) of WAF of diesel oil were delivered via sea water to established rocky shore mesocosms over a two year period. The numbers of *Asterias rubens* decreased at all tidal levels (even in the control mesocosms during the study) and *Asterias rubens* disappeared entirely from upper sublittoral samples in the mesocosm receiving a high dose of WAF diesel oil suggesting a negative effect upon this species caused by the high dose treatment.
2. Crude oil from the *Torrey Canyon* in 1967 off Land's End of Cornwall, and the detergent used to disperse it caused mass mortalities of echinoderms; *Asterias rubens*, *Echinocardium cordatum*, *Psammechinus miliaris*, *Echinus esculentus*, *Marthasterias glacialis* and *Acrocnida brachiata* (Smith, 1968). However, *Asterias rubens* was found to be fairly resistant to the oil dispersant used, BP1002. A concentration of BP1002 at 25 ppm was required in toxicity tests to kill 50% of *Asterias rubens* within 24 hours (Smith, 1968).

Radionuclide contamination Very low

Plutonium in seawater has a strong affinity for the mucus-rich epidermal layer of starfish which contributes to the relatively high levels of this radionuclide measured in these invertebrates. Guary *et al*., (1982) measured the body burden of ^{239}Pu ^{240}Pu and ^{238}Pu and found 94.5% and 95.6% respectively of the total body burden in the body wall of *Asterias rubens*. It became apparent that in the environment the water pathway predominates in the uptake of radionuclides by asteroids as the body wall is in constant contact with the transferring medium. However, there is insufficient information on the biological effects of radionuclides to comment further on the intolerance of this species to radionuclide contamination.

Changes in nutrient levels Low High Low Moderate

A population of *Asterias rubens* may benefit indirectly from an increased nutrient availability because major food items such as mussels filter feed upon phytoplankton and increase in abundance following nutrient enrichment. In combination with other factors an aggregation of feeding starfish may result (see adult distribution). However, an excess of nutrients (eutrophication) facilitating a high pelagic production, in combination with thermal stratification of the water column during summer is likely to cause hypoxia and starfish mortality (see oxygenation) (Josefson & Rosenberg, 1988; Rosenberg & Loo, 1988, Rosenberg *et al*., 1992). Extensive mortality of benthic populations including *Asterias rubens* was reported by Bokn *et al*., (1990) in response to hypoxic conditions caused by a toxic algal bloom of *Chrysochromulina polylepsis* along the Norwegian coast. However, these adverse effects are indirect and are only likely to occur in extreme situations. Intolerance directly to increased nutrient levels is assessed as low.

Increase in salinity High High Moderate Moderate

Echinoderms are stenohaline owing to the lack of an excretory organ and a poor ability to osmo- and ion-regulate. The inability of echinoderms to osmoregulate extracellularly causes body fluid volume to increase or decrease when individuals are transferred to lower or higher external salinity respectively, e.g. a sudden inflow of river water into an inshore coastal area caused mass mortality of the conspecific species *Asterias vulgaris* at Prince Edward Island, Canada (Smith, 1940, in Lawrence, 1995).

Decrease in salinity

Changes in oxygenation	High	High	Moderate	High

Asterias rubens is an aerobic organism and oxygen uptake is by the tube feet and across the body wall. Hypoxic conditions can occur within the habitat of *Asterias rubens* owing to current changes, thermal stratification of the overlying water column and eutrophication. Theede *et al.*, (1969) undertook experiments on the survival capacity of marine bottom invertebrates in oxygen deficient and hydrogen sulphide (H_2S) containing seawater at 10°C. The duration of exposure survived by 50% of *Asterias rubens* exposed to oxygen deficient seawater (0.15 ml O_2l^{-1} = 0.2 mg 0_2l^{-1}) was 84 hours. In the presence of H_2S (50 mg $Na_2S.9H_2O$ L^{-1}) the resistance of *Asterias rubens* to oxygen deficient water dropped to 67 hours, thus it is likely that this species would not survive a week of hypoxic conditions.

Biological Pressures

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

Factors affecting larval production and survival ultimately control the reproductive success of *Asterias rubens*. Male *Asterias rubens* and the conspecific starfish *Asterias vulgaris* are liable to gonad parasitisation by the ciliate parasite *Orchitophrya stellarum* (Vevers, 1951; Bouland & Claereboudt, 1994).
Orchitophrya stellarum causes complete atrophy of the testes leading to castration.
The parasite is only found between January and May when the hosts' testes are ripening or ripe. All that remains after the parastitic infection are the thick shrunken sheaths of the original testis tubules (Vevers, 1951). Infected males also show very weak carotenoid pigmentation and a general flabbiness of the body which lacks the fresh turgid appearance of a healthy specimen (Nichols & Barker, 1984).
In a parasitized population of *Asterias vulgaris* from Canada, Bouland & Claereboudt (1994) observed a lower abundance of males, which were small in size and had a reduced gonadal index (gonadal mass/body wall mass) in comparison with the females. These observations implied an overall drop in spermatozoa production at the population level, thus parasitism of the male testes has implications for recruitment. In a turbulent flow as found in most benthic habitats, the success of fertilization is limited by the concentration of gametes. With fewer spawning males in the population the fertilization rate will drop rapidly leading to a virtual sterilisation. The contribution of a parasitised population to the species reproductive effort would be negligible since the same number of planktonic predators and other adverse factors would be acting upon a reduced number of gametes.
A population of *Asterias rubens* on the Outer Grounds of the Eddystone, English Channel, was found to have > 20% of males parasitised with *Orchitophrya stellarum* in March 1947. Although the evidence was speculative, a reduction in the population of *Asterias rubens* in the locality was subsequently observed in 1948, 1949 and 1950 as compared to 1947 (Vevers, 1951).
However, *Asterias rubens* is a widespread and fecund species(> 1.5 million eggs per female) that reproduces annually and has long lived pelagic larvae (> 80 days), which have a high dispersal potential and are able to settle upon a variety of benthic substrates (Clark & Downey, 1992). Larval production by one population may influence settlement some

considerable distance away, while not affecting the original population (Morgan, 1995). Consequently, it may take more than one or two generations for a population to return to a pre-impact state, but recoverability is considered to be high.

Introduction of non-native species Not relevant

No evidence has been found of competition with or predation by non-native species affecting *Asterias rubens* in Britain and Northern Ireland.

Extraction of this species Not relevant Not relevant Not relevant Not relevant

Asterias rubens is not a targeted species for harvest, but it is frequently a component of commercial fishing activity by-catch (see extraction of other species).

Extraction of other species Low High Low Moderate

Fishing activities increase the input of carrion to benthic communities (Ramsay *et al*., 2000). The starfish *Asterias rubens* is an opportunistic scavenger that has been shown to gain extra food by foraging in fished areas upon damaged and displaced bivalves, gastropods, crustaceans and other echinoderms (Ramsay *et al*., 1998) and also feeds on fisheries discards (Ramsay *et al*., 1997; Lindeboom & de Groot 1998). Some studies have demonstrated that scavengers can gain more food by foraging in areas disturbed by fishing activity than in nearby unfished areas. Diver observations of fished and adjacent unfished areas have shown that the proportion of starfish *Asterias rubens* was higher in the fished area for up to 44 hours after fishing had taken place (Ramsay *et al*., 1998). There is some evidence that numbers of *Asterias rubens* have increased in the southern North Sea over the past 80 years, which may be linked to the effects of beam trawling in terms of subsidising the food supply to adults (Lindeboom & de Groot, 1998). However, benthic scavengers such as *Asterias rubens* are damaged by fishing activities themselves. Mechanical abrasion can induce autotomy (see abrasion) and *Asterias rubens* may constitute a proportion of the discarded non-commercial by-catch. The survival of discards depends on a number of factors, such as time spent in the cod end of the net, the time spent on board ship exposed to desiccating factors and the composition of the by-catch (e.g. a large proportion of debris will increase mortality rates). Overall taking account of the importance of discards as a source of food and the resilience of *Asterias rubens* to physical impact, fishing activity may favour populations of *Asterias rubens* and an intolerance assessment of low is given.

Additional information

Recoverability of *Asterias rubens* is likely to be high as it is widespread throughout shallow (< 600 m) areas of the North Atlantic. It is a fecund species (> 1.5 million eggs per female) that reproduces annually with long lived pelagic larva (> 80 days), that have a high dispersal potential and are able to settle upon a variety of benthic substrata (Clark & Downey, 1992). However, larval production by one population may influence settlement some considerable distance away (Morgan, 1995), while not affecting the original population, so consequently it may take more than one or two generations for a population to return to a pre-impact state.

Importance review

Policy/legislation

- no data -

Status

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

Non-native

Native	-		
Origin	-	**Date Arrived**	Not relevant.

Importance information

Ecosystem importance

Asterias rubens is of considerable negative economic importance, as it is a voracious consumer of the marketable shellfish *Mytilus edulis* (Hancock, 1958). *Asterias rubens* can influence the lower limit of the distribution of *Mytilus edulis*. Seed (1969) reported that *Asterias rubens* and *Nucella lapillus* eliminated mussels from the lower intertidal along a shore line on the east coast of England.

Fishing Impacts

Starfish such as *Asterias rubens* sustain damage to varying degrees as demersal trawls pass over them or when they pass into the cod end of fishing nets. However, they are quite resilient and probably suffer low mortality because of their regenerative abilities following autotomy of one or several arms. Kaiser (1996) collected specimens of *Asterias rubens* and *Astropecten irregularis* from areas of the Irish Sea that were subjected to different intensities of commercial beam trawling. The incidence of starfish, of both species, with damaged or regenerating arms increased with increased fishing intensity, as did the severity (number of regenerating arms) of damage. The proportion of starfish with damaged or regenerating arms may provide a useful short-term (1-2 years) biological indicator of physical disturbance by demersal fishing gear.

Metal pollution bioindicator species

The use of *Asterias rubens* as a reference species to monitor changes of marine heavy metal pollution has been examined as heavy metals are selectively distributed among the body compartments of *Asterias rubens* (Temara *et al*., 1997) (see adult heavy metal sensitivity). Temara *et al*., (1998) examined the contamination of *Asterias rubens* along spatial gradients of Pb, Cd and Zn identified in the Sørfjord, southwest Norway. They concluded that *Asterias rubens* appeared to be a valuable bioindicator of spatial and temporal trends of Pb and Cd contamination in the field, and that it appeared possible to differentiate the skeleton as a long-term bioindicator from the pyloric caeca as a short-term bioindicator

Curio use

Echinoderms such as *Asterias rubens* lend themselves excellently for preservation in a dried state.

Harvested targeted use

Asterias rubens has been commercially fished for fertiliser (Mortensen, 1927; Schäfer,1972).

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