GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

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Name of Organism:	***Crepidula fornicata*** **(Slipper Limpet)**
Objectives:	Assess the risks associated with this species in GB
Version:	Original draft 29/06/11
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N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the Risk Assessment?		Request made by GB Programme Board
2	What is the Risk Assessment area?		Great Britain
3	Does a relevant earlier Risk Assessment exist?	NO OR UNKNOWN (Go to 5)	
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?		
A	**Stage 2: Organism Risk Assessment SECTION A: Organism Screening**		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES (Give the full name & Go to 7)	Kingdom: Animalia Phylum:Mollusca Subphylum: Conchifera Class: Gastropoda Subclass: Prosobranchia Order: Mesogastropoda Superfamily: Crepiduloidea Family: Calyptraeidae Genus: *Crepidula* Species: *Crepidula fornicata*
6	If not a single taxonomic entity, can it be redefined?		N/A
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	YES (Go to 9)	Threatens species and alters habitat through spatial competition. Stacks of slipper limpets, when numerous, can prevent other macrobenthic species from settling (Blanchard, 1997) and through the deposition of faeces and pseudofaeces they can reduce hard substratum availability. Where abundant, *C fornicata* creates additional competition with suspension feeders for resources (Valdizan *et al*, 2009). A study by Blanchard *et al* (2008) suggested that *C. fornicata* larvae may outcompete oyster (*C.gigas*) larvae during summer months where the two species co-occur. In the study, larval grazing by slipper limpets was up to ten times higher than that of Pacific oysters. Decottignies *et al* (2007) report trophic competition between adult *C.fornicata* and *C.gigas* in France during winter and spring. In Mont Saint-Michel Bay, France, flatfish populations have been affected by slipper limpet populations. Changes in habitat structure and reduced abundance of suspension feeding organisms upon which the flatfish feed have been linked to slipper limpet extent (Kostecki *et al*, 2011).
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		marine invertebrate spreadsheet score of: 33 Although ignored due to response to Q 7
9	Does the organism occur outside effective containment in the Risk Assessment area?	YES (Go to 10)	Occurs in open water systems on the lower shore and below sublittoral where suitable hard substrate exists for settlement.
10	Is the organism widely distributed in the Risk Assessment area?	YES & Future conditions/management procedures/policies are being considered (Go to 19)	Widely distributed in South west England and Wales and spreading Northwards. Established population found in Belfast Lough, northeast Ireland in 2009 (McNeill *et al*, 2010). Studies undertaken to evaluate risk and measures implemented in North Wales to try and prevent introduction into Menai Strait with Mussel Seed Culture (Sewell *et al* 2008). Scoping study undertaken to evaluate potential for removing *C. fornicata* for control and commercial gain (FitzGerald 2007).
11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?		
12	Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?		
13	Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in the Risk Assessment area or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.		
14	Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment area or sufficiently similar for the organism to survive and thrive?		
15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?		

16	Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?		
17	Can the organism spread rapidly by natural means or by human assistance?		
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?		
19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.	Detailed Risk Assessment Appropriate GO TO SECTION B	
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.		

B	SECTION B: Detailed assessment of an organism's probability of entry, establishment and spread and the magnitude of the economic, environmental and social consequences			
	Probability of Entry	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	very many - 4	LOW - 0	**Adult:** Will attach to a number of commercial species transported for culture, including oysters (variety of species), mussels and scallops. This is the primary reason for European spread (Blanchard 1997). Able to attach to and travel with a variety of mobile host species, including the common whelk, scallops, species of crab and turtles. Transport attached to ships hulls, temporary harbour installations rafts and fishing gears (pots and buoys). Attach to and travel with floating litter and debris (reviewed in Sewell *et al*. 2008). **Larvae:** Transported long distances in water column with currents (Hessland 1951) and transport in ballast water (Blanchard 1997).
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	Transport with bivalves for culture (mussels and oysters)		Primary reason for spread in Europe (Blanchard 1997)
1.3	How likely is the organism to be associated with the pathway at origin?	very likely - 4	LOW - 0	Known to grow attached to commercially important bivalve species including mussels and oysters (Pacific and native). Recorded in locations where mussel seed occurs and areas of oyster culture and spat settlement, for example in the South East and Fal in Cornwall.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	likely - 3	MEDIUM -1	A gregarious species, which settles in stacks in large concentrations on suitable substrate (including bivalve shells) (Rayment 2007). Although abundance will depend upon location and environmental conditions.
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4	MEDIUM -1	Physiological tolerances similar to commercial species, therefore likely to thrive in similar conditions. Dredging and seabed modification processes undertaken during oyster culture and harvest are likely to favour *C. fornicata*, aiding dispersal and spread and increasing suitable settlement habitat.
1.6	How likely is the organism to survive or remain undetected by existing measures?	likely - 3	LOW - 0	Existing measures generally involve avoidance of transport from infected to uninfected areas. However, newly settled juveniles are inconspicuous and may easily be overlooked if present in stock and incidences of accidental transportation do occur, for example accidental introduction into the Menai Strait in 2006.
1.7	How likely is the organism to survive during transport /storage?	likely - 3	MEDIUM -1	Depends on transport/ storage techniques used. Known to survive transport with Mussel Seed. Known to have survived past transportation with oysters.
1.8	How likely is the organism to multiply/increase in prevalence during transport /storage?	moderately likely - 2	MEDIUM -1	Brooding of eggs, which occurs in shell may occur, although dispersal requires individuals to be submerged in water.
1.9	What is the volume of movement along the pathway?	major - 3	MEDIUM -1	Mussel production from wild seed estimated to reach 28,000 tonnes by 2010 (Brown *et al* 2006). Small scale translocation of wild oysters and cockles also occurs.
1.10	How frequent is movement along the pathway?	often - 3	MEDIUM -1	Movement of mussel seed for culture occurs annually in some areas, depending on conditions of seed beds.
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	widely - 3	MEDIUM -1	*C. fornicata* will inhabit a very wide range of habitat types with a range of environmental conditions, present throughout British coasts and seas.
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	moderately likely - 2	MEDIUM -1	It is likely that mussel seed beds are too short lived for *C. fornicata* populations to become established (Thieltges 2003). However *C. fornicata* settle several months after *M.edulis* larvae, meaning that young are likely to be present in seed and therefore transported. Adults are less likely to be transported on mussel seed as insufficient time will pass for full maturation to occur from settlement to when seed is harvested.
1.13	How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) or other material with which the organism is associated to aid transfer to a suitable habitat?	unlikely - 1	MEDIUM -1	Once mussels are harvested, provided waste is not disposed of in the sea at other locations, the risk of further spread is considered minimal.
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	likely - 3	MEDIUM -1	Mussel seed is usually laid in or close to habitat suitable for the establishment of *C. fornicata*.

	Probability of Establishment	RESPONSE	UNCERTAINTY	COMMENT
1.15	How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?	moderately similar - 2	MEDIUM -1	Temperature is slightly lower. Still within temperature tolerance of species ((Waugh, 1964, cited by (Rayment, 2007)) Thieltges et al. (2004) Suggest that the infestation density of *C. fornicata* may be limited by high mortalities associated with cold winter temperatures in Northern Europe. This controlling factor may however be lost as a result of warmer winter temperatures resulting from climate change.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	very similar - 4	LOW - 0	*C. fornicata* is currently found in a range of habitats, including shallow inlets, bays, estuaries and open coast. Suitable settlement surfaces and seabed types are likewise varied and can include rocks, man-made surfaces, coarse sand, gravel and mud. Abundance seems to be particularly high in less exposed areas. There are many examples of these habitat types throughout the risk assessment area.
1.17	How many species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism species are present in the Risk Assessment area? Specify the species or habitats and indicate the number.	very many - 4	MEDIUM -1	*C. fornicata* is an active suspension feeder, able to feed on a variety of food types (Pechenik *et al*., 1996; Rayment, 2007) likely to be present in the risk assessment area. Range of suitable habitat is present throughout risk assessment area. While it is reported to occur most often in sheltered shallow bays, *C. fornicata* was recently found in subtidal areas down to 60m, over rough ground with high current velocities off the Isle of Wight (Hinz *et al*, 2011).
1.18	How widespread are the species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism in the Risk Assessment area?	widespread - 4	MEDIUM -1	*C. fornicata* is an active suspension feeder, able to feed on a variety of food types (Pechenik *et al*., 1996; Rayment, 2007) likely to be widespread in the risk assessment area. Range of suitable habitat is widespread throughout risk assessment area, largely due to the wide variety of suitable habitat types in which *C. fornicata* is able to live, develop and multiply.
1.19	If the organism requires another species for critical stages in its life cycle then how likely is the organism to	N/A	LOW - 0	
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	very likely - 4	MEDIUM -1	*C. fornicata* is able to inhabit areas already inhabited by other species, by overgrowing settled individuals of other species, for example, mussels and oysters (Thieltges *et al*., 2003). These factors coupled with previous examples of successful invasions strongly suggests that establishment will not be inhibited by competition with other species. However, it is possible that some trophic competition and larvae predation will occur in areas where the blue mussel *Mytilus edulis* is found in abundance (Thieltges, 2005b).
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	likely - 3	MEDIUM -1	*C. fornicata* has very high levels of fecundity and potential predators including *Carcinus Maenus* and *Asterias rubens* have been shown to feed preferentially on native species over *C. fornicata* (Thieltges, 2005a), suggesting that predation by native species may be limited.
1.22	If there are differences in man's management of the environment/habitat in the Risk Assessment area from that in the area of present distribution, are they likely to aid establishment? (specify)	moderately likely - 2	LOW - 0	It is unclear whether or not the process of harvesting mussels from on-growing sites will disperse *C. fornicata* or remove individuals, reducing population. Man's management in other sites within the risk assessment area where *C. fornicata* may be introduced could potentially aid establishment, for example, where man made sea defences create sheltered sites, where *C. fornicata* will thrive or where man-made structures provide additional substrate for settlement.
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	moderately likely - 2	LOW - 0	Current measures seem to have so far proved ineffective at preventing the establishment of *C. fornicata* in the South of England and Wales. Attempts to destroy individuals found in mussel seed imported into the Menai Strait may have been successful, although the authors are unaware of evidence either way. It is likely that due to the potentially small size, during transportation, it may be difficult to locate new introductions. Current practice of not transporting seed from areas infected with *C. fornicata* may be effective, if a thorough assessment is undertaken to locate uninfected seed sites.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	N/A		May occur in aquaria with open seawater systems, although there are no known studies to suggest whether this is the case.
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	very likely - 4	LOW - 0	*C. fornicata* is a protandrous hermaphrodite, which forms chains or stacks, where the bottom individual is female and individuals on top are male or changing from male to female. The female exhibits egg brooding. And is able to reproduce from 1 year. The female may spawn twice a year, laying 11000 eggs at a time. A planktotrophic larval stage of 4-5 weeks, occurs, during which individuals can travel several kilometres a day, undetected. (Rayment 2007)
1.26	How likely is it that the organism's capacity to spread will aid establishment?	very likely - 4	LOW - 0	A planktotrophic larval stage of 4-5 weeks, (Rayment 2007) occurs, during which large numbers of individuals can travel several kilometres a day, undetected.
1.27	How adaptable is the organism?	adaptable - 3	MEDIUM -1	*C. fornicata* is able to settle on a wide range of surfaces in a variety of environmental conditions. Suggesting that it is very adaptable.
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	very likely - 4	LOW - 0	Current British populations are likely the result of several introductions from elsewhere around the world. English channel populations have high genetic diversity (Viard *et al* 2006).
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	very many - 4	LOW - 0	*C. fornicata* has been repeatedly introduced around the world by humans, in association with bivalve mariculture, shipping and other activities. See review of introductions in Sewell *et al* (2008).
1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	very likely - 4	LOW - 0	Eradication campaigns have been trialled elsewhere fairly extensively and largely failed (Fitzgerald 2007). However, this has been largely because such efforts were undertaken following the establishment of the species. A large limiting factor has been found to be financial constraints as removal procedures are costly.

1.31	Even if permanent establishment of the organism is unlikely, how likely is it that transient populations will be maintained in the Risk Assessment area through natural migration or entry through man's activities (including intentional release into the outdoor environment)?	very likely - 4	MEDIUM -1	Other vectors such as shipping, litter and natural spread of larvae through water currents are likely to take place whilst established populations exist elsewhere in British waters.

	Spread	RESPONSE	UNCERTAINTY	COMMENT
2.1	How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	rapid - 3	LOW - 0	*C. fornicata* is a protandrous hermaphrodite, which forms chains or stacks, where the bottom individual is female and individuals on top are male or changing from male to female. The female exhibits egg brooding. And is able to reproduce from 1 year. The female may spawn twice a year, laying 11000 eggs at a time. A planktotrophic larval stage of 4-5 weeks, occurs, during which individuals can travel several kilometres a day, undetected. (Rayment 2007). Once established in a new area, natural dispersal would therefore likely be rapid once a viable population is established.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	intermediate - 2	MEDIUM -1	Once in the Risk Assessment area, *C. fornicata* may be spread locally by humans by attachment to vessels and gears, larvae in ballast water and other means. According to Kostecki *et al* (2011) oyster farming enhances slipper limpet development, and shellfish dredging/fish trawling facilitate slipper limpet spread. Note slipper limpet is on Schedule 9 of the Wildlife and Countryside Act 1981 in England and Wales (making it an offence to release or alow this species to escape into the wild).
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	very difficult - 4	LOW - 0	Planktonic larvae would be impossible to control in open marine systems.
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.	British coastal and offshore areas with suitable habitat not yet infected	MEDIUM -1	*C. fornicata* has a large number of vectors for spreading and data shows that the species is spreading either by natural means or human vectors rapidly around the coast and offshore waters.

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	major - 3	MEDIUM -1	Increased costs associated with catching and processing bivalves in infected areas. Potential Cost of disposal of *C. fornicata* carcases following cleaning. Loss of suitable habitat for commercial species including finfish (including flatfish), scallops (Fitzgerald 2007, Kostecki *et al*, 2011).
2.6	Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, livestock health and production, likely to be? (describe) in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, likely to be?	massive - 4	MEDIUM -1	Area based on habitat resource for habitats where dense infestations may occur (shallow inlets and bays, estuaries and coastal lagoons). Also, mussel bed area in North Wales and Solway. At present, all area considered 'at risk' although this may not be realistic. Reefs not included as data included vast areas of offshore (deepwater) reef habitat. Area used by scallop dredgers and oyster farms not found. Other seabed areas may also be affected. Scallop beds in Bay of Brest had loss of 25% of harvestable beds a year, 97% loss in 12 years due to *C.fornicata* infestation (Fitzgerald 2007). Threat to amenity value of dive sites, angling sites, bird watching etc could not be quantified for this assessment. potential impacts on Finfish Nursery areas difficult to quantify. Percentage of resource already infested is very broad estimate based on species distribution from NBN gateway. Value of UK mussel + scallop fishery 2007 = £39.8 million (scallop =£38.8)(MFA UK fishing statistics 2007). cost of extraction = average of 3 costs given by Fitzgerald (2007) based on costs of removal with suction dredge in France (Euro 143,000 per year). Unlikely to lead to complete erradication and would have serious secondary environmental impacts. Given uncertainties and available information, any precise estimate is virtually impossible at present.
2.7	How great a loss in producer profits is the organism likely to cause due to changes in production costs, yields, etc., in the Risk Assessment area?	major - 3	LOW - 0	Great increases to production and processing costs associated with shellfisheries. Possible loss of some scallop fishing area (Fitzgerald 2007).
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	moderate - 2	MEDIUM -1	Higher processing costs for shellfish etc likely to impact cost to consumer. Amenity value of infected areas may be affected.
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	very likely - 4	MEDIUM -1	Restrictions may be imposed on transportation of infected stocks. Additional processing and capture costs likely to increase costs at all other levels, including export market.
2.10	How important would other economic costs resulting from introduction be? (specify)	major - 3	MEDIUM -1	Potential costs may be associated with control, loss of jobs in fishing and aquaculture sector. Channel dredging for shipping etc.
2.11	How important is environmental harm caused by the organism within its existing geographic range?	major - 3	LOW - 0	*C. fornicata* has the ability to smother species and alter the nature of sediment substrata, smothering areas previously dominated by bivalves (Minchin *et al*., 1995). Change in species composition has been recorded in some sites, including reduced species diversity and dominance by individual species (Vallet *et al*., 2001). Reduced bivalve abundance has been recorded on the French Coast as a result of *C. fornicata* infestation most severely on coarse sand and gravel (de Montaudouin & Sauriau, 1999). In Mont Saint-Michel Bay, France, a rapid proliferation of slipper limpets led to decreased available seabed habitat for flatfishes, restricting flatfish distribution in the bay (Kostecki *et al*, 2011).
2.12	How important is environmental harm likely to be in the Risk Assessment area?	major - 3	LOW - 0	Adult *C. fornicata* consume the same prey as the blue mussel *M. edulis* potentially resulting in trophic competition. It is likely that increased competition will impact mussel communities. Trophic competition is also reported with the Pacific oyster Crassostrea gigas (Blanchard et al, 2008; Decottignies et al, 2007). Competition may also occur with other species in the area. The consumption of larvae by *C. fornicata* may limit the settlement of other species including the native oyster *Ostrea edulis* (Walne, 1956). Likely to smother areas previously dominated by bivalves (Minchin *et al*., 1995), again including the native oyster Ostrea edulis (Walne, 1956). Should *C. fornicata* cover a sufficient area of the seabed following introduction, it is conceivable that certain species will be locally reduced or lost as a result of reduced or lost suitable habitat. Evidence suggests that negative impacts may be severe on course sand substrata, where reduced bivalve abundance has been recorded on the French Coast (de Montaudouin & Sauriau, 1999). *C.fornicata* may deter predators from mussel beds (Thieltges, 2005a) and increase pressure on alternative prey species. Will attach to a variety of 'host' species including oysters (both native and Pacific) (de Montaudouin & Sauriau, 1999). It is highly likely that the additional energetic demand associated with carrying *C. fornicata* individuals and colonies will have adverse effects on the host, including potential impacts on spawning, feeding and migratory behaviour. Large clumps of *C. fornicata* can disturb normal water flow, leading to the accumulation of fine sediments. Areas of hard or even substrate may be changed dramatically, to fine, nutrient rich sediment with slipper limpet stacks. The accumulation of fine sediments and suspended matter particles may reduce levels of suspended organic matter in the water column. Increased sedimentation caused by slipper limpets may threaten maerl beds (identified as a threat in Brittany; Clark, 2008).
2.13	How important is social and other harm caused by the organism within its existing geographic range?	minor - 1	MEDIUM -1	It is likely that loss of amenity value caused by *C. fornicata* infestation may occur. In addition, traditional fishing practices may be affected.
2.14	How important is the social harm likely to be in the Risk Assessment area?	moderate - 2	HIGH -2	In some areas with a disproportionate dependence on fishing activity, impacts may be very important.

2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	very unlikely - 0	LOW - 0	No native congeners are present
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no affect on populations of the organism if introduced?	very likely - 4	LOW - 0	Past studies have shown that potential predators such as *Carcinus maenas* and *Asterias rubens* will choose to feed preferentially on native species (Thieltges *et al*. 2004). High fecundity and reproductive strategy will also favour populations of *C. fornicata*.
2.17	How easily can the organism be controlled?	very difficult - 4	LOW - 0	Controls attempted in the past have been unsuccessful and often costly (See Fitzgerald 2007 for a review). A long, planktonic larval stage means that settlement may occur after removal of adults if timed badly. The method of breaking up clumps may serve to spread individuals further afield and encourage new 'stacks' to form, being counter productive (Fitzgerald 2007). A method of treating relatively small quantities of shellfish and oyster 'cultch' with hypersaline solutions are reported to be effective in controlling newly settled slipper limpets. This method is currently being investigated by a Seafish Industry Authority funded project although it is difficult to envisage such a method being applicable to a very large amount of material (North Western and North Wales Sea Fisheries Committee, 2009). Current advice given in the same report is to adopt a 'removal and smothering' approach (smothering with high density of seed mussel) which was successfully used in the Menai Strait following the discovery of slipper limpets on mussel lays; it is unlikely that these suspension feeders would be able to feed effectively if completely smothered.
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	unlikely - 1	HIGH -2	No evidence could be found to suggest that any disruption of this type is likely.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	moderately likely - 2	MEDIUM -1	Potential prey for American oyster drill *Urosalpinx cineria*.
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur	Commercial fishing areas and bivalve aquaculture sites. Biogenic reefs, sheltered, or enclosed water bodies, estuaries.	LOW - 0	Coastal fishing activities may be threatened because heavily-impacted areas become unfit for commercial exploitation. Estuarine shellfish operations (mussels, oysters, scallops) may be significantly affected; the slipper limpet is "a major potential threat to the continued viability of the native oyster fishery" [referring to Port of Truro] (Fitzgerald, 2007). Changes in the substratum may affect fish habitat, displacing commercially important species (this has occurred in Mont Saint-Michel Bay, France; Kostecki *et al*, 2011). Increased sedimentation caused by slipper limpets may threaten maerl beds (identified as a threat in Brittany; Clark, 2008).

Summarise Entry	very likely - 4	MEDIUM -1	Entry may occur via many pathways. Adults will attach to a number of commercial bivalves transported for culture, which is the primary reason for European spread. The species is also able to attach to and travel with a variety of mobile host species. Entry may also result from fouling vessels, temporary harbour installations, rafts, floating debris and fishing gears. Larvae may be transported long distances with currents and transport in ballast water. Where *C. fornicata* settles, it is likely to occur in high concentrations due to gregarious nature and habit of forming stacks. It's physiological tolerances are very similar to many commercial species and it is therefore likely to survive transportation and storage alongside these species. Dredging activities targeting oysters and scallops may facilitate further spread. Juveniles are easy to overlook in imported bivalves due to their size and cryptic colouration, making detection unlikely.
Summarise Establishment	likely - 3	MEDIUM -1	Although temperature is slightly lower in the risk assessment area than in the area of current distribution, it is still within the temperature tolerance of the species. However, infestation density of *C.fornicata* may be limited by high mortalities associated with cold winter temperatures in Northern Europe. Suitable habitat and available food for *C. fornicata* is widespread in the risk assessment area. *C. fornicata* is also known to overgrow existing species and as such, competition for settlement space is not likely to prevent establishment. Although potential predators are present, several of these choose to feed preferentially on native species. Coupled with *C.fornicata*'s high fecundity, predation by these species is unlikely to limit establishment. To date, attempts to eliminate populations once they have become established have been largely unsuccessful. Due to high fecundity and the ability fo *C. fornicata* to spread naturally, establishment once introduced is likely to be rapid.
Summarise Spread	rapid - 3	MEDIUM -1	Spread is likely to be rapid due to the life history. *C. fornicata* is a protandrous hermaphrodite, which forms chains or stacks, where the bottom individual is female and individuals on top are male or changing from male to female. The female exhibits egg brooding. And is able to reproduce from 1 year old. The female may spawn twice a year, laying 11000 eggs at a time. A planktotrophic larval stage, of 4-5 weeks occurs, during which individuals can travel several kilometres a day, undetected. Once established in a new area, natural dispersal would therefore likely be rapid once a viable population is established. *C. fornicata* has a large number of vectors for spreading and data shows that the species is spreading either by natural means or human vectors rapidly around the coast and offshore waters.
Summarise Impacts	massive - 4	MEDIUM -1	The potential economic impact of *C.fornicata* establishment is likely to be massive costs are associated with loss of revenue from fisheries and aquaculture, loss of fishing grounds and the potential costs of attempting to control populations. Environmental harm in the existing range is major and it is predicted that similar impacts are likely in the risk assessment area. Impacts include trophic competition; the consumption of larvae by *C. fornicata* limiting the settlement of some species including the native oyster O. edulis; smothering areas previously dominated by bivalves or reef forming species; Impacts on 'host' species through increased energetic demand on spawning, feeding and migratory behaviour. Large clumps of *C. fornicata* can disturb normal water flow, leading to the accumulation of fine sediments. Areas of hard or even substrate may be changed dramatically, to fine, nutrient rich sediment with slipper limpet stacks. The accumulation of fine sediments and suspended matter particles may reduce levels of suspended organic matter in the water column.
Conclusion of the risk assessment	HIGH -2	MEDIUM -1	Entry into the Risk Assessment area is thought to be very likely. Adults may enter via many potential pathways, both human and by natural means. The most important pathway is believed to be with the transportation of commercially important bivalves although individuals may be transported by fouling and larvae are likely to be trasnported in ballast water.*C.fornicata* may also arrive by natural means, by attacheing to mobile host species and through transort of larvae in the water column. Establishment in the Risk Assessment area is considered likely due to the similar conditions, habitat availability and food resource found here compared to those in the existing range. It has been suggested that populations may be less dense if established in these new areas due to lower winter temperatures, which may cause some mortality. *C.fornicata* is likely to inhabit a very broad range of habitats, including, rocks, mixed sediments, sand, esturaies, large, shallow inlets and bays and biogenic reef habitats. Many of the habitats most suitable for the establishment of the species are of conservation importance, including several listed in the EU Habitats Directive and present in UK European Marine Sites. Economic impacts may be massive, based on potential impacts on fisheries and aquaculture and the extremely high costs associated with controlling populations once established. Environmental impacts are also likely to be high. Particularly through smothering, trophic competition and larval predation.

Conclusions on Uncertainty		MEDIUM -1	Due to the commercial importance of *C. fornicata* globally, there is a large amount of available information on the species, particularly investigations into the tolerances and life cycle of the species. A good amount of information was also available on the impacts on species and habitats. A large amount of which has come from studies in France and the South of England. For the large part, evidence and information were available to answer most of the questions in the risk assessment fairly reliably. However precise information on potential economic impacts was limited and the data used to calculate these costs is unlikely to represent the true economic impacts, which may be associated with further infestations.

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