Japanese Oyster Drill (*Ocinebrellus inornatus*)

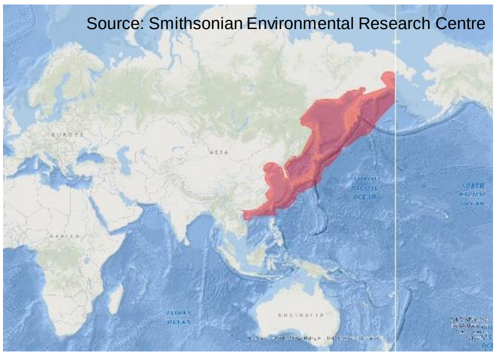
- A predatory marine snail with beige, brown, orange or striped shells that can reach a height of 50 mm.
- Found in rocky intertidal and shallow subtidal areas where it feeds on oysters, scallops, mussels, clams, cockles, barnacles and other gastropods.
- Not yet established in GB but could potentially be introduced with shellfish stock.

History in GB

Not yet recorded in GB. First reported in northern Europe from France in 1995 following introduction with aquaculture stock and has since been detected in Denmark, Portugal and the Netherlands. Non-native populations are also established on the pacific coast of North America.

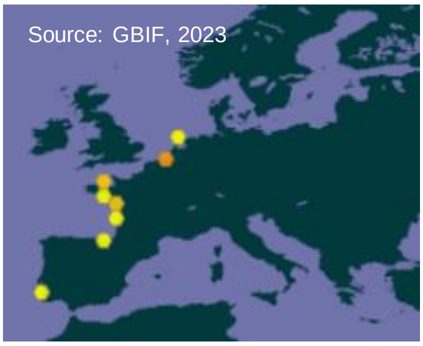
Native Distribution

The native range (in red) is northern China through Korea, and in all seas around Japan to Sakhalin and the Kurile Islands.



European Distribution

Reported from France (1995), Portugal (1999), Denmark (2006) and the Netherlands (2007).



Impacts

Economic (moderate, low confidence)

- Main impact is likely to be on cultivated oyster stocks, on which this species preys.
- In Washington state, USA, shellfish production costs increased by 20% and profits decreased by 50% due to infestation by this species.

Environmental (moderate, medium confidence)

- *O. inornatus* has the potential to cause a decline in native bivalve populations as it is known to prey on European flat native oysters (*Ostrea edulis*) and blue mussels (*Mytilus edulis*). This could severely impact the native oyster restoration programmes.
- It may also compete with native oyster drills.

Social (minimal, high confidence)

- None reported.

Introduction pathway

Primarily as hitchhikers on live pacific oysters and blue mussels. A small percentage of shellfish imports into GB come from places where this species is present.

Spread pathway

Natural (minor, very high confidence): limited to the movement of adults as the species has no larval phase.

Human (moderate, very high confidence): transferred within GB on oyster and mussel stock.

Summary

	Response	Confidence
Entry	MOD LIKELY	MEDIUM
Establishment	VERY LIKELY	HIGH
Spread	SLOW	MEDIUM
Impact	MODERATE	MEDIUM
Overall risk	MEDIUM	LOW

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: *Ocinebrellus inornatus* (Récluz, 1851), Japanese oyster drill
Author: Dr Jenni E. Kakkonen, Orkney Harbour Authority, Orkney Islands Council
Risk Assessment Area: Great Britain
Version: Draft 1 (Jan 2023), Peer review (Jan 2023), NNRAF 1 (Mar 2023), Draft 2 (Sep 2023), NNRAF 2 (Oct 2023), Draft 3 (Dec 2023), NNRAF 3 (Dec 2023)
Signed off by NNRAF: December 2023
Approved by GB Committee: April 2024
Placed on NNSS website: *to be completed*

What is the principal reason for performing the Risk Assessment?
The GB Committee for non-native species is considering whether to add this species to the list of species of special concern. This assessment will form part of the evidence used to inform the Committee's decision. During a GB wide horizon scanning exercise Japanese oyster drill *Ocinebrellus inornatus* (Récluz, 1851) was identified as one of the species with high likelihood to arrive and establish in Britain over the next ten years (Roy, Peyton and Rorke 2019).

SECTION A – Organism Information		
Stage 1. Organism Information	**RESPONSE**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES *Ocinebrellus inornatus* (Récluz, 1851), Japanese oyster drill. *O. inornatus* is a single taxonomic entity. *O. inornatus* is also known as Asian oyster drill, Asian drill and Japanese dwarf triton. Classification details: <u>Kingdom:</u> Animalia <u>Phylum:</u> Mollusca <u>Class:</u> Gastropoda <u>Subclass:</u> Caenogastropoda <u>Order:</u> Neogastropoda <u>Superfamily:</u> Muricoidea <u>Family:</u> Muricidae <u>Subfamily:</u> Ocenebrinae <u>Genus:</u> *Ocinebrellus* <u>Species:</u> *Ocinebrellus inornatus* Original name: *Murex inornatus* Récluz, 1851 Synonymised names (MolluscaBase eds. 2022): *Ceratostoma inornatum* (Récluz, 1851) *Ceratostoma inornatus* (Récluz, 1851) *Ceratostoma inornatus endermonis* (Smith, 1875)	

	Murex (Pteronotus) crassus Adams, 1853 *Murex acanthophorus var. endermonis* Smith, 1875 *Murex crassus* A. Adams, 1853 *Murex endermonis* E.A. Smith,1875 *Murex inornatus* Récluz, 1851 *Murex japonicus* Dunker, 1860 *Murex talienwhanensis* Crosse, 1862 *Ocenebra inornata* (Récluz, 1851) *Pteropurpura* (*Ocinebrellus*) *inornata* (Récluz, 1851) *Tritonium* (*Fusus*) *submuricatum* Schrenck, 1862 *Trophon incompta* Gould, 1860
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	N/A
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	NO or UNKNOWN Tillen *et al.* (2020) undertook an impact assessment of this species on Welsh MPA habitat features, fisheries and aquaculture, which concluded ‘moderate’ impact with low confidence on key MPA features with the potential for more severe impacts in the longer-term, and ‘moderate’ impacts on aquaculture potentially rising to major / massive in some circumstance.
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	N/A
5. Where is the organism native?	North-western Pacific *O. inornatus* is native to all coasts of Japan to South Korea and north of China along the Japan Sea (Choe

	and Park 1997; Amano and Vermeij 1998; Martel et al. 2004).
6. What is the global distribution of the organism (excluding the risk assessment area)?	First records of *O. inornatus* in its invaded range: **1924, USA**, Southern Puget Sound, Washington State (Galtsoff 1929, cited in Lützen et al. 2012). It was introduced to Puget Sound with the importation of Pacific oysters *Magallana gigas* seed oysters from Japan (Galtsoff 1929, cited by Chew 1960) After this first introduction to the USA, by 1930 *O. inornatus* had spread south to Netarts Bay, Oregon. By 1941 it was recorded from Morroa Bay and Tomales Bay, California and by 1965 from Willapa Bay, Washington State (Carlton 1992; GBIF 2022a). **1931, Canada,** Boundary Bay, Puget Sound, British Columbia (Sherwood 1931, cited by Carlton 1979). Introduction of *O. inornatus* within Puget Sound is believed to have been due to uncontrolled transfers of Pacific oysters *M. gigas* from one bay to another (Hannah 1966). Subsequently it was recorded from Ladysmith, Vancouver Island in 1934 (Elsey 1934, cited by Carlton 1979). **1995, France,** Marennes-Oléron Bay (de Montaudouin and Sauriau 2000). Martel et al. (2004) discuss the potential source populations for the French *O. inornatus* population. They conclude that oyster imports from Pacific coast of USA are the most likely route and the source population for *O. inornatus* on the French Atlantic coast (Martel et al. 2004). After this first record, *O. inornatus* has regularly been recorded along the French Atlantic coast (Garcia-Meunier et al. 2002; Martel et al. 2004). **1999, Portugal:** Sagres fishing harbour (Afonso 2011). *Ocinebrellus inornatus* was accidentally co-transported to south-west Portugal on juvenile oysters from oyster rearing grounds located in Brittany, France (Afonso 2011). No further records in Portugal were made until 2005 – 2008 when a considerable number (>100) of live

	specimens were sampled (Afonso 2011). Since then, the species has become so common at the oyster growing sites near Sagres that the local workers have been collecting them in significant quantities for their own consumption (Afonso 2011). **2006, Denmark,** Limfjord, NW Jutland (Lützen et al. 2012). Oyster transfers from France in the 1970s and 1980s is the most likely introduction vector to Denmark (Lützen et al. 2012). **2007, The Netherlands**: Oosterschelde estuary (Faasse and Ligthart 2009). Shellfish imports are the most likely route of introduction of *O. inornatus* to The Netherlands (Faasse and Ligthart 2009). *Ocinebrellus inornatus* is now well established in the Yerseke and Gorishoek area of the Oosterchelde estuary with established populations found from Yerseke to Yerseke Korringaweg and Gorishoek to Tuttelhoek (Didderen and Gittenberger 2013).  Figure 1. Map of introduced range of Japanese oyster drill *Ocinebrellus inornatus* (GBIF 2022b).
7. What is the distribution of the organism in the risk assessment area?	Not currently found in GB.
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in	Yes. *Ocinebrellus inornatus* is considered invasive in the USA, France, Portugal, Denmark and in The

the world?	Netherlands (Faasse & Ligthart 2009; Afonso 2011; Lützen et al. 2012; GBIF 2022a). *Ocinebrellus inornatus* predates on Pacific oysters *Magallana gigas*, European flat oysters *Ostrea edulis*, Olympia oysters *Ostrea lurida*, mussels *Mytilus edulis* and clams *Venerupis japonica* (Lützen et al. 2012). *Ocinebrellus inornatus* drills a perfectly circular hole by secreting an acid which softens the shell of the prey before using its radula to drill the hole. Once the hole is complete it introduces its proboscis through the hole to suck out the soft interior. This process can take from one day for a juvenile oyster to up to two weeks for an adult oyster (Babaran 2017). In its invaded range it has been documented to be destructive to native and to cultured oyster beds (Galtsoff 1932 cited in Hannah 1966; Didderen and Gittenberger 2013).
9. Describe any known socio-economic benefits of the organism in the risk assessment area.	Not present in the risk assessment area. *Ocinebrellus inornatus* is a potential food source, in Portugal workers at an oyster aquaculture site have been known to collect significant quantities of *O. inornatus* for their own consumption (Afonso 2011). There is also potential for *O. inornatus* to be able to control non-native Pacific oyster *M. gigas* feral populations.

SECTION B – Detailed assessment			
PROBABILITY OF ENTRY			
Important instructions: • Entry is the introduction of an organism into the risk assessment area. Not to be confused with spread, the movement of an organism within the risk assessment area. • For organisms which are already present in the risk assessment area, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	very few	high	One active pathway: Unintentional transfer of *Ocinebrellus inornatus* eggs, juveniles or adults on live shellfish or on shellfish net bags during transfers of shellfish stock. The shellfish transfers discussed in this Risk Assessment will concentrate on Pacific oyster *Magallana gigas* and blue mussel *Mytilus edulis* movements. Pacific oyster *M. gigas* movements have historically been the main pathway of translocation of *O. inornatus*. However, *M. edulis* will be considered as it is another potential vector for *O. inornatus* (Fey-Hofstede et al. 2010). In 2020 – 2022 Pacific oysters *M. gigas* have been imported to GB from four countries: France, The Netherlands, Northern Ireland and Republic of Ireland and from two British Crown Dependencies: Guernsey and Jersey, Table 1 and Appendix 1. During the same period blue mussel *M. edulis* imports have been received from Italy, Republic of Ireland, The Netherlands and from one British Crown Dependency: Jersey, Table 1 and Appendix 2. In addition to these, shellfish imports have been received from Norway in 2012 (Tidbury et al. 2016). During

			2020-2022 there were 280 Pacific oyster consignments to Scotland, comprising well over 11 million animals (Senior Fish Health Inspector, Marine Directorate 2023). In the same time period there were 85 consignments of blue mussels to Scotland with a total weight of over 690,000 kg (Senior Fish Health Inspector, Marine Directorate, 2023).

Table 1. Number of bivalve imports to GB by year and source country.

Year	Source Country	*M. gigas*	*M. edulis*	Total bivalve imports
2020	Guernsey	25*		25
	Jersey	1*	1	2
	Republic of Ireland	22*	54	76
2021	France	11		11
	Guernsey	95		95
	Jersey	130	4	134
	Northern Ireland	6		6
	Republic of Ireland	98	37	135
	The Netherlands	1		1
2022	France	12		12
	Guernsey	50		50
	Italy		1	1
	Jersey	89	2	91
	Republic of Ireland	121	10	131
	The Netherlands		1	1

* Data for Scotland only

1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	unintentional transfer of eggs, juveniles or adults on live shellfish or on shellfish net bags during transfers of shellfish stock.		During import of oysters or mussels to GB.
Pathway name:	Unintentional transfer of eggs, juveniles or adults on live shellfish or on shellfish net bags during transfers of shellfish stock.		
1.3. Is entry along this pathway intentional (e.g., the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	accidental	very high	*Ocinebrellus inornatus* introductions into countries outside the risk assessment area have been as unintentional transfers of eggs, juveniles or adult individuals carried amongst imported Pacific oyster *Magallana gigas* imports (Galtsoff 1932 cited in Hannah 1966; Faasse and Ligthart 2009; Afonso 2011; Didderen and Gittenberger 2013).
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	moderately likely	medium	In 2010 UK Pacific Oyster imports amounted to 292 tonnes (Herbert et al. 2012). Murray et al. (2020) detail the Pacific oyster movement network for Scotland for the period of 2009-2012. During this period there were 547 movements of oysters within Scotland with oyster spat imports received directly from England, Guernsey and Jersey. In recent years Pacific oyster imports for Scotland were 13 tonnes in 2020, 21.5 tonnes in 2021 and 7 tonnes in 2022, originating from three source countries: The Republic of Ireland, Guernsey and Jersey (Pers Comms Senior Fish Health Inspector, Marine Directorate, 15 December 2022). During 2021, 2022 and first half of 2023 there were 475 Pacific oyster imports to England and Wales with Pacific oysters imported from France, Guernsey, Jersey, The Netherlands, Northern Ireland and

			Republic of Ireland (Cefas 2023). Among the source countries and Crown Dependencies, only France and The Netherlands have established populations of *O. inornatus* (de Montaudouin and Sauriau 2000; Martel et al. 2004; Faasse and Ligthart 2009). There has been one importation of oysters from The Netherlands to GB, this was in 2021. In 2021, 2022 and 2023 there were eleven, twelve and three import events, respectively, carried out from France to England and Wales (Cefas 2023). The import route from France to England and Wales is the only direct route for the organism to travel and therefore poses the highest risk of introducing *O. inornatus* to GB. Further detailed research is required to understand the full network of oyster imports and exports within and to GB.
1.5. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.	very likely	high	The *O. inornatus* is an intertidal gastropod and is used to daily emersion. The eggs, juveniles and the adults are known to survive the transfers from one location to another (Lützen et al. 2012). All known introductions of *O. inornatum* have been linked to Pacific oyster transfers which indicates that it is able to survive the transfer.
1.6. How likely is the organism to survive existing management practices during passage along the pathway?	moderately likely	medium	All bivalve imports to GB are regulated; the import of live shellfish to England and Wales is regulated by Department of Environment, Food and Rural Affairs (Defra) and Centre for Environment, Fisheries and Aquaculture Science (Cefas) and to Scotland by Marine Directorate, Fish Health Inspectorate. Marine Directorate in Scotland inspect all imported bivalves for diseases and for invasive non-native species (Pers Comms Senior Fish Health Inspector, Marine Directorate , 19 July 2023). For *M. gigas* and *M. edulis* imports to Scotland the following procedure

			is followed, as detailed by Senior Fish Health Inspector, Marine Directorate (2023). "In cases when non-native species are observed the inspector would note this down on the health certificate. If communication between the competent authorities is good, then hopefully one would inform the other of the species and then a decision would be made on whether to allow the import or not. Or, if the import was coming through a border control post, then the vet checking the consignment would decide to let it through or not. This decision would be based on the species observed, taking into account if they are invasive species or if they're a hitchhiker species, are they susceptible or vectors to the notifiable pathogens. There is no set species list, but the consignments are checked for all species." Cefas do not check bivalve imports for invasive non-native species coming into to England and Wales (Cefas pers. com., 15 August 2023). They rely on the official signing the health certificate to ensure the consignment only contains the specified species being imported, and that the health certificate states the correct required health declarations for the imported species (Cefas pers. com., 15 August 2023). From data received from Marine Directorate and Cefas for this RA, no bivalve imports from countries with known established populations of *O. inornatus* were imported to Scotland in 2020-2022 (Appendix 1 and 2). For England and Wales, bivalve imports from two countries, France and The Netherlands, with established populations of *O. inornatus* were received in 2021 and in 2022 (Appendix 1 and 2). These imports accounted 3.2% of all live shellfish movements to GB for the 2020-2023 period. Trade purposes for these imports were breeding (0.5%), purification (0.4%), human consumption (0.1%) and not known (2.3%). Unless shellfish from the 'not known' imports were for relaying, no *M. gigas* or *M. edulis* were destined for relaying in aquaculture facilities in England and Wales.

			The organism would be able to survive the transfer but current management practises i.e. low number of imports from countries with established *O. inornatus* populations and the trade purpose (as per data for 2020-23 period) have prevented the introduction of the organism in the risk assessment area. However, both source countries and the trade purpose can change at any point in time. Freshwater treatment, while effective for destroying some invasive species associated with shellfish and therefore recommended as part of robust biosecurity measures (e.g. Carman et al., 2016; Denny, 2008), is not effective at reducing the risk of Atlantic oyster drill *Urosalpinx cinerea* transfer on shellfish (Brink & Wijsman, 1993). No data for *O. inornatus* and freshwater treatment is available. The two species of oyster drills have similar life cycles which can be an indicator for comparable response to freshwater treatment.
1.7. How likely is the organism to enter the risk assessment area undetected?	likely	high	Unintentional transfer of eggs and juveniles on live shellfish or on shellfish net bags during transfers of shellfish stock is a known invasion pathway of this organism.
1.8. How likely is the organism to arrive during the months of the year most appropriate for establishment?	very likely	medium	*Ocinebrellus inornatus* has two egg laying periods, during spring and summer (Martel et al. 2004, Faasse and Ligthart 2009) increasing the chance of establishment after introduction. The species reaches reproductive maturity after the first year of growth and at reaching 27mm (Buhle et al. 2005; van den Brink and Wijsman 2010).
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very likely	very high	If the oyster or other bivalve transfers are for an operational shellfish site within GB, *O. inornatus* would be transferred directly to a suitable habitat.
1.10. Estimate the overall likelihood of	moderately likely	medium	Live bivalve imports to GB are mostly from countries or Crown

entry into the risk assessment area based on this pathway?			Dependencies where the organism is not present: Guernsey, Jersey, Republic of Ireland, Norway, Northern Ireland and Italy, Table 1, Tidbury et al. (2016), Murray et al (2020). In 2021 and 2022 twenty-four imports were from two countries with established populations of *O. inornatus:* The Netherlands (2 imports) and France (22 imports). The relatively low number of imports from these countries and the purpose of the imports, breeding, purification or for human consumption, indicates that the risk of introduction due to importing of oysters and mussels is possible but low. The purpose of importation could change at any point, highlighting the importance of recording both the source country and the purpose of the imports.
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into the risk assessment area based on all pathways (comment on the key issues that lead to this conclusion).	moderately likely	medium	See 1.6 and 1.10. A limited number, 2.3%, of all bivalve imports in 2020-2023, arrived from countries with established populations of *O. inornatus*, from these none were specified for relaying. The number of imports and the total number of consignments from countries where the species is present is low. The presence of fish health certification and biosecurity measures increases the chance of the species being detected at point of importation. Imports from hatcheries are low risk. The species has been in France for nearly 30 years and has not been introduced to the risk assessment area. Considering the above and with increased awareness of this species the risk of it entering on this pathway is unlikely.

PROBABILITY OF ESTABLISHMENT			
Important instructions: • For organisms which are already well established in the risk assessment area, only complete questions 1.15, 1.21 and 1.28 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
1.12. How likely is it that the organism will be able to establish in the risk assessment area based on the similarity between climatic conditions in the risk assessment area and the organism's current distribution?	very likely	very high	*Ocinebrellus inornatus* are found in estuarine and marine habitats and can survive at a wide range of sea water temperatures, including freezing temperatures of 0-1ºC (Faasse & Ligthart 2009; Fey-Hofstede et al. 2010). The climatic conditions of the risk assessment area are suitable for establishment.
1.13. How likely is it that the organism will be able to establish in the risk assessment area based on the similarity between other abiotic conditions in the risk assessment area and the organism's current distribution?	very likely	very high	The organism's current distribution, both native and invaded, is in fully saline habitat (Sherwood 1931, cited by Carlton 1979; de Montaudouin and Sauriau 2000; Afonso 2011; Faasse and Ligthart 2009; Lützen et al. 2012). In laboratory conditions the organism have been known to tolerate salinities as low as 23 PSU (Lützen et al. 2012). The Japanese oyster drill is typically found on substratum including gravel, mud, sand and shells, particularly where the *M. gigas* is present (Buhle et al. 2004). Suitable habitat for establishment is found throughout the risk assessment area.
1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in the risk assessment area? Subnote: gardens are not considered protected conditions	very likely	very high	The organism would be able to survive and establish in shellfish hatcheries as the conditions required for growing shellfish are suitable for the establishment of *O. inornatus*.

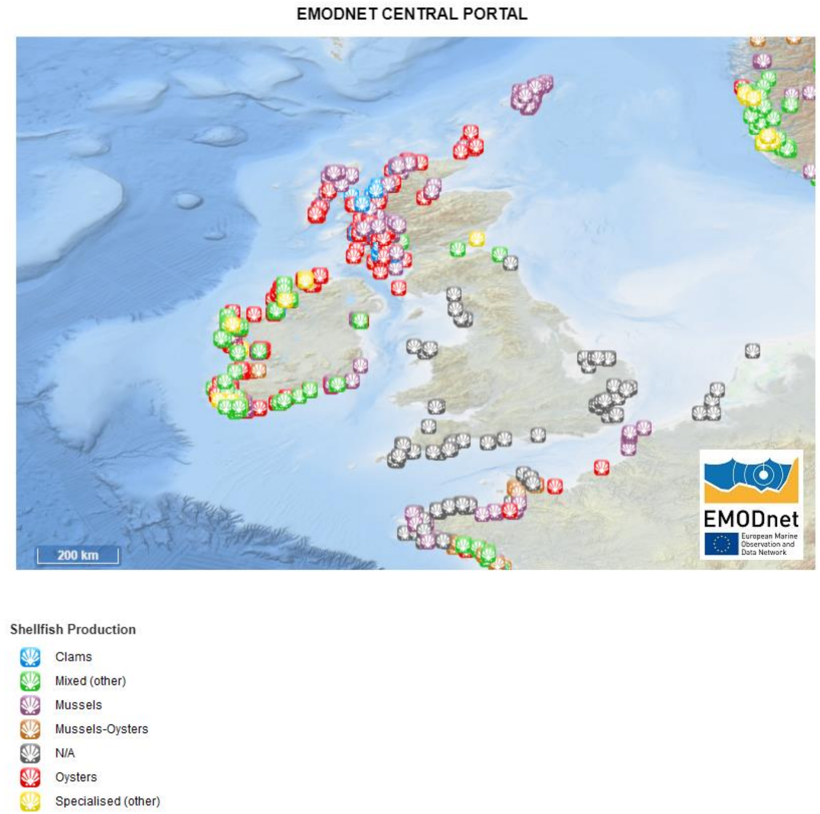
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in the risk assessment area?	widespread	high	Cumulatively Pacific oyster *Magallana gigas*, European flat oyster *Ostrea edulis* and blue mussel *Mytilus edulis* beds or cultivation sites cover most of the coastline in GB (Herbert et al. 2012; Tyler-Walters 2008; zu Ermgassen et al. 2021) and Section 2.4. *Ocinebrellus inornatus* prefer to lay their eggs on Pacific oyster shells and to feed on them (Chew 1960; Lützen et al. 2012; Didderen and Gittenberger 2013). In the absence of Pacific oysters, the organism will predate on European flat oysters *Ostrea edulis*, Olympia oysters *Ostrea lurida*, mussels *Mytilus edulis* and clams *Venerupis japonica* (Lützen et al. 2012). However even in the presence of these other bivalve species it always prefers to lay its eggs on Pacific oyster shells, this may be a limiting factor for its establishment (Lützen et al. 2012).
1.16. If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in the risk assessment area?	very likely	high	The organisms rely heavily on Pacific oyster *M. gigas* as a food source and substrate to attach egg cases on (Lützen 2012; Chew and Eisler 1958).
1.17. How likely is it that establishment will occur despite competition from existing species in the risk assessment area?	very likely	high	In France and The Netherlands, the *O. inornatus* has been co-existing with native European sting winkle *Ocenebra erinacea* (Faasse and Ligthart 2009).
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in the risk assessment area?	very likely	high	Egg cases and juveniles might be consumed by crabs, lobsters, fish and birds, there are no known predators of adults (Thinkport 2005, Fofonoff et al. 2022).
1.19. How likely is the organism to establish despite existing management practices in the risk assessment area?	highly likely	high	See Sections 1.6 and 1.10.
1.20. How likely are management practices in the risk assessment area to facilitate	likely	high	See Sections 1.6 and 1.10.

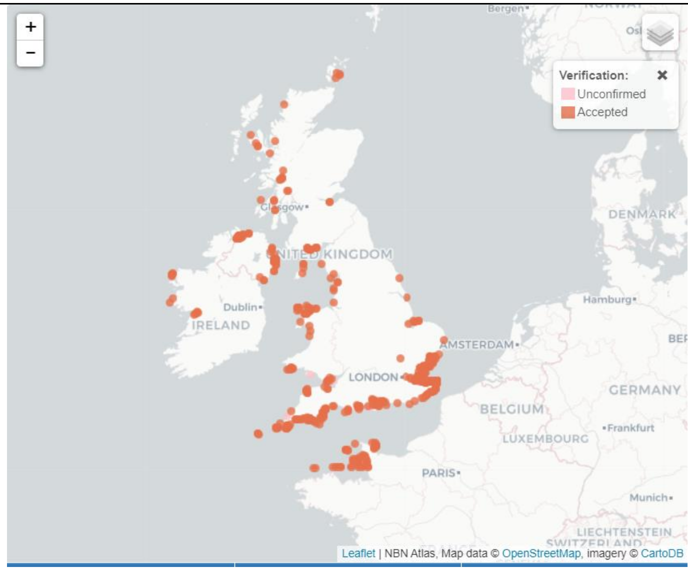
establishment?			
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in the risk assessment area?	highly likely	high	There are no known cases of successful eradication of the organism (Duckwall 2009; Lützen et al. 2012; Didderen and Gittenberger 2013).
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?	very likely	high	*Ocinebrellus inornatus* prefer to lay their eggs on Pacific oyster shells and to feed on them (Chew 1960; Lützen et al. 2012; Didderen and Gittenberger 2013). Both cultivated oyster beds and wild oysters are present in the risk assessment area indicating that *O. inornatus* would be able to reproduce and feed.
1.23. How likely is the capacity to spread of the organism to facilitate its establishment?	very unlikely	medium	Natural spread is limited due to lack of free-swimming larval stage.
1.24. How likely is the adaptability of the organism to facilitate its establishment?	moderately likely	medium	In the absence of Pacific oysters *O. inornatus* will predate on European flat oysters *Ostrea edulis*, Olympia oysters *Ostrea lurida*, mussels *Mytilus edulis* and clams *Venerupis japonica* (Lützen et al. 2012). However even in the presence of these other bivalve species it always prefers to lay its eggs on Pacific oyster shells, this may be a limiting factor for its establishment (Lützen et al. 2012).
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?	very likely	very high	Martel et al. (2004) researched the origins of the French populations of Japanese oyster drill. Their analyses of mitochondrial DNA and allozyme polymorphism concluded that the French population of oyster drills were closer to the American population that to the Asian oyster drills (Martel et al. 2004). The low genetic diversity within the source population from Asia to America to France has not hindered the establishment of this invasive species in Europe.
1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in the risk assessment area? (If possible, specify the instances in the comments box.)	very likely	high	Records of *O. inornatus* establishment have been reported from USA, Canada, France, Portugal, Denmark and The Netherlands (Carlton 1992; de Montaudouin and Sauriau 2000; Garcia-Meunier et al. 2002; Faasse and Ligthart 2009; Afonso 2011; Lützen et al. 2012). In USA the initial introduction was to Puget Sound, from there secondary

			introductions via oyster transports occurred in Canada and south along the coast to Oregon and California. Oyster transports from Puget Sound led to the introduction of *O. inornatus* to Marennes-Oléron Bay, France where it has since been regularly observed (de Montaudouin and Sauriau 2000; Afonso 2011). The similarity of GB's environmental conditions to areas of the invaded range of *O. inornatus* means the species is likely to establish in the risk assessment area.
1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in the risk assessment area but is established because of continual release, is an example of a transient species.	moderately likely	high	The risk of transient populations is possible if uncontrolled or infected shellfish transfers occur to the risk assessment area.
1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).	very likely	high	If *O. inornatus* enters the risk assessment area, it is very likely that it will establish.

PROBABILITY OF SPREAD			
Important notes: • Spread is defined as the expansion of the geographical distribution of a pest within an area.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
2.1. How important is the expected spread of this organism in the risk assessment area by natural means? (Please list and comment on the mechanisms for natural spread.)	minor	very high	Natural spread is limited to the movement of the adult oyster drills. *Ocinebrellus inornatus* life cycle has no planktonic phase, the eggs are laid on oyster shells and once hatched the juveniles settle directly to the substrate, natural spread is therefore very slow (Buhle and Ruesink 2009; van den Brink and Wijsman 2010; Lützen et al. 2012; Babaran 2017).
2.2. How important is the expected spread of this organism in the risk assessment area by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	moderate	high	Human mediated transfer of Pacific oysters from one site to another is the main route of spread for *O. inornatus*. If *O. inornatus* are present at oyster cultivation sites, it is likely that both species are co-transferred resulting in spread of the invasive *O. inornatus*. The organism could also be transferred amongst blue mussel *M. edulis* stock. The oyster and mussel transfer network within GB is unknown and it is therefore difficult to estimate the potential spread. Scotland, England and Wales are in the same health zone, businesses carrying out shellfish movements from one country to another are not required to notify the relevant fish health inspectorates of these movements.
2.3. Within the risk assessment area, how difficult would it be to contain the organism?	with some difficulty	high	*Ocinebrellus inornatus* is an intertidal species and is often limited to oyster or mussel beds due to its limited ability for natural spread. This will enable a degree of containment in the natural environment. However, the species can occupy sub-tidal habitats where containment would be difficult.

2.4. Based on the answers to questions on the potential for establishment and spread in the risk assessment area, define the area endangered by the organism.	shellfish beds, cultivated and natural	high	Suitable habitat for establishment is available throughout the risk assessment area. Shellfish production sites are located all around the GB coastline, with the highest number in Scotland, Figure 1. The data for the European Marine Observation and Data Network (EMODnet) was collated in 2014 and shows active and inactive shellfish aquaculture sites. These data are old but can be used as an indication of shellfish productions sites in the risk assessment area. Pacific oyster *M. gigas* records from the natural environment have been reported from the risk assessment area with highest number of records from south coast of England, Figure 2.

			 Figure 1. Shellfish production sites in GB, shellfish production database was created in 2014. EMODnet Map Viewer https://emodnet.ec.europa.eu/geoviewer/ Accessed 19/07/2023.

			 Figure 2. Pacific oyster *Magallana gigas* records from NBN Atlas. https://species.nbnatlas.org/species/NHMSYS0021185273#overview Accessed 19/07/2023.
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of the risk assessment area where the species could establish), if any, has already been colonised by the organism?	0-10	high	*Ocinebrellus inornatus* is not present in GB.
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0-10	medium	In Portugal six years after the first record of a single specimen of *O. inornatus* it was found in significant numbers, after a further three years it was common amongst the oyster cultures and harbour rock environment (Afonso 2011). This indicates that within 11 years from introduction the organism had established and dispersed within a small fishing harbour, but no mention of actual distance or scale was stated (Afonso 2011). If only natural spread is considered, then within 5 years a single oyster

			growing site would have an established *O. inornatus* population. If uncontrolled oyster transfers within the risk assessment area are considered, then several sites might have established populations of the organism within 5 yrs. It is not possible to know the exact number of sites as oyster transfers within the risk assessment area are in the same health zone and it is not required to notify the relevant fish health inspectorates of these movements.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in the risk assessment area? (Please comment on why this timeframe is chosen.)	20	medium	In the Portuguese case it took the organism 11 years to establish in a single site. If uncontrolled oyster or mussel transfers were to be carried out in the risk assessment area it would be possible for the organism to have significant further spread in the risk assessment area within 20 years.
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	0-10	low	Natural spread would be low. Without knowing the current oyster and mussel transfer network within the risk assessment area, it is not possible to estimate the proportion of area / habitat that would be invaded. If links with all oyster growing sites and wild oyster habitats are active, it is possible that a large proportion, if not all of the habitat, would be invaded.
2.9. Estimate the overall potential for future spread for this organism in the risk assessment area (using the comment box to indicate any key issues).	slowly	medium	Natural spread of *O. inornatus* is very slow and limited to the movement of the adult oyster drills. The shellfish transfer network within GB is unknown and it is therefore difficult to estimate the potential spread. Scotland, England and Wales are in the same health zone, businesses carrying out oyster movements from one country to another are not required to notify the relevant fish health inspectorates of the movements.

PROBABILITY OF IMPACT			
Important instructions: • When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment. • Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section). • Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in the risk assessment area separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENTS**
2.10. How great is the economic loss caused by the organism within its existing geographic range **excluding the risk assessment area**, including the cost of any current management?	moderate	low	*Ocinebrellus inornatus* can have a detrimental impact on cultivated oysters. It can cause 25-50% mortality of Pacific oyster stocks (Duckwall 2009) and in field experiments *O. inornatus* accounted for up to 70% of total mortality on native oysters (Grason and Buhle 2016). In *O. inornatus* infested areas of Washington USA, the shellfish production costs increased by 20% and profits decreased by 50% due to the drill infestation (Elston 1997 in Fey et al 2010). However, Buhle and Ruesink (2009) considered the effect of *O. inornatus* on oyster populations to be moderate. No management costs were included in searched literature. Management measures include hanging the oysters on trellises and manually collecting eggs or adults (Buhle et al. 2005), all of these are labour intensive indicating moderate to hight cost implications.
2.11. How great is the economic cost of the organism **currently** in the risk assessment area **excluding management** costs (include any past costs in your response)?			Not present.

2.12. How great is the economic cost of the organism likely to be **in the future** in the risk assessment area **excluding management** costs?	moderate	low	Costs are likely to include: • Reduced production of oysters due to mortality of oyster populations. and • Increased husbandry costs in aquaculture installations. Fey et al. (2010) described a 'worst case' scenario following an invasion of *O. inornatus* of all mussel plots in Wadden Sea, causing a 25% mortality which corresponds with a loss of 6.5 million kg of mussels with a value of 9.5 million Euro. Using 2011/12 market prices, the value of the UK Pacific oyster industry was estimated at £13 million (Annual Gross Output, being 5 times the first sale value), and over £10 million Gross Value Added (GVA) for total UK production (Syvret et al., 2021). If the organism was widespread, cost to the oyster production industry could be in millions of pounds. In field experiments *O. inornatus* accounted for up to 70% of total mortality on native oysters (Grason and Buhle 2016).
2.13. How great are the economic costs **associated with managing** this organism **currently** in the risk assessment area (include any past costs in your response)?			Not present.
2.14. How great are the economic costs **associated with managing** this organism likely to be **in the future** in the risk assessment area?	moderate	medium	Management costs would be linked to the manual removal of eggs and adult *O. inornatus* from oyster beds or lifting oyster cultures off the ground. Other costs may include: the introduction of a formal monitoring system for *O. inornatus* and other NNS using both traditional and eDNA survey methods, introduction of controls and mandatory requirement for reporting all movements of oysters and mussels into and within GB, including testing for NNS. The costs for these are unknown.
2.15. How important is environmental harm caused by the organism within its existing geographic range **excluding the**	moderate	high	*Habitat alternation* Fey-Hofstede et al. (2010) note that if native bivalves are fundamental to the local ecosystem by providing habitats and food for other native species, the

risk assessment area?			*O. inornatus* has the potential to alter the local environment. This has especially been a cause of concern for native oyster restoration projects in America and in Europe (Gillespie 1999; Buhle and Ruesink 2009; Duckwall 2009; van den Brink and Wijsman 2010; Babaran 2017; Zu Ermgassen et al. 2021). *Threat to native species* *Ocinebrellus inornatus* can devastate native bivalve populations (Duckwall 2009; van den Brink and Wijsman 2010).
2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) **currently** in the risk assessment area (include any past impact in your response)?			Not present.
2.17. How important is the impact of the organism on biodiversity likely to be in the **future** in the risk assessment area?	moderate	medium	*Threat to native species* *Ocinebrellus inornatus* has the potential to cause a decline in native bivalve populations as it is known to prey on European flat oysters *Ostrea edulis* and blue mussels *Mytilus edulis* (Lützen et al. 2012). This could severely impact the native oyster restoration programmes (zu Ermgassen et al. 2020). In France *O. inornatus* has outcompeted native oyster drills *Ocenebra erinacea* (Lützen et al. 2012). *Control of feral Pacific oysters* There is also potential for *O. inornatus* to be able to control feral populations of non-native Pacific oyster *M. gigas.*
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism **currently** in the risk assessment area (include any past impact in your response)?			Not present.

2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism likely to be in the risk assessment area in the **future**?	moderate	high	Native bivalves are fundamental to the local ecosystem by providing habitats and food for other native species, by predating on native oysters *O. inornatus* has the potential to alter the local environment (Fey-Hofstede et al. 2010).
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism **currently** in the risk assessment area?			Not present.
2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism likely to be in the **future** in the risk assessment area?	moderate	medium	The presence of non-native species has the potential to affect WFD classification negatively, positively or not at all (Harrower et al. 2021). Due to its invasive nature and potential for altering ecosystems and devastating oyster populations, *O. inornatus* would most likely have a negative effect on the WFD classification. This species may also have an impact on natural biogenic reefs through the removal of reef forming species (oysters and mussels) (Tillen *et al.* 2020). The impact of *O. inornatus* on oysters may threaten the success of native oyster restoration work being undertaken in the risk assessment area.
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	minimal	high	There is no evidence of hybridisation with other species or viral mediated gene transfer.
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	minimal	high	None reported.

2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	minimal	high	In laboratory experiments red rock crabs (*Cancer productus*) native to USA consumed both *O. inornatus* and *Urosalpinx cinerea* at approximately the same rate when either prey was offered (Grason and Miner 2012a). Red rock crabs had a strong preference for juvenile oysters when they were allowed to choose among three prey items (Grason and Miner 2012b). No evidence or examples of the organism as food, a host or a vector for other damaging organisms were reported.
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box)	n/a		There is potential for *O. inornatus* to be able to control feral populations of non-native Pacific oyster *M. gigas.*
2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in the risk assessment area?	moderate	high	The edible crab *Cancer pagurus* is a potential predator of *O. inornatus* in NW Europe (Lützen et al. 2012). *Cancer pagurus* is also native to GB and could therefore be a predator of *O. inornatus* in the risk assessment area. There is potential that other native crabs could prey on the organism.
2.27. Indicate any parts of the risk assessment area where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	all shellfish productions sites	high	See Section 2.4. Shellfish production sites provide ideal habitat for *O. inornatus* with environmental conditions suitable for establishment.
2.28. Estimate the overall impact of this organism in the risk assessment area (using the comment box to indicate any key issues).	moderate	medium	If established, *O. inornatus* could have a moderate impact on cultivated and native oyster populations in GB.

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	moderately likely	medium	*Ocinebrellus inornatus* has not been recorded from GB. Main worldwide pathway of introduction for Japanese oyster drill *Ocinebrellus inornatus* is the unintentional transfer of eggs, juveniles or adults on live Pacific oyster *Magallana gigas* and blue mussel *Mytilus edulis* transfers. Limited number, 2.3% of all bivalve imports in period of 2020-2023, arrived from countries with established populations of *O. inornatus*, from these none were specified for relaying. The source country and purpose of importation could change at any point highlighting the importance of vigilance, recording and monitoring of both by inspectors.
Summarise Establishment	very likely	high	The environmental conditions and habitat availability are favourable for successful establishment of *O. inornatus* in the risk assessment area.
Summarise Spread	slowly	medium	Natural spread of *O. inornatus* is very slow and limited to the movement of the adult oyster drills as the species has no larval phase. Secondary spread through uncontrolled shellfish transfers within the risk assessment area would increase the speed of the spread of the species. There is no requirement to report any shellfish transfers within the risk assessment area as all countries within GB are in the same health zone.
Summarise Impact	moderate	medium	Once established *O. inornatus* could have a detrimental impact on cultivated oyster farms causing reduced production due to predation, increased management costs due to eradication efforts, and therefore leading to increased economic losses for the shellfish industry. Native oyster restoration projects could be hindered by the presence of *O. inornatus*.
Conclusion of the risk assessment	medium	low	The relatively low number of imports from countries with established *O. inornatus* populations and the purpose of the imports (breeding, purification or for human

			consumption) indicates that currently the risk of introduction due to importing of oysters and mussels is possible but low. The source and trade purpose could change at any time. If an introduction were to occur the risk of establishment would be high due to the availability of suitable habitat and suitable environmental conditions. Natural spread is very slow due to lack of larval phase. If established, the management costs of this organism to shellfish aquaculture could be in millions of pounds.

Additional questions are on the following page ...

ADDITIONAL QUESTIONS – CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	Temperature Precipitation Extreme weather events	high	No direct evidence reported, indirect affects due to reduced prey and habitat. Combination of anthropogenic stressors, including increased sea surface temperature, precipitation and extreme weather events, were considered to be the key factors for the decline of blue mussels *M. edulis* in Sweden (Baden et al. 2021). As *O. inornatus* use mussels as prey there is potential for reduced availability of prey. Warming sea water temperatures accelerate the range expansion of *M. gigas* (King et al. 2021). This will support the northwards expansion of the feral populations of *M. gigas*, this in turn would increase the available habitat for *O. inornatus* (Cook et al. 2013).
3.2. What is the likely timeframe for such changes?	20years	high	Blue mussels are already in decline in Sweden and in the north Atlantic (Baden et al. 2021). Climate warming is likely to affect *M. gigas*, approximately in the next 30+ years (Abe 2021; King et al. 2021).
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	Establishment, Spread	high	Establishment and Spread of the organism are related to habitat and food availability both of which can be affected by climate change.
ADDITIONAL QUESTIONS – RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	Yes	high	Further detailed research is required to understand the full network of oyster and mussel imports and exports within and to GB. Cost implications of *O. inornatus* invasion are unclear. Further research into costs relating to management and eradication and economic losses for Pacific oyster and blue mussel industry are recommended. Need to understand how much of a risk *O. inornatus* is to native species as it prefers Pacific oysters *M. gigas* as food and habitat.

REFERENCES:

Abe, H. 2021 Climate warming promotes Pacific oyster (*Magallana gigas*) production in a subarctic lagoon and bay, Japan: Projection of future trends using a three dimensional physical-ecosystem coupled model, Regional Studies in Marine Science, 47, p. 101968. https://doi.org/10.1016/j.rsma.2021.101968

Amano, K., & Vermeij, G. J. 1998. Taxonomy and evolution of the genus Ocinebrellus (Gastropoda: Muricidae) in Japan. Paleontological Research, 2(3), 199-212.

Afonso, C.M.L. 2011. Non-indigenous Japanese oyster drill *Pteropurpura (Ocinebrellus) inornata* (Récluz, 1851)(Gastropoda: Muricidae) on the South-west coast of Portugal. Aquatic Invasions, 6(1), pp.85-88. Doi: 10.3391/ai.2011.6.S1.019

Babaran, D., 2017. Japanese oyster drills (*Ocinebrellus inornatus*): Exploring Prey Size and Species Preference in The Netherlands. Delta Academy Final Report, pp.50.

Baden, S., Hernroth, B. and Lindahl, O., 2021. Declining populations of *Mytilus* spp. in North Atlantic coastal waters—a Swedish perspective. Journal of Shellfish Research, 40(2), pp.269-296.

Buhle, E.R., Margolis, M. and Ruesink, J.L. 2005. Bang for buck: cost-effective control of invasive species with different life histories. Ecological Economics, 52(3), pp.355-366.

Buhle, E.R. and Ruesink, J.L. 2009. Impacts of invasive oyster drills on Olympia oyster (Ostrea lurida Carpenter 1864) recovery in Willapa Bay, Washington, United States. Journal of Shellfish Research, 28(1), pp.87-96.

Carman, M. R., Lindell, S., Green-Beach, E., & Starczak, V. R. 2016. Treatments to eradicate invasive tunicate fouling from blue mussel seed and aquaculture socks. Management of Biological Invasions, 7(1), 101–110. https://doi.org/10.3391/MBI.2016.7.1.12

Carlton, J.T. 1979. History, biogeography, and ecology of the introduced marine and estuarine invertebrates of the Pacific Coast of North America., Ph.D. dissertation, University of California, Davis. Pp. 1-904

Carlton, J.T. 1992. Introduced marine and estuarine mollusks of North America: an end-of-the-20th-century perspective. Journal of shellfish research, 11(2), pp.489-505.

Cefas, 2023. Information received under Freedom of Information requests: 726, 732, 733. Includes Crown copyright.

Chew, K.K. 1960. Study of food preference and rate of feeding of Japanese Oyster Drill, *Ocinebra japonica* (Dunker) (No. 365). US Department of Interior, Fish and Wildlife Service.

Chew, KK, and Eisler R. 1958. A preliminary study of the feeding habits of the Japanese oyster drill, *Ocinebra japonica*. Journal of the Fisheries Research Board of Canada 15: 529–535, http://dx.doi.org/10.1139/f58-025

Choe, B.L. and Park, J.K. 1997. Description of muricid species (Gastropoda: Neogastropoda) collected from the coastal areas of South Korea. Korean Journal of Biological Sciences, 1(2), pp.281-296.

Cook, E.J., Jenkins, S., Maggs, C.A., Minchin, D., Mineur, F., Nall, C. and Sewell, J., 2013. Impacts of climate change on non-native species. Marine Climate Change Impact Partnership: Science Review, pp.155-166.

Denny, C. M. 2008. Development of a method to reduce the spread of the ascidian *Didemnum vexillum* with aquaculture transfers. ICES Journal of Marine Science, 65(5), 805–810. https://doi.org/10.1093/icesjms/fsn039

Didderen, K. and Gittenberger, A. 2013. Distribution and risk analysis of the American and Japanese oyster drill (*Urosalpinx cinerea*, *Ocenebra inornata*) update 2013. Bureau Waardenburg report, (13-203), p.76.

Duckwall, L., 2009. Pacific Northwest Aquatic Invasive Species Profile, Japanese Oyster Drill *Ocinebrellus inornatus*. Pp.12.

Faasse, M. and Ligthart, M. 2009. American (*Urosalpinx cinerea*) and Japanese oyster drill (*Ocinebrellus inornatus*) (Gastropoda: Muricidae) flourish near shellfish culture plots in The Netherlands. Aquatic Invasions, 4(2), pp.321-326.

Fey-Hofstede, F.E., van den Brink, A.M., Wijsman, J.W.M. and Bos, O.G. 2010. Risk assessment on the possible introduction of three predatory snails (*Ocinebrellus inornatus*, *Urosalpinx cinerea*, *Rapana venosa*) in the Dutch Wadden Sea (No. C032/10). IMARES.

Fofonoff, P. W., Ruiz, G. M., Steves, B., Simkanin, C., & Carlton, J. T. 2022. National Exotic Marine and Estuarine Species Information System. Available from: http://invasions.si.edu/nemesis. [Accessed 14 December 2022]

Garcia-Meunier, P., Martel, C., Pigeot, J., Chevalier, G., Blanchard, G., Goulletquer, P., Robert, S. and Sauriau, P.G. 2002. Recent invasion of the Japanese oyster drill along the French Atlantic coast: identification of specific molecular markers that differentiate Japanese, *Ocinebrellus inornatus*, and European, *Ocenebra erinacea*, oyster drills. Aquatic Living Resources, 15(1), pp.67-71.

GBIF 2022a. *Ocinebrellus inornatus* (Récluz, 1851) in GBIF Secretariat (2022). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2022-12-16.

GBIF 2022b. Ocinebrellus inornatus (Récluz, 1851) in GBIF Secretariat (2022). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2023-06-27.

Grason, E.W. and Buhle, E.R. 2016. Comparing the influence of native and invasive intraguild predators on a rare native oyster. Journal of Experimental Marine Biology and Ecology, 479, pp.1-8.

Grason, E.W. and Miner, B.G., (2012a) Preference alters consumptive effects of predators: top-down effects of a native crab on a system of native and introduced prey, PLOS ONE 7(2): e51322

Grason, E.W. and Miner, B.G. (2012b) Behavioral plasticity in an invaded system: non-native whelks recognize risk from native crabs, Oecologia 169: 105-115

Hanna, G. 1966. Introduced mollusks of Western North America. Occasional Papers of the California Academy of Sciences 48. Pp.108.

Harrower, C., Jones, J.I., Kratina, P., Murphy, J.F., Peyton, J., Pretty, J.L., Rorke, S., Roy, H. 2021. Linking the presence of invasive alien species to measures of ecological quality. Chief Scientist's Group report, May 2021, SC170007/R , Environment Agency, Pp. 254.

Herbert, R.J.H., Roberts, C., Humphreys, J. and Fletcher, S. 2012. The Pacific oyster in the UK: Economic, legal and environmental issues associated with its cultivation, wild establishment and exploitation. For: Shellfish Association of Great Britain, London

King, N.G., Wilmes, S.B., Smyth, D., Tinker, J., Robins, P.E., Thorpe, J., Jones, L. and Malham, S.K., 2021. Climate change accelerates range expansion of the invasive non-native species, the Pacific oyster, Crassostrea gigas. *ICES Journal of Marine Science*, *78*(1), pp.70-81.

Lützen J, Faasse M, Gittenberger A, Glenner H, Hoffmann E., 2012. The Japanese oyster drill *Ocinebrellus inornatus* (Récluz, 1851) (Mollusca, Gastropoda, Muricidae), introduced to the Limfjord, Denmark. Aquatic Invasions, 7(2):181-191 http://dx.doi.org/10.3391/ai.2012.7.2.004

Marine Directorate 2023. Information received during email correspondence with Senior Fish Health Inspector, Marine Scotland - Science in December 2022 and July 2023.

Martel, C., Viard, F., Bourguet, D. and Garcia-Meunier, P., 2004. Invasion by the marine gastropod *Ocinebrellus inornatus* in France: I. Scenario for the source of introduction. Journal of Experimental Marine Biology and Ecology, 305(2), pp.155-170.

MolluscaBase eds. 2022. MolluscaBase. *Ocinebrellus inornatus* (Récluz, 1851). Accessed through: World Register of Marine Species at: https://www.marinespecies.org/aphia.php?p=taxdetails&id=578702 on 2022-12-02

de Montaudouin, X. and Sauriau, P.G. 2000. Contribution to a synopsis of marine species richness in the Pertuis Charentais Sea with new insights in soft-bottom macrofauna of the Marennes-Oléron Bay. Cahiers de Biologie marine, 41(2), pp.181-222.

Murray, A.G., Munro, L.A. and Matejusova, I. 2020. The network of farmed Pacific oyster movements in Scotland and routes for introduction and spread of invasive species and pathogens. Aquaculture, 520, p.734747.

National Research Council. 2004. Nonnative Oysters in the Chesapeake Bay. Washington, DC: The National Academies Press. https://doi.org/10.17226/10796.

Roy, H.E., Peyton, J., Rorke S. 2019. Horizon-scanning for invasive alien species with the potential to threaten biodiversity and ecosystems, human health and economies in Britain. UK Centre for Ecology & Hydrology. Pp.25

Syvret, M., Horsfall, S., Humphreys, J., Williams, C., Woolmer, A., & Adamson, E. (2021). The Pacific Oyster: Why we should love them. For: Shellfish Association of Great Britain.

Thinkport 2005. Maryland Bayville Factsheet – Oyster drills – the oyster's enemy. Available from: https://pdf4pro.com/view/oyster-drills-the-oyster-s-enemy-thinkport-org-4689e3.html [Accessed 14 December 2022]

Tidbury, H.J., Taylor, N.G., Copp, G.H., Garnacho, E. and Stebbing, P.D., 2016. Predicting and mapping the risk of introduction of marine non-indigenous species into Great Britain and Ireland. Biological Invasions, 18, pp.3277-3292.

Tillin, H.M., Kessel, C., Sewell, J., Wood, C.A., Bishop, J.D.D. 2020. Assessing the impact of key Marine Invasive Non-Native Species on Welsh MPA habitat features, fisheries and aquaculture. NRW Evidence Report. Report No: 454, 260pp, Natural Resources Wales, Bangor.

Tyler-Walters, H. 2008. *Mytilus edulis* Common mussel. In Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 14-12-2022]. Available from: https://www.marlin.ac.uk/species/detail/1421

van den Brink, A.M. and Wijsman, J.W.M., 2010. High risk exotic species with respect to shellfish transports from the Oosterschelde to the Wadden Sea (No. C025/10). IMARES.

Zu Ermgassen, P.S., Bos, O., Debney, A., Gamble, C., Glover, A., Pogoda, B., Pouvreau, S., Sanderson, W. and Smyth, D. 2021. European Native Oyster Habitat Restoration Monitoring Handbook. Pp. 39.

Zu Ermgassen, P.S.E., Gamble, C., Debney, A., Colsoul, B., Fabra, M., Sanderson, W.G., Strand, Å. and Preston, J. (eds) (2020). European Guidelines on Biosecurity in Native Oyster Restoration. The Zoological Society of London, UK., London, UK.

APPENDIX 1.

SCOTLAND – Pacific oyster *Magallana gigas* import data (Marine Directorate 2023)

Year	Trade purpose	No. of movements	Stage	Number	Weight (Kg)	Source Country
2020	Human Consumption	1	Adult		1,000	Jersey
2020	Relaying	7	Spat	2,435,000		Guernsey
2020	Scientific Research	6	Adult	44		Guernsey
2020	Human Consumption	11	Adult		12,000	Guernsey
2020	Human Consumption	1	Adult	10,000		Guernsey
2020	Relaying	3	Spat	1,588,300		Republic of Ireland
2020	Human Consumption	19	Adult	228,000		Republic of Ireland
2021	Relaying	8	Spat	3,607,000		Guernsey
2021	Scientific Research	5	Adult	42		Guernsey
2021	Scientific Research	1	Spat		0.15	Guernsey
2021	Human consumption	17	Adult		21,500	Guernsey
2021	Human Consumption	80	Adult	870,500		Republic of Ireland
2022	Relaying	11	Spat	3,525,000		Guernsey
2022	Relaying	1	Spat		150	Guernsey
2022	Relaying	1	Adult		500	Guernsey
2022	Human consumption	7	Adult		6,350	Guernsey
2022	Human consumption	100	Adult	1,457,150		Republic of Ireland

ENGLAND and WALES - Pacific oyster *Magallana gigas* import data (Cefas 2023)

Year	Trade purpose	No. of movements	Stage	Number	Weight (Kg)	Source Country
2021	Not known	3	Not known		11,000	France
2021	Not known	8	Not known	Not known	Not known	France
2021	Not known	21	Not known			Guernsey
2021	Not known	43	Not known		2,066,165	Guernsey
2021	Not known	62	Not known			Jersey
2021	Not known	32	Not known	211,110		Jersey
2021	Not known	36	Not known		74,909	Jersey
2021	Not known	1	Not known			The Netherlands
2021	Not known	4	Not known		1,464	Northern Ireland
2021	Not known	2	Not known	544		Northern Ireland
2021	Not known	2	Not known		1,050	Republic of Ireland
2021	Not known	12	Not known	11,700		Republic of Ireland
2021	Not known	4	Not known	Not known	Not known	Republic of Ireland
2022	Breeding	3	Not known	19,199,000		France
2022	Breeding	1	Not known		58	France
2022	Purification	2	Not known	20,000		France
2022	Purification	1	Not known		110	France
2022	Not known	3	Not known	6,601,373		France
2022	Not known	2	Not known		601,500	France
2022	Breeding	1	Not known		25	Guernsey
2022	Breeding	7	Not known	2,230,000		Guernsey
2022	Relaying	13	Not known		18,000	Guernsey
2022	Research	2	Not known	20		Guernsey
2022	Sample	2	Not known	240		Guernsey

2022	Not known	5	Not known		6,500	Guernsey
2022	Purification	33	Not known		59,180	Jersey
2022	Relaying	26	Not known		79,100	Jersey
2022	Research	1	Not known		6	Jersey
2022	Sample	4	Not known		21	Jersey
2022	Not known	25	Not known		42,000	Jersey
2022	Breeding	2	Not known	868,000		Republic of Ireland
2022	Relaying	6	Not known		3,700	Republic of Ireland
2022	Relaying	5	Not known	1,187,700		Republic of Ireland
2022	Human Consumption	3	Not known	2,360		Republic of Ireland
2022	Human Consumption	4	Not known		5,800	Republic of Ireland
2022	Commercial Sale	1	Not known	700		Republic of Ireland

APPENDIX 2.

SCOTLAND - Blue mussel *Mytilus edulis* import data (Marine Directorate 2023)

Year	Trade purpose	No. of movements	Stage	Number	Weight (Kg)	Source Country
2020	Relaying	54	Spat	396,000		Republic of Ireland
2021	Relaying	31	Spat	9,564		Republic of Ireland

ENGLAND and WALES - Blue mussel *Mytilus edulis* import data (Cefas 2023)

Year	Trade purpose	No. of movements	Stage	Number	Weight (Kg)	Source Country
2020	Not recorded	1	Not known	Not recorded	Not recorded	Jersey
2021	Scientific Research	1	Not known		1	Jersey
2021	Human Consumption	1	Not known		1	Jersey
2021	Not recorded	1	Not known		1	Jersey
2021	Not recorded	1	Not known	Not recorded	Not recorded	Jersey
2021	Human Consumption	1	Not known	55,000		Republic of Ireland
2021	Human Consumption	1	Not known		6,000	Republic of Ireland
2022	Human Consumption	1	Not known	10,000		Italy
2022	Sample	2	Not known		4	Jersey
2022	Commercial sale	1	Not known	9,000		Republic of Ireland
2022	Human Consumption	7	Not known	64,000		Republic of Ireland
2022	Human Consumption	2	Not known		19,000	Republic of Ireland
2022	Human Consumption	1	Not known		250	The Netherlands