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IUCN Red List of selected molluscs and echinoderms in Great Britain

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Summary

This report presents the first attempt to assess the extinction risk of selected marine molluscs and echinoderms in the coastal and offshore waters of Great Britain, applying the IUCN Red List Categories and Criteria at a regional scale. The assessment followed the standard three-step process: defining the region and taxa, assigning preliminary status using global criteria, and adjusting for potential interactions with populations outside the region. The final categorisation reflects the risk of extinction within Great Britain.

Species were drawn from the Marine Species of the British Isles and Adjacent Seas list, with families selected that were relatively well recorded. Non-native species, vagrants, and taxa with insufficient evidence were excluded. In total, 117 species were assessed, representing approximately 6% of molluscs and 4% of echinoderms known from British waters.

The evidence base combined occurrence records from the National Biodiversity Network Atlas and GBIF, trait databases, published literature, and expert knowledge. Key metrics included extent of occurrence, area of occupancy, life history traits, and known threats. However, data limitations were significant: population size and trends were unknown for all species, and no quantitative extinction risk analyses could be undertaken. For many species, particularly those that are small, infaunal or occur offshore, under-recording meant that estimates of abundance and range were likely to be conservative.

The majority of species were assessed as Least Concern, reflecting broad distribution and the absence of evidence for recent declines. A substantial proportion were classed as Data Deficient, largely due to sparse records or identification challenges. A small number of species were assessed as Vulnerable, either because of historical declines or restricted distribution. These include *Arctica islandica*, listed under Criterion A2a due to past reductions linked to fishing activities, and several species assessed under Criterion D2, such as the snails *Boreotrophon clathratus* and *Jujubinus striatus*, and the urchins *Paracentrotus lividus* and *Strongylocentrotus droebachiensis*, all of which have very limited area of occupancy and occur at few locations.

The discussion highlights the profound challenges of applying Red List criteria to marine invertebrates. Monitoring of subtidal and offshore habitats is sparse, costly, and biased towards accessible areas, resulting in major knowledge gaps. For many species there is little knowledge of key aspects of ecology and life history to support assessment. While some species have benefited from regulatory changes, such as the recovery of dogwhelk populations following the ban on tributyltin (TBT), others remain vulnerable to pressures including bottom trawling, habitat loss, and climate-driven range shifts. Climate change is expected to drive range shifts, benefiting some southern species while increasing vulnerability for northern taxa.

In summary, most assessed species are not currently at high risk of extinction, but the lack of robust data means that confidence in many assessments is low. The report concludes that further GB Red List assessments on additional marine invertebrate families is not recommended at present. Future progress will depend on improved monitoring, enhanced data flows, and the adoption of new technologies such as environmental DNA and automated image recognition to address the substantial evidence gaps that currently constrain species-level assessments.

Contents

1. Introduction

Here we report on the first attempt to assess the extinction risk faced by selected marine molluscs and echinoderms in the coastal and marine waters of Great Britain (the region being considered: England, Scotland, Wales) to the edge of the Economic Exclusion Zone. This excludes Northern Ireland and the self-governing British Crown Dependencies of the Isle of Man, Guernsey and Jersey.

The Phylum Mollusca embraces several animal classes occupying all habitats and having a variety of body forms. Marine molluscs include chitons (coat-of-mail shells), gastropods (limpets, snails, sea slugs, etc), bivalves (clams, oysters, mussels etc), cephalopods (octopuses, nautiluses, squids, cuttlefish etc) and scaphopods (tusk shells). Very few of these have been subject to IUCN Red List assessments and none at a GB scale. The families included in this project are found in a wide range of habitats, including the intertidal zone, shallow subtidal and deeper offshore waters and encompass a range of functional types, including, filter feeders, grazers and predators. We included species subject to commercial exploitation as well as those which are currently unexploited.

Echinoderms are a solely marine phyla, dominant in many soft and hard bottom marine assemblages. The phylum contains a variety of trophic groups, including detritovores, filter-feeders, grazers, scavengers and active predators, and as such play an important role in the structure and functioning of benthic communities. Echinoderms may compete for food resources with demersal fish and predate on commercially important bivalves and be a major food source for fish and are commercially exploited (e.g. *Echinus esculentus*, *Paracentrotus lividus*).

The process of undertaking IUCN Red List assessments is comprehensively documented (e.g. IUCN 2012a, 2012b, 2022). In short, available data are collated, summarised to produce standard metrics and compared against strictly defined criteria to determine which Red List category a species should be placed. The report outlines the methodology applied and the results obtained for the taxa selected. Issues that arose relating to assessing the available mollusc and echinoderm data within this framework are fully discussed, including specific problems of applying the standard methodology to marine species with large ranges and broadscale larval dispersal, operating within the constraints of politically, rather than geographically defined territories (see Hawkins 2017 for comments on the mismatch of political and legislative boundaries with marine ecological processes).

2. Methods

2.1. Regional assessments

Regional assessments are carried out in a three-step process. Firstly, assessors must define the region, then determine which taxa and which regional populations to assess (step one). Next, the regional population size, trend (decline) and range for each taxon is evaluated according to the IUCN Red List Global Categories and Criteria (IUCN 2012a), and a preliminary status category is assigned (step two). The effect of populations of the same taxon in neighbouring regions on the regional population is then considered, and the preliminary category is up- or down-listed if appropriate (step three). Thus, the final categorization reflects the extinction risk for the taxon within the region being evaluated, having considered potential interactions with populations outside that region.

2.2. Species selection

The mollusc and echinoderm families selected for assessment are based on information from the full mollusc and echinoderm lists from the Marine Species of the British Isles and Adjacent Seas (MSBIAS). MSBIAS is a UK (and adjacent seas) subset of the World Register of Marine Species (WoRMS) and essentially serves as a list of marine species in the UK. MSBIAS is updated by the Archive for Marine Species and Habitats Data (DASSH) from a species list sent by JNCC, this list is collated from requests by individuals/organisations who have reason to believe that a species, not currently available in MSBIAS, is present in the UK. DASSH will then verify the evidence provided, and then if found to be sufficient will manually add this species to be viewable on MSBIAS. This evidence can range from a photo taken, to a reference made in a peer reviewed paper. Therefore, species records are not necessarily recorded in the National Biodiversity Network Atlas /Global Biodiversity Information Facility (GBIF) or within the general data flow, particularly if the species are new or rare.

The MSBIAS list is very likely to include species whose distributional ranges are currently expanding from outside into the home region or retreating from it in response to climate change. According to IUCN guidelines, taxa that appear to be in a colonization phase within the region should not be considered for regional assessment until the taxon has reproduced within the region for several years (typically for at least 10 consecutive years). This criterion would exclude most taxa recorded for the first time in MSBIAS.

MSBIAS contained records for 1740 Mollusc species with accepted scientific names in 330 families. Echinoderm records spanned 157 species in 62 families. It was not possible within the scope of this assessment to review the status of all families. Therefore, we applied a set of criteria to reduce the list of families. The MSBIAS records for extant UK marine species were first downloaded. The taxon lists were then compared with the number of species records from the NBN atlas. We excluded **families** with less than 10 NBN records as these are likely to be naturally rare, not recorded, vagrant species or data deficient for assessment. JNCC were provided with a proposed family and species list for assessment, and they agreed the final selection of families, with the project resources allowing review and assessment, if possible, for approximately 80 species, with 117 selected for assessment. All species within the selected families, as listed on MSBIAS were assessed. Many of these were subsequently found to be non-native or to have no records. The evaluated species represent approximately 4% of Echinoderms and 6% of molluscs.

The families selected for assessment were:

- Seven echinoderm species from the intertidal and subtidal in the following families: Echinidae (1 species), Parechinidae (2 species), Strongylocentrotidae (2 species), Brissidae.

- All mollusc species in the following families: Arcticidae (1 species), Haliotidae (1 species) Patellidae (4 species), Pinnidae (1 species), Littorinidae (13 species, including species previously identified as Lacunidae), Trochidae (24 species), Mytilidae (35 species); Muricidae (29 species) and Onchididae (1 species).

2.2.1. Selecting species for assessment within families

IUCN guidelines states that the categorization process should be applied to the following:

- Wild populations inside their natural range and to populations resulting from benign introductions (IUCN 1998, 2001, 2012).

- All taxa for which an important part of any stage of their life cycle (breeding, wintering, migrating, etc.) takes place in the region.

- Taxa only marginally within the region should also enter the assessment.

2.3. Species not applicable for assessment

IUCN Guidelines state that a taxon that only occasionally breeds under favourable circumstances in the region but regularly becomes (regionally) extinct should not be considered.

Not Applicable (NA) is a status that can be used within regional Red List assessments (but not global ones) and is defined as a 'category for a taxon deemed to be ineligible for assessment at a regional level'. The following are considered ineligible for assessment and therefore Not Applicable (NA) and are not assessed:

- hybrids,

- varieties,

- species that have not yet been described taxonomically,

- species which likely became extinct in Britain before 1500 AD,

- non-native species introduced to Britain since 1500 AD, and

- vagrants ('a taxon found only occasionally within the boundaries of a region').

Examples of vagrant species included the green ormer (*Haliotis tuberculata*) which is only occasionally found in southern England but occurs in the Channel Islands (outside the geographic scope of this study).

Species considered invasive, non-native species (INNS) introduced to Britain since 1500 AD, include: the Asian date mussel (*Arcuatula senhousia*), *Brachidontes exustus*, *Ocinebrellus inornatus*, veined rapa whelk or Asian rapa whelk (*Rapana venosa*), American Sting Winkle (*Ocinebrellus inornatus*), Atlantic oyster drill (*Urosalpinx cinerea*) and the slipper limpet (*Crepidula fornicata*). Records for all these species were confirmed as non-

native based on expert knowledge and cross-checked with NBN atlas and the GB Non-native Species Secretariat (GBNSS). In Appendix 2, species assessed as Not Applicable and that were not assessed are identified in tables for each family.

The first stage of the assessment used previously published information on INNS from GBNNSIP, with distribution data provided by the GBIF and NBN atlas.

None of the assessed mollusc or echinoderm species are known to have been deliberately introduced to Britain for any reason. However, the Pacific oyster (*Magallana gigas*), that is not included in this assessment has been introduced deliberately for aquaculture and this has also led to wild escapes of this species and the introduction of other species, including predatory molluscs in contaminated stock.

Climate changes are driving shifts in marine species ranges worldwide. Some southern species are already increasing in abundance and expanding or may expand into GB waters (Genner *et al*. 2004; Hiscock *et al*. 2004; Herbert *et al*. 2022). Species which have been added to MSBIA and for which there are no current records in GBIF and NBN atlas may be the first colonists expanding their range.

2.4. Evidence review

A rapid evidence gathering exercise was undertaken to support the assessments and gather critical data for species status and life history traits supporting the assessments. Information was collected on the following:

- Species status (native, invasive, possible misidentification).
- Size: to indicate whether species is likely to be under recorded, smaller species are less likely to be noticed and are under sampled by trawls, although may be collected in grabs but these sample much smaller areas.
- Lifespan and age at sexual maturity: (information on age of sexual maturity was found for 13 species and information on lifespan was sourced for 19 species) as generation time is fundamental to the IUCN assessment.
- Reproductive type, fecundity and larval duration: will provide a proxy for population connectivity and dispersal potential and support assessment of sub-populations and whether outside populations may provide a rescue effect via propagule dispersal.
- Life habit: infauna (living in sediments, on burrowing species under rocks, etc) or epifauna (found on surface): this also reflects how likely the specie is to be recorded but also indicates they type and therefore presence and extent of suitable habitats.
- Depth range: intertidal, subtidal, depth limits (subtidal populations especially those in offshore deep water are less likely to be sampled; deeper habitats may offer refuges from over-exploitation, climate change, habitat loss).
- Habitat type: any information, generalist species occupying a variety of habitats are likely to have broader ecological niches and more extensive ranges.
- Threats: if any, not likely to be recorded for most species, but could include, climate change, over-fishing, harvest and collection, contaminants, habitat loss and degradation).

- Record any evidence for a decline or increase in the species population abundance and range.
- Other information relevant to assessing population status (records, special traits leading to vulnerability such as protandry).

2.4.1. Sources of evidence

The following sources were agreed with JNCC to be used for the project, plus authors' knowledge:

- Google and Google scholar: accepted name and synonyms were searched.
- NBN atlas: source of data points to assess distribution and occurrence.
- BIOTIC traits catalogue: provides information on life history traits.
- GBIF: checked for worldwide distribution.
- Marine Species Identification Portal: MSIP (now retired but with information available at Linnaeus NG.
- Sea Life Base: provides information on life history traits.
- MarLIN: distribution and natural history.
- Natural History Museum of Wales (NHMW): Home | Marine Bivalve Shells of the British Isles (museumwales.ac.uk).

2.5. Geographic scale

The geographic scale for the assessment is Great Britain (England, Scotland and Wales), which excludes the Isle of Man, the Channel Islands and Northern Ireland. None of the mollusc species considered are capable of migrating any great distance as adults. Bivalves may be capable of small-scale movements, particularly when juvenile when they may be able to drift using byssus threads. Gastropods (snails) are able to crawl and may raft on drifting seaweed and other debris especially as juveniles. The echinoderms considered have limited mobility. Storms may also transport individuals and aggregations, either in the water column or in sediments (bed load transport). For the purposes of this assessment however, no species are considered to migrate or to be inter-connected as adults with those in other areas. (i.e. there are no visiting or migrating taxa to assess). No species are known that are present in the region only as larvae- however, this may apply some species in MSBIAs as the basis of the records are not clear. None of the evaluated species were present only as larvae based on readily available information used in the assessments.

The main type of movement for the species considered is dispersal by pelagic larvae and in this form they may be capable of long-range movements. Information on the type of development and the presence of a larval stage was a category assessed by discussion with experts and literature review. For some species the duration of the pelagic larvae has been recorded which provides an indicator of potential for dispersal and connectivity between areas. Juvenile rafting can occur in direct developers such as *Littorina saxatilis* or those laying egg-masses on seaweed such as *Littorina obtusata*, leading to colonisation.

2.6. Information sources

Species occurrence records can vary between data aggregators even if there is a direct data flow between them. Where there is a record in NBN, and not in GBIF, the record is likely to be in the process of being passed onto GBIF and will be available on the platform in the future once the data have been processed. Where there are records in GBIF but not in NBN, these are from other data aggregators, and there is not a two-way flow meaning that GBIF do not pass UK records onto NBN. This means the two sources are not identical and both were checked for information.

2.7. Taxonomic checklist

The World Register of Marine Species (WoRMS) was used to check taxonomy.

2.8. Application of IUCN categories and criteria

The IUCN Red List categories and criteria (IUCN 2012; Figure 1; Table 1), provides a standard framework to produce Red Lists and is here applied.

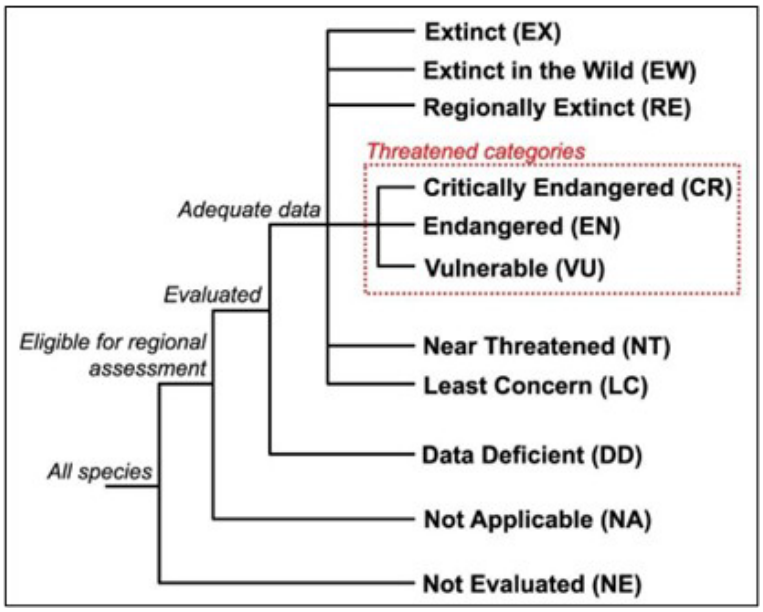

Figure 1. IUCN Red List categories (from IUCN 2012).

Table 1. Summary of IUCN Red List criteria for threatened status (from IUCN 2012).

A. Population size reduction, measured over the longer of 10 yr or 3 generations, based on any of A1 to A4.

Criteria	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%
A1. Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased. **A2**. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible. **A3**. Population reduction projected, inferred or suspected to be met in the future (up to a max. of 100 yr) *[(a)below cannot be used for A3].* **A4.** An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 yr in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible. Any of the above based on any of the following: (a) direct observation *[except A3]* (b) an index of abundance appropriate to the taxon (c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality (d) actual or potential levels of exploitation (e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.			

B. Geographic range in the form of either B1 and/or B2.

Criteria	Critically Endangered	Endangered	Vulnerable
B1. Extent of occurrence	< 100 km^2	< 5,000 km^2	< 20,000 km^2
B2. Area of occupancy	< 10 km^2	< 500 km^2	< 2,000 km^2
AND at least 2 of sub-criteria (a), (b) or (c):			
(a) Severely fragmented OR number of locations:	1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

C. Small population size and decline.

Criteria	Critically Endangered	Endangered	Vulnerable
Number of mature individuals AND at least 1 of C1 or C2:	< 250	< 2500	< 10,000
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):	25% in the longer of 3 yr or 1 generation	20% in the longer of 5 yr or 2 generations	10% in the longer of 10 yr or 3 generations
C2. An observed, estimated, projected or inferred continuing decline AND at least 1 of sub-criteria (a) or (b):			
(a) (i) Number of mature individuals in each subpopulation	< 50	< 250	< 1,000
(a) (ii) % of mature individuals in 1 subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals			

D. Very small or restricted population.

Criteria	Critically Endangered	Endangered	Vulnerable
D1. Number of mature individuals	< 50	< 250	< 1,000
D2. Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.	n/a	n/a	AOO < 20 km^2 or number of locations ≤5

E. Quantitative analysis.

Criteria	Critically Endangered	Endangered	Vulnerable
Indicating the probability of extinction in the wild to be:	≥ 50% in the longer of 10 yr or 3 generations (100 years max.)	≥ 20% in the longer of 20 yr or 5 generations (100 years max.)	≥ 10% in 100 years

2.8.1. Mature individuals (Criteria A, B, C and D)

Data on maturity can be limited, especially as size classes are often not reported from field samples. Molluscs can be aged using shell sections and information on lifespan is available for a range of species. Echinoderms, however, are difficult to age as they do not provide distinct growth bands. For assessments all species records were assumed to represent mature individuals on the basis that there was no distinction in the evidence sourced between immature and mature individuals. Most species evaluated have short life-histories < 5 years with some exceptions, listed in the accompanying descriptions.

2.8.2. Population and population size (Criteria A, C and D)

The term 'population' is used in a specific sense in the Red List Criteria (IUCN 2012a). Population is defined as the total number of individuals of the taxon in the region being considered. Population size is measured as numbers of mature individuals only. In the case of taxa obligately dependent on other taxa for all or part of their life cycles, biologically appropriate values for the host taxon should be used.

There are no accurate data for population size for any of the assessed species. Population size was inferred from number of records, supported by evidence where possible for Criterion A.

Criterion D relates to very small or restricted populations. For a species to qualify under D1 a knowledge of the number of mature individuals is required. In the species considered here there were no populations for which this evidence was available. Therefore, this category was assigned either to "Not met", where it was estimated that the population was much larger than the threshold or "No evidence" where this was uncertain.

2.8.3. Subpopulations (Criteria B and C)

Subpopulations are defined by IUCN guidelines as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less). In general Molluscs and Echinoderms have pelagic life stages so that marine populations have a potential high degree of connectivity. Exceptions of species that directly hatch and do not have a pelagic larval stage are the Celtic Sea slug (*Onchicdella celtica*), the dog whelk (*Nucella lapillus*) and some direct developing or egg-laying littorinids. As noted above there is evidence of rafting occurring in dogwhelks and littorinids other than those with a pelagic stage (*L.littorea, Melaraphe neritoides*), therefore, populations with direct development modes may still be connected via water column transport.

2.8.4. Generation length (Criteria A, C1 and E)

Criteria A thresholds relate to the rate of reduction in population size of a species over the last 10 years or three generations, whichever is longer. Change can be observed, estimated, inferred, suspected and in some cases projected (i.e. into the future).

"Generation length is the average age of parents of the current cohort (i.e. newborn individuals in the population)" (IUCN Guidelines).

Several ways of estimating generation length are proposed in the IUCN guidelines, all of which are typically difficult to apply to the assessed species because of the lack of data for lifespan and reproductive rates over that lifespan.

For generation length, the assessments have used information where available on the age at which sexual maturity is reached and population lifespan. Where information was missing, the characteristics of closely related species (congeners) were adopted where possible.

The assessed species provide a variety of examples of generation length. The assessed species list includes very long-lived species such as the Icelandic cyprine, *Arctica islandica*, which is extremely long-lived, with individuals attaining at least an age of 400 years (see Appendix 1). In contrast the chink snails (*Lacuna* spp.) reproduce and die within the same year (annuals).

For many species there is little life history information, with subtidal and deeper water offshore species being particularly little studied.

2.8.5. Extreme fluctuations (Criteria B and C2)

Extreme fluctuations are included in Criteria B and C. Populations that undergo extreme fluctuations are likely to have highly variable growth rates and are therefore likely to be exposed to higher extinction risks than populations with lower levels of variability. Fluctuations may occur regularly or sporadically. Extreme fluctuations are defined as changes in population size or distribution area that vary widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e. a tenfold increase or decrease) (IUCN 2022).

Fluctuations must be inferred only where there is reasonable certainty that a population change will be followed by a change in the reverse direction within a generation or two. In contrast, directional changes will not necessarily be followed by a change in the reverse direction.

Annual species that reproduce once and then die, such as *Lacuna* spp., were not considered to represent extreme fluctuations as the change is annual and predictable and these species have traits that allow populations to recover quickly.

The evidence review sought life history information for species, and this would have been expected to flag extreme population fluctuations. NBN atlas records were also checked over decadal and annual time scales. No fluctuations were reported that met the definition.

Many marine species, in most phyla including molluscs and echinoderms, show much fluctuation in recruitment to the benthic juvenile nursery areas or adult populations from year to year due to stochastic events in the pelagic stage. Such fluctuations are often dampened out by density processes including inter-age class interactions (e.g. in limpets, Boaventura *et al*. 2003). Such fluctuations in recruits are considered out with the definition used by IUCN.

2.8.6. Extent of occurrence (Criteria A and B)

Extent of occurrence (EOO) was assessed by JNCC. MBA provided JNCC with records downloaded from NBN atlas clipped to the UK EEZ and excluded habitats from Northern Ireland, the Channel Islands and Isle of Man. JNCC applied the minimum bounding geometry tool in QGIS to generate the species minimum convex polygons. The area of these minimum convex polygons (km^2) was then sent back to MBA to be used as the EOO.

2.8.7. Area of occupancy (Criteria A, B and D)

Area of occupancy was assessed by clipping all records for each individual species from the National Biodiversity Network Atlas download to the assessed GB area. Species were assigned to pseudotetrads (2 km x 2 km), duplicates removed and the number of pseudotetrads summed.

2.8.8. Location (Criteria B and D)

The term ‘location’ has a specific meaning for IUCN Red List categorisation (IUCN 2022). It refers to a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat. For marine species, the two most serious

threats are climate change which can affect large areas (such that entire regions may be considered a location) and fishing using towed gears. This may operate over wide areas, but at the local scale fishing using towed gears is patchy, with some areas unsuitable for trawling because of local topography offering refugia for species. Species sensitive to fishing are likely to already have experienced significant declines before the advent of modern marine survey and recording, as such many species that are widespread tend to be robust, small, recover rapidly or a combination of these. Species which have undergone recorded declines due to fishing assessed by the current project include, *Arctica islandica* and *Atrina fragilis* (see Appendix 2).

Species can be assessed as Vulnerable under Criterion D2 if there is a restricted area of occupancy (typically AOO < 20 km^2 or number of locations < =5), coupled with a 'plausible future threat that could drive the taxon to CR or EX in a very short time.'

2.8.9. Data Deficient

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. For example, less than 0.001% of habitat sampled, or species that cannot be differentiated from common species except by genetic testing. Effort was made to review available data against the criteria thresholds, to justify placing a species into a category other than Data Deficient. Where a species has been assessed as Data Deficient, explanation has been provided within the assessment.

2.8.10. Assessing status under Criterion E

Criterion E requires a quantitative analysis to be undertaken that indicates the probability of future extinction in the wild over a set time-period. No analyses have been undertaken for British molluscs and echinoderms and hence Criterion E could not be used in the assessment. It is likely that data challenges will preclude this sort of assessment being conducted for most marine species in the foreseeable future, other than some well-characterised intertidal or shallow subtidal species at their equatorward range edges at threat from rapid climate change and its interaction with other impacts such as fishing or habitat loss within the British Isles.

2.8.11. Near threatened

A taxon can be classed as Near Threatened (NT) when it has been evaluated against all possible criteria and does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future. The Guidelines note that NT is appropriate 'especially when there is a high degree of uncertainty'. NT would therefore be applied based on the proximity of a species to the qualifying criteria for the category (e.g. limited AOO, < 10 locations, and plausible threat of future decline). Or, If the range of plausible categories include both LC and VU (or EN), and expert judgement did not estimate the species as being VU (or EN). However, no species were assessed as NT.

3. Results

The results of the assessment process are summarised below in Figure 2. Species were identified as 'Not assessed' where there was no information to support the assessment, typically species for which there were no readily available records (based on GBIF, National Biodiversity Network Atlas, or rapid evidence assessment. Species assessed as 'Not applicable' were those excluded from Red List Assessment on the basis these are non-natives that are not established and potential vagrant or range expansion species from outside GB area.

For the present assessment no taxa were identified that were formerly considered to have been extinct that have naturally re-colonized the region or been re-introduced. No species were identified as being endemic, marine populations tend to be well-connected via pelagic larvae and with few unique habitats in the UK (Tillin *et al*. 2023).

3.1. Red list assessment summary

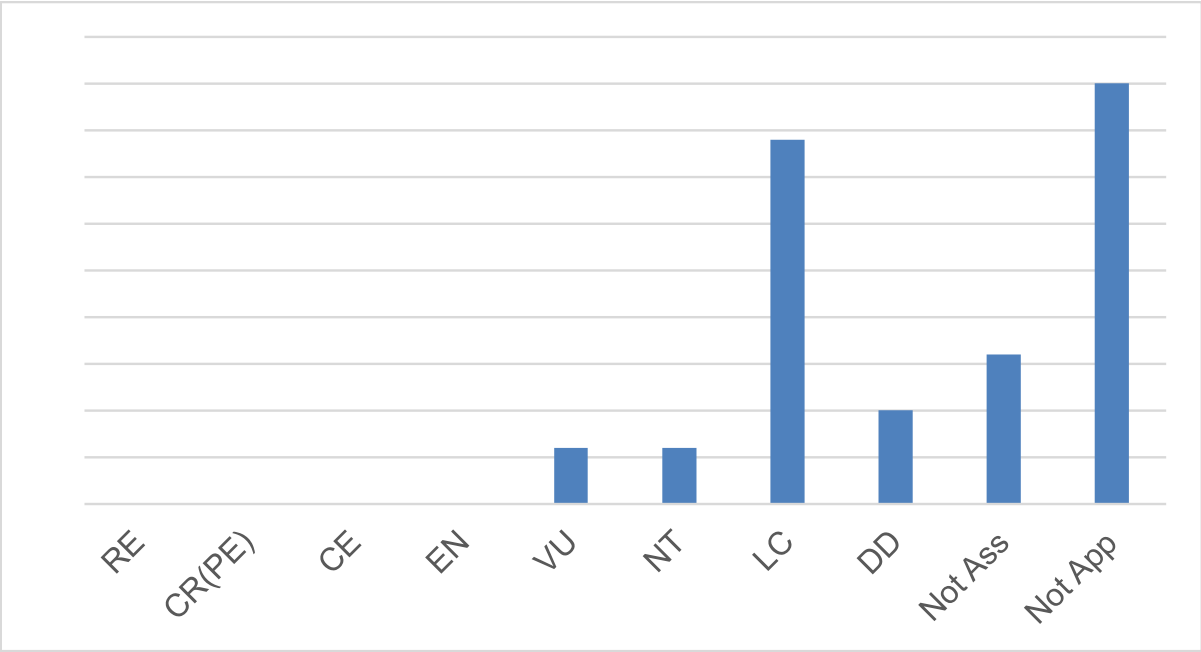

Figure 2. Number of molluscs and echinoderms assigned to each IUCN category. RE – Regionally Extinct, CR(PE) – Critically Endangered (Possibly Extinct), CR – Critically Endangered, EN –Endangered, VU – Vulnerable, NT – Near-threatened, LC - Least Concern, DD – Data Deficient, Not Ass – Not Assessed, Not App – Not Applicable.

4. Discussion

Compared to terrestrial habitats, marine habitats are inaccessible to humans without equipment and training and are more costly to survey and monitor, thus there is limited knowledge of the extent of habitats and species populations and their condition. The poor state of knowledge of the marine environment is exemplified by recent discoveries of distinct biogenic habitats, that occur on the surface of the seabed, in shallow waters close to shore. In 2022 acoustic surveys conducted by Cornwall IFCA, found that St Austell Bay is supporting Cornwall's largest known seagrass bed at 359.1 hectares (887 acres). The area of seagrass within St Austell Bay also makes it one of the largest known beds within the UK. The acoustic surveys mapped the extent of seagrass but are unable to identify and record invertebrate species. While there are significant gaps in monitoring and recording of inshore marine habitats, the extent of offshore monitoring is far less. In deeper environments, dive surveys cannot be carried out, water turbidity and depth inhibit visual survey (using drop down cameras and sleds) and the resources required to mobilise expeditions and analyse samples preclude extensive surveys.

There are no systematic recording schemes for subtidal seabed habitats, and record gathering is ad-hoc and biased towards conspicuous species that are readily identified and that live on the surface in accessible habitats such as intertidal rocky shores. Grab samples and beam trawl surveys are expensive and result in sampling bias, with mesh trawls not retaining smaller species or sampling those buried deeply in sediments and grab samples underestimating large species and those that are patchily distributed. To process a single grab sample to provide evidence, costs approximately £1,000 and would provide information on the species living within 0.1m^2 of sediment. This means that even for site monitoring by the conservation agencies only a small amount of data can be collected. For example, for high intensity monitoring of the marine protected area Hartland to Tintagel a single grab sample was taken every 7 km (Mike Young, Natural England, pers comm). Similarly, a survey of the Offshore Overfalls Marine Conservation Zone took grab samples for infauna of 0.0000003% of the surface habitat (Hawes *et al*. 2024). Nearly half of the attempted samples were unsuccessful due to the coarse substratum (grabs work better in softer sediment). The work was intended to provide a monitoring baseline for timeseries and the small area covered reflects the time and cost of surveying and processing samples and the small area of sediments that can be sampled for infauna. At another marine protected area in the Farnes East, one station that was sampled using ten grab sample replicates, identified three different broadscale habitats (habitats assessed based on sediment type) as present (Mike Young, Natural England, pers. comm.). This represents considerable habitat heterogeneity that further confounds knowledge of habitat presence and extent based on small samples.

The issues relating to the availability and quality of marine data hinder Red List assessments using the standard IUCN methodology, although every attempt was made to assess against criteria. The National Biodiversity Network Atlas was used as a source for species occurrence data, to estimate population trends (Criteria A), EOO and AOO (Criteria B), and to suggest the degree of isolation and number of locations a species was present at. Previous projects have assessed marine habitats against Red List Criteria. Gubbay *et al*. (2016) assigned the category data deficient to 60% of assessed marine habitats in the North East Atlantic, this result indicates the challenges in undertaking Red List assessments for marine ecosystems and the individual species within them.

The most widespread human pressure on seabed sediment habitats is from towed fishing gear that contact the seabed. Towed nets and dredges in contact with the seabed disturb the upper layers of the sediment and can damage both the epifauna and shallow infaunal communities, as well as leading to much by-catch mortality (Philippart 1998). Associated

increases in suspended sediments may also have a smothering effect on filter-feeding species. The severity of effects depends on factors such as the local conditions, intensity and frequency of disturbance by the trawls. Frequent trawling can permanently alter species composition by favouring fast growing scavenger/predator species. Most sediment benthic systems of the continental shelf of Europe have been modified by bottom-fishing activity in the last 100 years, particularly by mobile demersal gears, and this remains a significant pressure (Smith 2013). Biogenic habitats made by reef forming species are highly sensitive to disturbance and have likely been removed over large areas before the advent of marine surveys.

4.1. Summary

Species data for marine and coastal Mollusc and Echinoderm species is, overall, inadequate to assess extinction risk for marine species across the IUCN Red List Criteria. Conservation management and policy in the UK reflects the difficulties in managing and surveying marine habitats and has therefore tended towards feature-based management and ecosystem management, rather than focussing on species (beyond commercially targeted species, biogenic habitats and selected low mobility invertebrate species). Information on species ecology and life history is very limited.

We do not know population size for any species and as there is no population monitoring scheme for any species, we were able unable to make assessments against Criterion C and D1 but made four assessments based on D2 (number of locations). We were only able to assess one species on Criterion A (*Arctica islandica*). Whilst much more information was available on range, recording effort was such that estimates of AOO were frequently below the criteria thresholds even though the species is likely or known to be widely distributed and numerous, to the extent that significant under-recording hampered too many assessments.

We do not recommend that the remaining marine mollusc and echinoderm families are assessed as we know that the groups included within the current project are amongst the better recorded. In short, we are unable to be confident that any marine invertebrate taxa will be sufficiently recorded to permit GB IUCN assessments to be made with confidence, except for the most common species. There are efforts within Natural England and others to expand species monitoring, to improve data flows and to collect more evidence via citizen science and other schemes and to utilise technologies such as automated image recognition, and environmental DNA collection to increase the amount of information that can be processed. In future, there may well be a stronger basis to understand the extinction risk to species.

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Appendix 1. IUCN justification for categorisation of species

Molluscs

Family: Arcticidae

Arctica islandica

Distribution: The ocean quahog or Icelandic cyprine, *Arctica islandica* is an arctic-boreal species of the North Atlantic and adjacent waters, recorded from Iceland, the Faeroe Islands, Onega Bay in the White Sea to the Bay of Biscay in the north-east Atlantic, including the Kattegat and western Baltic, and from Labrador to North Carolina in the west Atlantic and around all British coasts (Tyler-Walters & Sabatini 2017; OSPAR 2009).

Habitat and ecology: Found buried in sandy and muddy sediments and occurs from very low on shores to deeper offshore waters. It is the longest-lived of all bivalve and molluscan species on earth (Ridgway & Richardson 2011). Reported maximum life span around Iceland is close to 400 years. Recruitment is sporadic (10–20) years or longer has been observed for populations but given longevity this will not give rise to extreme fluctuations (Hennen 2015). Generation length is estimated as at least 35 years based on sexual maturity at 11+ years.

The species has a lengthy reproduction season with larvae believed to be in the water column for several months allowing wide dispersal and interconnectivity between areas. Populations within the GB area are therefore not fragmented and do not represent sub-populations. It has been considered unlikely for *A. islandica* to become extinct in the North Sea because of its relatively long pelagic larval stage (which is not affected by fishing activity) (OSPAR 2009).

Population: Populations within the GB area are connected via pelagic larvae to the European stock, therefore they are not fragmented and do not represent sub-populations. There are no accurate data for population size for *A. islandica*. Information on the distribution and density of *A. islandica* in the North Sea reveals changes during the last century. A comparison of historic epifauna data from 1902–1912 collected during ICES routine cruises in the North Sea, with epifauna data from the ICES-Benthos Survey of 1986, shows that *A. islandica* was present at 45% of the stations sampled in the early part of the century compared to between 20–30% of all stations in 1986 (Rumohr *et al*. 1998). Most of the difference was due to its absence at the shallower sampling stations between 30–50 m. There is also information on the density of *A. islandica* in different parts of the North Sea including a detailed study of the south-eastern North Sea suggesting a significant decrease in relative abundance between 1972–1980 and 1990–1994 (Witbaard 1997).

Maximum densities occurred in the northern part of the distribution area (up to 100 individuals/m²), whereas in the North Sea maximum densities range from 0.18 individuals/m² in the south-eastern part (AquaSense 2001) to 12 individuals/m² on the Fladen Ground, where almost every boxcore sample yields one or more living specimens. In July 2000, quantitative sampling with the Triple-D dredge which retains all specimens larger than 10 mm, gave an entirely new picture with estimated local densities up to 286 individuals/m² (Witbaard & Bergman 2003). However, even with these new numbers, it remains evident that the occurrence of *A. islandica* in the North Sea had decreased between the beginning of the 20th century and the 1990s (AquaSense 2001, Witbaard & Bergman 2003).

Until regular surveys are conducted, future trends cannot be predicted. Recruitment in *A. islandica* is reported to be variable with a steady low level of recruitment interspersed with

unpredictable large recruitment events at intervals of one or more decades, depending on location (Hennen 2015). However, the apparent large declines in abundance in recent decades serve as grounds for precautionary measures that led to the OSPAR designation as a threatened and declining species (OSPAR 2009).

EOO: 797,810 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1,188 km^2 AOO based on 297 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019. Meets criteria for vulnerable.

Threats: *Arctica islandica* are impacted by bottom trawling fisheries which has led to a decline in some regions. Mortality of *Arctica* caught in a beam trawl has been estimated to be in the range of 74–90% (Fonds, 1991). However, there is no indication that the entire population is threatened (for example, there is no decline in the Baltic, and the species is common along the Norwegian coast) (OSPAR 2009). The failure of recruitment for many years in the North Sea is a possible point of concern (OSPAR 2009).

Threatened category: Vulnerable A2a

Rationale: Suitable habitats for *Arctica islandica* are very widespread in the GB marine area as this species is found from the shallow subtidal to deeper areas and inhabits sand and muds that cover extensive areas. The species is very long-lived (up to 400 years) and reaches sexual maturity within 11 years. The species has a lengthy reproduction season with larvae believed to be in the water column for several months allowing wide dispersal and interconnectivity between areas, however recruitment of juveniles to the population is sporadic (as with some other molluscs) and there are concerns that there have been recruitment failures in the North Sea, although no recent evidence or reports was found from the previous decade as to whether this has changed. Populations are considered to have declined because of fishing, and the species is assessed as Vulnerable (A2a), based on an observed population reduction in the past (in this instance from the 20th century), that is, greater than 30% where the cause of reduction, (in this instance mortality from fishing gears) has not ceased. Although this population reduction would likely reduce AOO and EOO there are no past systematic records from the last 100 years to support an assessment under A2c and recent changes in AOO and EOO may reflect changes in sampling effort for this species which occurs in the offshore subtidal as well as coastal waters. The AOO (1,188 km^2) meets the criteria for VU (Criteria B2) but the sub-criteria severely fragmented, ongoing decline and extreme fluctuations are not met, suggesting an assessment of NT. *A. islandica* is not considered to meet the criteria to have a very small, declining population (Criteria C) or restricted population (Criteria D). Although there are no systematic surveys or recording to support this, there are records throughout GB. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Family: Littorinidae

Lacuna crassior

Distribution: The snail *Lacuna crassior* is a northern circumboreal and subarctic species that may be found in the Channel Islands and Roscoff, which are the edges of its southerly range. Fretter and Graham (1980) state it is not recorded from most British shores with earlier reports confining it to some areas of the east coast, northwards from Scarborough, although authors report seeing specimens from Dorset, Milford Haven and the Celtic Sea. Records on NBN atlas online (checked January 2024) show that this species has been recorded from all GB coasts and offshore.

Habitat and ecology: No information was found on lifespan and reproduction but based on other *Lacuna* spp, this species is inferred to be a short-lived species (annual) with a free swimming pelagic larval phase that supports population connectivity. It is found on shores from low water and offshore at depths up to 90 m. It can be found among stones within mud, sand, gravel and coarser sediments. The World Register of Marine Species (WoRMS) suggests the size is 14 x 10 mm.

Population: Jørgensen (2001) considers this species rare compared with other *Lacuna* spp. Records from National Biodiversity Network Atlas show that on a decadal scale reported occurrence fluctuates but there is no clear declining trend. As this species is an annual this is probably within a normal range of variability (from a minimum of 36 records a decade to maximum of 94) with annual reporting showing similar fluctuations. The variability does not

meet the criteria for extreme fluctuations. From this information it is inferred that this species was never common and that there is no evidence for decline and it may be under reported and confused with *L. vincta* as some authors suggest it is synonymous. The population trend is not known, but in the absence of threats and no current (within three years) changes in habitat extent the species population is inferred to be stable.

EOO: 243,089 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 100 km^2 AOO based on 25 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Although climate change may cause retreat northwards or into deeper waters over the next 100 years, there is no evidence for a current change in population size.

Threatened category: Least concern

Rationale: *Lacuna crassior* is widespread and occupies habitats that cover an extensive area of the GB intertidal and subtidal areas. There are no reported threats to the species or habitat, although fishing may impact subtidal, offshore populations, however due to small size this species would pass through meshes or may be pushed aside by the pressure wave created in front of towed gear. It is likely to be under recorded and reported as the low water habitats in which it occurs in the intertidal are exposed for short periods only and the offshore habitats in which it occurs are rarely sampled, it is too small to be retained by trawl nets and the coarse and stony habitats with which it is associated are not suitable for sampling either by trawls and grabs. The population trend is not known, but no declines have been reported or are indicated by changes in records on the National Biodiversity Network Atlas. Populations are not considered to have undergone population reduction (Criteria A), they are considered stable and there is no evidence for threats to the species or habitat that will cause decline within the next 10 years. The AOO =100 km^2 which meet the criteria for EN for Criteria B2 (restricted geographic range). However, as stated this species is likely to be under recorded and reported. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Lacuna pallidula

Distribution: A small (1 cm) snail, *Lacuna pallidula,* is widely distributed in north-west Europe including the UK and extending as far south as the west coast of France with a few records in northern Spain (Global Biodiversity Information facility online atlas). It is found all around Britain on the lower shore of semi-exposed to sheltered rock shores and occurs in

the sublittoral to 70 m (Fish & Fish 1996). *Lacuna* is a northern genus, and the British Isles are near the southern edge of the range of this species.

Habitat and ecology: Adults are typically found on the brown seaweed *Fucus serratus* (Smoth 1973).

Population: Breeding occurs from winter to spring and there is no pelagic stage. Population turnover and mortality are high, as this species is short-lived (one year) (Fish & Fish 1996). Population trend is unknown but National Biodiversity Network Atlas (checked December 2022) show that records have increased since the 1960s and that these are relatively stable. The lack of direct threat supports an assessment of population stability.

EOO: 404,662 km^2 EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 396 km^2 AOO based on 99 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019).

Threats: Climate change may cause retreat northwards and to deeper areas (over 100 years). This threat is not considered in this assessment of the current state of the population.

Threatened category: Least concern

Rationale: *Lacuna pallidula* is widespread and occupies habitats that cover an extensive area of the GB intertidal and subtidal areas. There are no reported threats to the species or habitat, although fishing may impact subtidal, offshore populations, however due to small size this species would pass through meshes or may be pushed aside by the pressure wave created in front of towed gear. It is likely to be under recorded and reported as the low water habitats in which it occurs in the intertidal are exposed for short periods only and the offshore habitats in which it occurs are rarely sampled, it is too small to be retained by trawl nets and the coarse and stony habitats with which it is associated are not suitable for sampling either by trawls and grabs. The population trend is not known, but no declines have been reported or are indicated by changes in records on the National Biodiversity Network Atlas. Populations are not considered to have undergone population reduction (Criteria A), they are considered stable and there is no evidence for threats to the species or habitat that will cause decline within the next 10 years. The AOO = 396 km^2 which meet the criteria for EN for B2 (restricted geographic range). However, as stated this species is likely to be under recorded and reported. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Lacuna parva

Distribution: *Lacuna parva* is widely distributed in north-west Europe (Fish & Fish 1996). *Lacuna* is a northern genus, and the British Isles are near the southern edge of the range of this species. It occurs from the Barents Sea south to Iberia (Conchological Society website).

Habitat and ecology: A very small (4 mm) snail. Epifaunal species feeding on seaweeds and hence found where hard substrate provides suitable attachment, this species can vary in shape and colour, and this may lead to misidentification. Jørgensen (2001), suggests this species predominantly inhabits the sublittoral, all records from NBN atlas are coastal.

Population: Population turnover and mortality are high, as this species is short-lived (one year) and dies after spawning (Fish & Fish 1996). Records reported to NBN atlas increased in every decade from 1960–1969 (45 records) to 2000–2009 (254 records) but have declined since 2015 from 1–2 records in each of 2020, 2021 and 2022. However, records from NBN atlas must be interpreted cautiously as they are not produced by systematic and repeated sampling. There is no evidence for extreme fluctuations, number of records reported on NBN atlas have remained relatively consistent between 1990–2019. This species is small and is likely to be under recorded and reported and subtidal GB habitats are not being effectively sampled due to the small size of this species, which will pass through trawl meshes, and the unsuitability of hard substrate to deploy grabs for sampling. It is considered there is no reliable evidence to indicate this species has declined.

EOO: 410,989 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 196 km^2 AOO based on 49 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Climate change may cause retreat northwards and to deeper areas (over 100 years). This threat is not considered in this assessment of the current state of the population.

Threatened category: Least concern

Rationale: *Lacuna parva* is widespread and occupies habitats that cover an extensive area of the GB intertidal and subtidal areas. There are no reported threats to the species or habitat, although fishing may impact subtidal, offshore populations, however due to small size (4 mm) this species would pass through meshes or may be pushed aside by the pressure wave created in front of towed gear. It is likely to be under recorded and reported as the low water habitats in which it occurs in the intertidal are exposed for short periods only and the offshore habitats in which it occurs are rarely sampled, it is too small to be retained by trawl nets and the coarse and stony habitats with which it is associated are not suitable for sampling either by trawls and grabs. Changes in water temperature may lead to a retreat from shallower to deeper habitats and the recent changes in the number on NBN atlas records may reflect this but there is no reliable evidence from systematic monitoring to identify a decline or support this supposition. Populations are not considered to have undergone population reduction (Criteria A), they are considered stable and there is no evidence for threats to the species or habitat that will cause decline within the next 10 years. The AOO = 196km^2 which meets the criteria for EN for B2 (restricted geographic range). However, as stated this species is likely to be under recorded and reported. The wide distribution of records from 2010–2019 on NBN atlas show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc) based on National Biodiversity Network Atlas records. The number of mature individuals is likely to exceed the

criteria for small populations (Criteria C and D) and these are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Lacuna vincta

Distribution: *Lacuna vincta,* is distributed from the Arctic Ocean to Rhode Island, Alaska to California (based on GBIF records). *Lacuna* is a northern genus, and the British Isles are near the southern edge of the range of this species. Widely distributed in north-west Europe and extends as far south as the Channel coast of France (GBIF records). EOO has remained relatively consistent between 1990–2019 (based on NBN atlas records).

Habitat and ecology: A small (one cm) snail, it is found all round Britain on semi-exposed to sheltered shores where it feeds on seaweeds (Fish & Fish 1996). The species is found on a wide variety of coasts round the British Isles. It occasionally settles from the plankton as high as the mid tide level but is more typically found much further down the shore. The larvae settle out on a variety of algal species. The species is capable of widespread dispersal, as pelagic larvae spend up to six months in the water column, ensuring it is widely dispersed, and populations are connected. Females are estimated to produce 53,500 eggs in the breeding season. Development inside the egg takes 2.5 to 3.5 weeks (BIOTIC 2006).

Population: In north-east England densities have been recorded at 300 per m^2 (BIOTIC 2006). Population turnover and mortality are high, as this species is short-lived (one year) (Fish & Fish, 1996). National Biodiversity Network Atlas (online) checked December 2022 shows an increase in records over last 30 years although it is not clear whether this is due to greater survey effort or an actual increase in populations.

EOO: 515,889 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1,224 km^2 AOO based on 306 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Lacuna vincta* is widespread, common and abundant with densities up to 300 per m^2 being recorded. Suitable habitats are found all round GB. The population trend is not known, but the number of national records has increased in the past 30 years (based on National Biodiversity Network Atlas records available online). Populations are, therefore, not considered to have undergone population reduction (Criteria A), they are considered stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 1,224 km^2 which meets the criteria for VU for B2 (restricted geographic range); however, this is likely to be an underestimate.

Widespread dispersal of pelagic larvae ensure populations are connected and may recover rapidly from local disturbances and impacts. It is likely to be under recorded and reported as it occurs on the lower shore among seaweed these low water habitats are exposed for short periods only and offshore habitats are rarely sampled. Due to small size (1 cm) this species would pass through beam trawls and subtidal rocky habitats are not suitable for grab or mobile gear sampling. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals exceeds the criteria for small populations (Criteria C and D) and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

BIOTIC - Biological Traits Information Catalogue. 2006. Marine Life Information Network [online]. Plymouth, Marine Biological Association of the United Kingdom. Available from: www.marlin.ac.uk/biotic

Fish, J.D. & Fish, S. 1996. *A Student's Guide to the Seashore.* Cambridge University Press, ISBN 0-521-16819-1.

Littorina arcana

Distribution: Part of the *Littorina saxatilis* species complex and occurring in the intertidal on rocky shores. The complex includes *L. arcana L. compressa* and *L. saxatilis*. There are few records for this species in GBIF although it appears to occur from Norway to Northern Spain and France. It has a more restricted distribution than other members of the *L. saxatilis* complex (Mill & Graham 1990) and is absent along much of the south English coast, central Cardigan Bay and possibly northern Scotland; it is not found in estuaries (Mill & Graham 1990). Studies using dissection to identify this species have recorded it as from the northeast coast from Fife as far south as Humberside and present westwards from Lyme Regis around the Devon and Cornish coasts and into Somerset. It is also present on Lundy Island and in southwest Wales, including both St Ann's and St David's peninsulas in Dyfed, as well as the islands off the west Dyfed coast, on the Lleyn peninsula in North Wales and in Anglesey. Further north there were just two records on the west coast of Scotland (Mill & Graham 1990).

Habitat and ecology: Found on rocky shores in the intertidal, ranging from the high to midshore. Members of the order *Neotaenioglossa* are mostly gonochoric and broadcast spawners. Life cycle: Embryos develop into planktonic trocophore larvae and later into juvenile veligers before becoming fully grown adults (SeaLifeBase website)

Population: There are few recent records for *L. arcana* on NBN atlas but as identification requires dissection and examination of the armature of a deciduous penis, this species is most likely under reported and recorded as *L. saxatilis*. Future bar-coding studies using genetic markers may help clarify its extent.

EOO: 2,408 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 36 km^2 AOO based on nine GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Data deficient

Rationale: *Littorina arcana* is most likely under reported and recorded as *L. saxatilis*. There are few recent records for this species, and it can only be reliably identified using dissection to distinguish it from the very common *Littorina saxatilis*. Studies using dissection to identify this species in the 1990s recorded it as widespread but there are less than 10 recent records for *L. arcana* on NBN atlas for (2010–2019). Given that identification requires killing the individual to dissect it and that there are no monitoring programmes it is not clear whether the population is stable or declining for Criteria A. While the AOO of 36 km^2 and EOO 2,408 km^2 meets the criteria for EN under Criteria B it is considered unreliable due to the identification difficulties and there is no evidence to assess the further geographic range sub-criteria (severely fragmented, present at a small number of locations undergoing ongoing decline or extreme fluctuations), or to assess whether the population is small and declining (Criteria C) and present at few locations (Criteria D). Populations may be connected by pelagic larvae and hence the number of locations are unlikely to be restricted given the lack of threats at a regional level and populations are more likely to be connected rather than fragmented. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment. Given the lack of evidence for changes in population this species is assessed as Data Deficient, but is likely to be of Least Concern, given the lack of threats and changes to habitat. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Mill, P.J. & Grahame, J. 1990. Distribution of the species of rough periwinkle (*Littorina*) in Great Britain. *Hydrobiologia*, **193**(1), 21-27.

Littorina compressa

Distribution: Part of the *Littorina saxatilis* species complex, this is a northeastern North Atlantic species (Doellman *et al*. 2011) the range includes Norway and the Barents Sea, to Brittany. In the UK, records from The National Biodiversity Network Atlas show that it is present in N. Ireland, and the west coasts of the UK, and is found in England, the Isles of Scilly, Wales and Scotland. It is absent from the east coast of England.

Habitat and ecology: Habitat studies in Norway have found that while *L. compressa* can be found on the upper parts of rocky shores it prefers the lower shore in areas with Fucoid (brown) seaweeds (especially *Fucus vesiculosus*). It is found on the surface and beneath the fucoid mass and occasionally open gravel habitats (Maltseva *et al*. 2021). It is likely to graze bacterial films from the surface of fucoids (Maltseva *et al*. 2021). Unlike *L. saxatilis*, *L. compressa* is an egg-layer, rather than spawner, this may limit range expansion (Doellman *et al*. 2011).

Population: The *Littorina saxatilis* complex includes the recognized species *L. arcana*, *L. compressa* and *L. saxatilis*. Records on National Biodiversity Network Atlas (accessed 2023) do not suggest that the species has declined. However, *L. compressa* and *L. arcana* are the least studied of the species complex because of the difficulties involved in their identification (Maltseva *et al*. 2021). The wide distribution of records from 2010–2019 on NBN atlas show it is present in Scotland, Wales and England. Although there are few records, the species is likely to be under reported and is not considered to be restricted in terms of number of locations, sub-populations, or to have few mature adults.

EOO: 82,861 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 88 km^2 AOO based on 22 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: There are few recent records (2010–2019) for *Littorina compressa*, however, it is likely to be under reported as it is found within seaweed and the lower shore habitats in which it occurs have limited daily exposure limiting sampling time. In addition, individuals may be recorded as *L. saxatilis* as it is part of a complex of similar species and is difficult to distinguish. While the AOO of 88 km^2 meets the criteria for EN under geographic range criteria (Criteria B), it is considered unreliable due to the identification difficulties. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered likely to be small and declining (Criteria C) and does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Doellman, M.M., Trussell, G.C., Grahame, J.W. & Vollmer, S.V. 2011. Phylogeographic analysis reveals a deep lineage split within North Atlantic *Littorina* saxatilis. *Proceedings of the Royal Society B: Biological Sciences*, **278**(1722), 3175-3183.

Maltseva, A.L., Varfolomeeva, M.A., Ayanka, R.V., Gafarova, E.R., Repkin, E.A., Pavlova, P.A., Shavarda, A.L., Mikhailova, N.A. & Granovitch, A.I. 2021. Linking ecology, morphology, and metabolism: Niche differentiation in sympatric populations of closely related species of the genus *Littorina* (Neritrema). *Ecology and Evolution*, **11**(16), 11134-11154.

Littorina fabalis

Distribution: The flat periwinkle, *Littorina fabalis* (previously *L. mariae*) is distributed from the western Mediterranean to northern Norway (GBIF atlas), it is found through GB on all coasts in England, Wales, and Scotland (NBN atlas and is typically found in the lower intertidal associated with seaweeds (Williams 1990). There are actually two species of flat periwinkle and L. *fabalis* can't be reliably identified from *Littorina obtusata* without dissection.

Habitat and ecology: *L. fabalis* is generally present at the lower intertidal and *L. obtusata* is usually found in the mid-upper intertidal (Williams 1990). Although there is no free-swimming larval stage and therefore, low dispersal capacity, *L. fabalis* can occasionally raft longer distances attached to drifting macroalgae (Reid 1996).

Population: This is a widespread, common species that is found in high abundance throughout GB where suitable rocky habitats are present. Based on the absence of threats and no current (within three years), changes in habitat extent the species population is inferred to be relatively stable.

EOO: 460,864 km^2 EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 500 km^2 AOO based on 125 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Littorina fabalis* is widespread and common and abundant within its range where suitable rocky habitats are present. Populations have not undergone population reduction (Criteria A), are considered to be stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 500 km^2 which meets the threshold for Vu under Criteria B2, but it is considered unreliable due to the identification difficulties and lack of reporting based on its occurrence on the lower shore which has limited daily exposure and the lack of monitoring and reporting of intertidal species. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of small number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C) and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Williams, G. A. 1990. The ecologies of the flat periwinkles, *Littorina obtusata* (L.) and *L. mariae* Sacchi et Rastelli. *Field Studies*, **7**, 469–482.

Littorina littorea

Distribution: The edible periwinkle, *Littorina littorea*, is distributed from northern Spain to the White Sea (northern Russia), it is found on all British coasts, though rare or absent in the Isles of Scilly and Channel Isles (Jackson 2008).

Habitat and ecology: Mainly found on moderately exposed or sheltered rocky shores in the intertidal zone but is also found on artificial substrates and sheltered and slow draining sediments such as muddy habitats within estuaries (Newell 1958). The species is most commonly found on the mid-lower shore and shallow subtidal (Newell 1958) but in ideal conditions may be found higher up, especially in pools. However, the lower limit is poorly defined and will depend on factors such as predation likely to vary with latitude and location. It may be found in the infra- and circalittoral zones. However, in deeper water the species is only found as isolated individuals in very low densities. This species breeds throughout the year and has a free-swimming larval stage, supporting localised recovery and connectivity between populations (Johanneson 1992).

Population: Widespread around the coasts of GB and locally abundant where conditions are favourable and larval supply is high. *L. littorea* can reach densities of hundreds of individuals per square metre; in the UK densities are normally < 200 per square metre (Norton *et al*. 1990). The population trend is not known, but there are no current (within three years) changes in habitat extent the species population is inferred to be stable. Exploitation does occur but is concentrated on larger size classes in denser populations (Professor S.J. Hawkins, pers. comm.) leaving large numbers of smaller individuals behind.

EOO: 483,714 km^2 EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 3,028 km^2 based on 757 unique pseudotetrads.

Threatened category: Least concern

Rationale: *Littorina littorea* is widespread, common and abundant within its range where suitable rocky habitats are present. The population trend is not known, but no declines have

been reported or are indicated by changes in records on the NBN atlas. Populations are not considered to have undergone population reduction (Criteria A), they are considered to be stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 3,028 km^2 and EOO = 531,647 km^2 which do not meet the criteria for restricted geographic range. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. This species is typically present at high densities, and the number of mature individuals exceeds the criteria for small populations (Criteria C and D) and are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Newell, G.E., 1958. The behaviour of *Littorina littorea* (L.) under natural conditions and its relation to position on the shore*. Journal of the Marine Biological Association of the United Kingdom*, **37**(1), 229-239.

Norton, T.A., Hawkins, S.J., Manley, N.L., Williams, G.A. & Watson D.C., 1990. Scraping a living: a review of littorinid grazing. *Hydrobiologia*, **193**, 117-138.

Littorina obtusata

Distribution: The flat periwinkle, *Littorina obtusata* is distributed from the western Mediterranean to northern Norway and Iceland (Global Biodiversity Information facility online atlas), it is found throughout GB on all coasts in England, Wales, and Scotland (National Biodiversity Network online atlas).

Habitat and ecology: *L. obtusata* is typically found in the mid and lower intertidal zone associated with seaweeds (Williams 1990). There are two species of flat periwinkle due to splitting of *Littorina* littoralis into *L. obtusata* and *L.fabalis*. They can be separated in the field on shell morphology with practise or dissection. *L. fabalis* is generally present at the lower intertidal on *Fucus serratus* and *L. obtusata* is usually found in the mid-upper intertidal on *Ascophyllum nodosum* and *Fucus vesiculosus* (Williams 1990). They both lay egg capsules on fucoid fronds, hence there is no free-swimming larval stage and therefore, lower dispersal. Intertidal snails can occasionally raft longer distances attached to drifting macroalgae (Reid 1996).

Population: The population trend is not known, but in the absence of threats and no current (within three years) changes in habitat extent, the species population is inferred to be stable in the region. Further south in their range, climate change will result in even fewer fucoids restricting habitat.

EOO: 489,515 km^2 EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1,308 km^2 (AOO based on 727 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019).

Threatened category: Least concern

Rationale: *Littorina obtusata* is widespread, common and abundant within its range where suitable rocky habitats are present. The population trend is not known, but no declines have been reported or are indicated by changes in records on the NBN atlas. Populations are not considered to have undergone population reduction (Criteria A), they are stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 1,308 km^2 which meets the Criteria Vu for B2, however, the wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. Although there are no population estimates the number of mature individuals is considered to exceed the criteria for small populations (Criteria C and D) and this species is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence Criterion E could not be used in this assessment.

References

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Littorina saxatilis

Distribution: The rough periwinkle, *Littorina saxatilis*, is widely distributed throughout western Europe, including the western parts of the Baltic, and is also found on north eastern and north western coasts of North America (Global Biodiversity Information Facility (GBIF) online atlas). It is common around the coasts of Britain and Ireland (Based on National Biodiversity Network online Atlas).

Habitat and ecology: Occurs in a range of habitats on rocky shores from the upper to lower shore where it is typically found in crevices of bedrock, empty barnacle shells and under stones. It is also associated with saltmarshes, firm mud banks, and brackish lagoons. It is found in a wide range of habitats from exposed peninsulas to estuaries on all shores where there is a suitable rocky or stony substrate (Mill & Graham 1990). The young are brooded by females and are produced throughout the year. Breeding activity peaks between late spring and early summer where a single female may have up to 100 embryos in different stages of development.

Population: The population trend is not known but based on the absence of threats and no current (within three years) changes in habitat extent the species population is inferred to be stable. Despite apparent low dispersal potential *L. saxatilis* is frequently found colonising recently established habitats by means of passive transport, especially by rafting on macrophytes and by aerial dispersal attached to birds and has demonstrated its ability to successfully found new populations with only a few individuals (Wilhemsen 1998).

EOO: 370,03 3km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 220 km^2. AOO based on 55 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019).

Threatened category: Least concern

Rationale: *Littorina saxatilis*is widespread, common and abundant within its range being able to utilise a wide range of habitats. The population trend is not known, but no declines have been reported or are indicated by changes in records on the NBN atlas. Populations are not considered to have undergone population reduction (Criteria A), they are stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 220 km^2 which meets the Criteria EN for B2, however this is considered to be an underestimate, resulting from the lack of monitoring and reporting of coastal intertidal species, the wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. Although there are no population estimates the number of mature individuals is considered to exceed the criteria for small populations (Criteria C and D) and this species is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence Criterion E could not be used in this assessment.

References

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Melarhaphe neritoides

Distribution: A southern species of intertidal snail, the small periwinkle, *Melarhaphe neritoides* occurs on wave exposed rocky coasts and may be found high on the shore. The southern range boundary extends to North Africa and the Mediterranean. Commonly recorded throughout Britain and present in England, Wales, and Scotland. Populations are expanding northwards and eastwards in range, and it now occurs on all GB coasts occupying artificial habitat on the coasts between the Solent and Humber lacking much rocky shore habitat (Hawkins *et al*. 2008, 2009).

Habitat and ecology: A small snail (typically 4–9 mm). Breeding takes place throughout winter and spring, the larvae spend about three weeks in the water column before settling which supports population connectivity around the coastline of GB.

Population: No information was found on population trends but there is no evidence to suggest this species is declining and there is no current (within 3 years) change in habitat extent, and the population is inferred to be stable.

EOO: 451,944 km^2. EOO estimate based on minimum convex hull and GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 476 km^2. Based on 119 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Melarhaphe neritoides* **is** widespread and commonly recorded throughout England, Wales and Scotland where it may be abundant in suitable habitats. Larvae spend about three weeks in the water column before settling which supports population connectivity around the coastline of GB. No information was found on population trends but there is no evidence to suggest this species is declining (Criteria A) and there is no current (within three years) change in habitat extent, and the population is expanding northwards and eastwards in range (Hawkins *et al*. 2008, 2009). The AOO = 476 km^2 which meets the Criteria EN for B2, however, this is considered unreliable as this species is small and often overlooked as it occurs high in the intertidal in crevices and old barnacles. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. Although there are no population estimates, the number of mature individuals is considered to exceed the criteria for small populations (Criteria C and D) and this species is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence Criterion E could not be used in this assessment.

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Family: Muricidae

Boreotrophon clathratus

Distribution: Found in the Arctic, Eastern Pacific, and Northeast Atlantic: Alaska, Canada and Russia, Barents Sea. Boreal to polar (Based on records in the Global Biodiversity Information Facility). It is a northern species in GB (based on the National Biodiversity Network Atlas) and is recorded from one location only in GB (offshore, Northern Scotland), based on a cluster of records from the 70s to present day. Given the inferred restricted extent, this range edge species is potentially vulnerable to climate change (see Threats).

Habitat and ecology: A small snail (25–50mm), snail predatory on barnacles (Yakovis & Artemieva 2015) and found on rock and possibly other substratum. Found from the shallow subtidal to deeper waters (5–238 m from SealifeBase online). It was scarce in sites around the White Sea studied by Yakovis and Artemieva (2015) with high mortality of juveniles (35–40%) attributed to predation. The species formed part of the diet of wolf fish and eider and, it was presumed but not certain, spider crabs. Little life history information was found for this species.

Population: It is considered to be poorly recorded and a rare species for which risk of extirpation is potentially high (as the available records suggest few known occurrences within a single location) but there is insufficient data to conclusively assess distribution and status. No evidence is found for extreme fluctuations in population abundance or extent; records present a similar distribution in 2010–2019 as in the 1970s and 1980s - the decades for which most records were reported. The population within GB is considered to occur at a single location, the degree to which this population is connected to other offshore and more northern populations is unclear, it is likely this species does not produce a pelagic larval stage and therefore populations may be largely self-sustaining and unconnected. This isolation may increase regional extinction risk.

EOO: 13,305 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 20 km^2. AOO based on five GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Considered likely to be highly sensitive to climate change based on its northerly (Arctic) distribution but no evidence for this or impacts was found with insufficient data exist to conclusively assess distribution and status. The Maine Government wildlife plan (online) suggests that in North America this species is: currently undergoing steep population declines, which has already led to, or if unchecked is likely to lead to, local extinction and/or range contraction. The Clathrate Trophon is considered sensitive to large-scale, unintentional catch by commercial trawling which reduces population size and subsequently results in local extinctions (Maine Government 2016). The conclusions and the applicability to GB are not evidenced; however, these are considered to broadly indicate that this species is under threat from a number of potential human pressures but with climate change as the greatest threat. The extent to which deep waters off north coast Scotland may provide a refuge is unclear as there is little evidence and no systematic monitoring of populations, abundance and distribution.

Threatened category: Vulnerable (D2)

Rationale: *Boreotrophon clathratus* is a northern species at its equatorward range edge in GB waters. All records are from offshore Northern Scotland, and it is likely to have been restricted to this area as a small and isolated population (although possibly connected via larval supply to other populations offshore. There is insufficient data to conclusively assess distribution and status. No evidence was found for population decline (Criteria A) or extreme fluctuations in population abundance or extent; records present a similar distribution in 2010–2019 as in the 1970s and 1980s- the decades for which most records were reported. The main threat is climate change although there is no good evidence to assess potential change, range shifts following increases in sea water temperature may cause declines, however, there is no evidence to assess life span, sexual maturity and generation time to apply Criteria A3. The EOO = 13,305 km^2 and the AOO = 20 km^2 which meet the criteria for EN under geographic range. While there is no evidence to support ongoing decline (Criteria Bb) or extreme fluctuations (Bc) the population within GB is considered to be NT as it occurs at a single location (Criteria Ba in addition to B1 and B2 but no other geographic range criteria met). The degree to which this population is connected to other offshore and more northern populations is unclear, it is likely this species does not produce a pelagic larval stage and therefore populations may be largely self-sustaining and unconnected. This isolation may increase regional extinction risk. It is not possible to estimate the population size to support assessments under Criteria C and D (small population size) as no information on gregariousness or suitable habitats was found to support assessments of density in potential habitat extent. However, it was considered VU under Criteria D2 as it is only found offshore in Scottish waters, where presumably the deeper waters offer colder

habitats suitable for this species. This offshore area is considered to represent a single location that could be threatened by climate change. It is, however, likely to survive further north in following climate change. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Maine Government. 2015. Wildlife Action Plan Revision [online]. Available from: https://www.maine.gov/ifw/wildlife/reports/pdfs/SGCN_Reports/SGCN/Clathrate%20Trophon__Boreotrophon%20clathratus.pdf [Accessed 5 January 2023].

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Boreotrophon truncatus

Distribution: A circumboreal species, *Boreotrophon truncatus* occurs in the deep waters of the western Baltic Sea from the Kattegat to the entrance of the Baltic and extends south into the northern North Sea and down the western coasts of the British Isles to Biscay (Hayward & Ryland 1996).

Habitat and ecology: Found from the intertidal fringe to 200 m on stony and gravelly bottoms (Hayward & Ryland 1996). This is a small species (15 mm) based on Hayward and Ryland (1996).

Population: Records from the National Biodiversity Network Atlas (online) suggest northward retreat of this species, with fewer records in Wales and England for 2010–2019 than previous years, although the species is recorded throughout inshore and offshore Scottish waters. There are no obvious decadal trends in occurrence data with peaks in number of records in 1970–1979 and 2010–2019. This species was described as ‘not uncommon’ in dredged samples by Hayward & Ryland (1996).

EOO: 478,320 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 208km^2. AOO based on 52 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Boreotrophon truncatus* is a widespread species which is not considered to be under imminent extinction risk but as a circumboreal species, climate change with subsequent northwards retreat may occur in the future. There are no reported short-term threats to the species or habitat, although fishing may impact subtidal, offshore populations, however due to small size (15 mm) this species would pass through meshes or may be pushed aside by the pressure wave created in front of towed gear. It is likely to be under recorded and reported as the low water habitats in which it occurs in the intertidal are exposed for short periods only and the offshore habitats in which it occurs are rarely sampled and it is too small to be retained by trawl nets and the coarse and stony habitats with which it is associated are not suitable for sampling either by trawls or grabs. The population trend is not known, but no declines have been reported or are indicated by changes in records on the National Biodiversity Network Atlas. Populations are not

considered to have undergone population reduction (Criteria A), they are stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 208 km^2 which meets the criteria for EN for B2 (restricted geographic range). The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Hayward, P.J. & Ryland, J.S. 1996. *The Marine Fauna of the British Isles and North-West Europe*. Oxford University Press, Oxford.

Nucella lapilus

Distribution: The predatory dogwhelk (*Nucella lapillus*) is a snail found throughout the intertidal zone of the North Atlantic from the Arctic to the Algarve in the east, Iceland and the Faroes, and from Long Island north to southwest Greenland in the west. It is common on all rocky coasts of Britain and Ireland and on favourable, moderately exposed shores may be highly abundant,

Habitat and ecology: Found on wave exposed to sheltered rocky shores from the mid shore downwards. They are gregarious and common amongst barnacles and mussels on which they feed. *N. lapillus* lacks a dispersive pelagic larval phase, and they are relatively inactive as adults, moving mostly at night or when submerged (males more than females) but rarely far (BIOTIC 2006).

Population: Although dispersal is limited, juveniles may be transported by waves, currents and rafting and populations within GB are not considered to be isolated or fragmented. The population trend for this species is increasing, as populations have recovered after the banning of anti-fouling paints (in 1986) that had caused reproductive failures and impacts on whole populations in some areas (Spence *et al*. 1990).

EOO: 538,579 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 3,360 km^2. Based on 840 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Populations further south in Portugal are declining as the range of this northern species contracts due to warming but currently populations in GB are not considered to be under threat.

Threatened category: Least concern

Rationale: *Nucella lapillus* is widespread and common and abundant within its range where suitable habitats are present. Populations have been increasing from the late 1980's when anti-fouling paints that caused reproductive issues were banned. Currently populations and habitats in GB are not considered to be under threat, are considered stable or increasing and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The wide distribution of records from 2010–

2019 on National Biodiversity Network Atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of small number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C) and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Ocenebra erinaceus

Distribution: The snail, *Ocenebra erinacea* is a southern species that extends from the British Isles to the Mediterranean, Madeira and the Azores. Occurs mainly on the west and south coasts of Britain and northwest Ireland.

Habitat and ecology: Predominantly found in the sublittoral, where it occurs on rocks and under stones to depths of 150 m, but also it may often be found on the lower parts of sheltered rocky shores in the summer (Skewes 2005).

Population: The population trend for this species is increasing (based on NBN atlas), as populations recover after the banning of anti-fouling paints (in 1986) that had caused reproductive failures and impacts on whole populations in some areas. Climate change may also favour range expansion of this southern species, along with that of one of its common prey species of barnacle, *Perforatus perforatus*.

EOO: 390,604 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1252 km^2. Based on 313 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Ocenebra erinaceus* is widespread and common within its range. Populations have been increasing from the late 1980's when anti-fouling paints that caused reproductive issues were banned and therefore this species does not meet Criteria A (population decline). Currently populations and habitats in GB are not considered to be under threat, this species is a southern species which is likely to benefit from climate change in the future. There are no reported short-term threats to the species or habitat, although fishing may impact subtidal, offshore populations. It is likely to be under recorded and reported as the low water habitats in which it occurs in the intertidal are exposed for short periods only and the offshore habitats in which it occurs are rarely sampled and it is too small to be retained by trawl nets and the coarse and stony habitats with which it is associated are not suitable for sampling either by trawls or grabs. The AOO = 1,252 km^2 which meets the criteria for EN under geographic range (B2). However, it is likely to be under sampled and reported and the wide distribution of records from 2010–2019 on National Biodiversity Network Atlas, show it

is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range in terms of Criteria B1 (EOO = 390,604 km^2), small number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C), and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Skewes, M. 2005. *Ocenebra erinaceus* Oyster drill. In Tyler-Walters H. & Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews [online]. Plymouth, Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/1653 [Accessed 1 February 2023].

Ocinebrina aciculata

Distribution: *Ocinebrina aciculata* forms a species complex, of at least five species (Barco *et al.* 2017). This is a southern species reaching its northern range edge in GB, it is found in the Eastern Atlantic, from the Scilly Islands, English Channel and Channel Islands and at least to southern Spain and Alboràn Sea to the south (Barco *et al.* 2017).

Habitat and ecology: No information found.

Population: There are few records in NBN atlas (total 82) and some of these are outside the GB area. There is no clear trend on population discernible, although there are more records for 1990–1999 (41) than any other decade. There is no evidence to indicate population trends for this species but given its relatively small size (1–1.5 cm) and offshore habitat in deeper waters, it may be under recorded as there is very limited monitoring in the offshore and this species would pass through the mesh of a beam trawls. As a southern species it may benefit from climate change.

EOO: 161 km^2 EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 12 km^2 Based on three GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Data deficient

Rationale: Due to data limitations, no assessment has been made for this species. There is no evidence to assess population trends, population size, geographic range or number of locations to assess Criteria A, B, C and D. Although the AOO = 12 km^2 and EOO = 161 km^2 meets the criteria for EN under B1 and B2, there is no evidence to assess against sub-criteria and due to lack of monitoring in subtidal areas this may be an underestimate. No threats are known to assess (D2), and the species (population and distribution) is likely to be under-recorded, as it is small and lives offshore in deeper habitat. The population size is unknown and could not be confidently inferred to assess Criteria D1. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Trophonopsis barvicensis

Distribution: Eastern Atlantic, From Iceland and northern Norway to Morocco; deeper than 50 m in the north, deeper than 200 m in the south; Gorringe seamount, rare in 180–360 m. Some forms possibly attributed to this species occur in the Azores. Mediterranean only in the Alboran Sea (World Register of Marine Species, source not cited). Northerly species in GB that occurs around Scotland (Hayward & Ryland 1996). retreats into deeper waters further south.

Habitat and ecology: No information found.

Population: No information found. The population is not restricted in extent and occurs mostly around offshore Scotland. There are no obvious trends in records with peaks in 1970s and 2010–2019, so that EOO and AOO have increased since 1990s.

EOO: 348,081 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 120 km^2. Based on 30 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Data deficient

Rationale: Given its small size and offshore habitat *Trophonopsis barvicensis* is likely to be under reported, with no information on habitat, ecological and population to make an assessment. There is no evidence to assess population trends, population size, geographic range or number of locations to assess Criteria A, B, C and D. There is no information on habitats or ecology or likely density to estimate population size. Although the AOO = 120 km^2 and thus meets the criteria for EN under B2, there is no evidence to assess against sub-criteria and due to lack of monitoring in offshore deeper areas the AOO may be an underestimate. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Hayward, P.J. & Ryland, J.S. 1996. *The Marine Fauna of the British Isles and North-West Europe*. Oxford University Press, Oxford.

Trophonopsis muricata

Distribution: This species occurs in sublittoral European waters, in the Mediterranean Sea, in the Black Sea, in the Northwest Atlantic Ocean off Portugal, Spain and the Azores (Based on records in World Register of Marine Species).

Habitat and ecology: A small species of 1–2 cm, that occurs in the sublittoral on muddy, sandy and gravelly bottoms from 20–300 m (Hayward & Ryland 1996).

Population: Described as 'Not uncommon' by Hayward and Ryland (1996) but with no further detail to describe this. As this is a southern species it may benefit from climate change which may expand the range of suitable habitats northwards.

EOO: 125,393 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 20 km^2. Based on five GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Data Deficient

Rationale: Given its small size and offshore habitat *Trophonopsis muricata* is likely to be under reported, with no information on habitat, ecological and population to make an assessment. There is no evidence to assess population trends, population size, geographic range or number of locations to assess Criteria A, B, C and D. From the limited information available it appears that the habitats that are suitable for this species are very extensive around GB covering broad areas. However, grab sampling is only suitable for muddy sediments and the area sampled by this approach is very small and is not suitable for species that are patchily distributed. On sandy and gravelly bottoms where trawls are likely to be used for sampling, the small size of this species means that it will pass through trawl meshes and not be sampled. The lack of records may indicate that the species is rare or that it is under sampled and under reported. Although the AOO = 20 km^2 and thus meets the criteria for EN under B2, there is no evidence to assess against sub-criteria and due to lack of monitoring in offshore deeper areas the AOO may be an underestimate. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Hayward, P.J. & Ryland, J.S. 1996. *The Marine Fauna of the British Isles and North-West Europe*. Oxford University Press, Oxford.

Family Mytilidae

Crenella decussata

Distribution: The bivalve *Crenella decussata* is widely distributed globally from the Bering Sea to San Pedro, California; Greenland to Carolina and with record from Norway and further north. It is found in the Sea of Japan and in the Sea of Okhotsk (Kolotukhina *et al.* 2011). In the UK it is found at shelf depths across the northern areas reaching southwest Wales in the west and Dogger Bank in the North Sea (National Museum of Wales).

Habitat and ecology: The species is gregarious living in groups of 5–6 adults (Morton *et al.* 2016) and has a short pelagic dispersal stage. It is therefore unlikely to be isolated as subpopulations. It is found in gravelly sand, a widespread habitat (Conchological Society).

Little information is available for this species. As it is small (4 mm) (National Museum of Wales) and lives infaunally within burrows, called crypts (Morton *et al.* 2016) it is likely to be under recorded.

Population: No evidence was found for population trends, but it is assumed that these are at least stable as numbers of records have increased from 2000–2009 (NBN atlas). The habitats in which this species is found (subtidal sands and gravels) are very widespread in Scotland where it is mostly reported. The species is gregarious; thus, the population is estimated to be greater than > 5000 based on each reported individual of the last 10 years likely to be associated with at least 5-6 other adults (Morton *et al.* 2016).

EOO: 564,102 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 392 km^2. Based on 98 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Although it is considered very vulnerable to physical disturbance (Borja *et al*. 2000), no evidence of a decline is apparent from the number of records. Threats may include aggregate extraction (although this will be restricted to shallower habitats) and physical disturbance from fishing. Based on the circumboreal distribution, climate change may threaten this species.

Threatened category: Least concern

Rationale *Crenella decussata* is widely distributed, it is found in gravelly sand, a widespread habitat, is gregarious and has a short pelagic dispersal stage. It is therefore unlikely to be isolated as subpopulations. The habitats in which *Crenella decussata* is found (subtidal sands and gravels) are very widespread in Scotland where it is mostly reported. Although it is considered very vulnerable to physical disturbance, no evidence of a decline is apparent from the number of records. It is likely to be under recorded as it is very small and would pass through trawl meshes and lives infaunally in offshore gravelly sand which is not suitable for grab sampling. There is very limited sampling and monitoring of subtidal habitats. No evidence was found for population size or trends, but it is assumed that these are at least stable as numbers of records have increased from 2000-2009 (NBN atlas). Populations are, therefore, not considered to have undergone population reduction (Criteria A). The AOO = 392 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitats and the unsuitability of this species for recording via trawls, grabs or drop-down cameras. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland and England with population connectivity supported by a pelagic larval stage. It is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D), and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

Anonymous. 2016. *Crenella decussata* (Montagu 1808). Marine Bivalve Shells of the British Isles [online]. Natural History Museum of Wales. Available from: https://naturalhistory.museumwales.ac.uk/britishbivalves/browserecord.php?-recid=39.

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Dacrydium vitreum

Distribution: The Arctic glassy-mussel, *Dacrydium vitreum* is an Arctic species that has been recorded very rarely from deep water to the north of the Faroes and Iceland. Salas and Gofas (1997) do not give any boreal records for this species, and most have been confused with *D. ockelmanni* (Oliver *et al.* 2016). It has been recorded prior to 2010 in offshore waters around Shetland (based on the online National Biodiversity Network Atlas) but these records may have been mis-attributed.

Habitat and ecology: A small species, up to 5 mm (Oliver *et al.* 2016). Found on the Continental Margin Zone (200–500 m) and bathyal (500–2000 m) (Oliver *et al.* 2016). GB represents the southern range edge for this species, and suitable habitats are restricted to offshore deep waters around Scotland.

Population: There is no evidence for population size or current presence. This species may have retreated northwards, based on a lack of recent records but there is no definitive evidence to support this. This is a small species occurring in habitats which are deep and offshore so inaccessible to public recorders, difficult to grab sample and that are not routinely monitored.

EOO: No GB records for 2010–2019.

Threats: Rising water temperatures may cause this species to retreat further north. In terms of climate change threats, habitats in Scotland from where the species has previously been recorded can be considered to represent one location.

Threatened category: Data Deficient

Rationale: This is a northern species, with very restricted suitable habitats available in the UK. It is a range edge species, unlikely to have ever been present in extensive areas around GB given the lack of suitable deep water habitats. The lack of records may indicate that the species is rare or that it is under sampled and under reported as it is too small to be sampled using trawls. Grab sampling may be suitable for this species but effort and coverage in deep water areas in GB is very limited with less than 0.01% of habitat sampled. No information was available on threats to this species, and it is not clear whether fishing or other environmental changes may impact this species. However, as this is a northern species, at the southern range edge, climate change may represent a threat. There is no evidence to assess population trends, population size or number of locations. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment. Therefore, this species is assessed as data deficient.

References

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Idas argenteus

Distribution: There is very little information for this species within UK waters. The species within this genus are typically found in deep waters (> 200 m), in association with organic material such as sunken wood or cetacean remains (Delongueville & Scaillet 2019). The specificity of their habitats makes them difficult to locate and they are likely to be naturally scarce. Historic whaling has reduced whale populations, so that fewer whales fall to the seabed. The replacement of wooden ships by steel may have further restricted suitable habitats. The NBN atlas shows no records for GB or Northern Ireland with only limited areas of deep-water habitats available in the UK Exclusive Economic Zone.

The GBIF atlas provides one record between the Isle of Lewis and the Faroe Islands, which may be the historic record extracted from sunken wood, from the Triton expedition of 1882 from the Wyville-Thomson Ridge at a depth of 944 metres (Oliver & Holmes 2008). The Ocean Biodiversity Information System (OBIS) contains 22 records for this species from 1875–2016. The global distribution is understood from OBIS and GBIF to be North and South America where it may be misidentified (Mietto *et al.* 2019) with scattered records across the Atlantic Ocean. The documented worldwide distribution is the Mediterranean (Eastern Basin) and North Atlantic Ocean (Gofas *et al.* 2001).

No EOO or AOO: no recent records.

Threats: There is no evidence to suggest that this species has declined over time. Its offshore habitat in deep waters and small size (5 mm) suggest that it may be under recorded. As it is found in specific deep-sea habitats associated with organic matter it is likely to have always had a restricted range. There is no evidence to assess population trends, population size, geographic range or number of locations. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

Threatened category: Data deficient

Rationale: There are only two potential records for *Idas argenteus* in GB waters. The extent of suitable habitats is likely to be extremely limited as it is found specifically in deep-sea habitats associated with organic matter. The specificity of their habitats makes them difficult to find and they are likely to be naturally scarce. Historic whaling has reduced whale populations, so that fewer whales fall to the seabed. The replacement of wooden ships by steel and improvements in maritime safety may have further restricted suitable habitats as the number of wooden wrecks will have reduced. There are no records for GB with only limited areas of deep-water habitats available in the UK Exclusive Economic Zone. The lack of records may indicate that the species is rare or that it is under sampled and under reported as it is too small to be sampled using trawls. Grab sampling is suitable for this species but effort and coverage in deep water areas in GB is very limited with less than 0.01% of habitat sampled. No information was available on threats to this species, and it is not clear whether fishing or other environmental changes may impact this species. There is no evidence to assess population trends, population size or number of locations. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Websites

NBN atlas occurrence records for *Idas argenteus*

Ocean Biodiversity Information System: *Idas argenteus*

Idas simpsoni

Distribution: Northern species in GB found in offshore areas around Scotland, recorded distribution includes the North East Atlantic from Southern Iceland to Portugal, Northern France, Adriatic (Bolotin *et al.* 2005) and Mediterranean.

Habitat and ecology: The species is associated with organic deposits, including cetacean bones (Bolotin *et al.* 2005), wood and in large numbers on diesel contaminated mud under oil rigs in the northern North Sea (Southward 2008). Size to 40 mm.

Population: This species has a wide geographical distribution (southern Iceland to Mediterranean) and is found on the continental shelf (to 200.m) (NHMW 2016). Given the habitat requirement for organic matter, it is likely to have an extended larval stage to allow colonisation. The largest specimen recorded is from Iceland (Warén 1991), those found in the Adriatic were around 2 cm (Bolotin *et al.* 2005). The small size and habitat specificity mean it is discovered only sporadically but is likely to be widespread.

No EOO or AOO: only two records between 2010–2019, this species is thought to be widespread and under recorded due to its small size and habitat specificity.

Threats: Historic whaling has reduced whale populations, so that fewer whales fall to the seabed. The replacement of wooden ships by steel may have further restricted suitable habitats. Decommissioning of oil and gas fields in North Sea may limit organic inputs.

Threatened category: Data deficient

Rationale: Data deficient. The small size and habitat specificity mean it is discovered only sporadically but is likely to be widespread, based on global distribution from Iceland to the Mediterranean. The specificity of their habitats, associated with organic matter, makes them difficult to find and they are likely to be naturally scarce. Historic whaling has reduced whale populations, so that fewer whales fall to the seabed. The replacement of wooden ships by steel and improvements in maritime safety may have further restricted suitable habitats as the number of wooden wrecks will have reduced. There are no recent records for GB. There is no evidence to assess population trends, population size, geographic range or number of locations to assess Criteria A, B, C and D. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Modiolula phaseolina

Distribution: Ranges from northern Norway to Mediterranean and north-west Africa (Hayward & Ryland 1995). Distributed widely but less frequent in the North Sea and apparently absent from the southern North Sea. Attached by the byssus and nestling in crevices or among epifauna including horse mussel beds (Oliver *et al.* 2016).

Habitat and ecology: Occurs from low in the intertidal to moderate shelf depths (Oliver *et al.* 2016). Size: 2 cm.

Population: No evidence for population size, this species occurs in the subtidal and may be under-reported. Records on the National Biodiversity Network Atlas (online) have increased from 1990, however, as monitoring and recording are not systematic it is not clear that this represents an increase in abundance and wider distribution.

EOO: 487,633 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 492 km^2. AOO based on 123 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Assessment: *Modiolula phaseolina* is widely distributed. No evidence was found for population size or trends, but it is assumed that these are at least stable as records on the National Biodiversity Network Atlas (online) have increased from 1990, however, as monitoring and recording are not systematic it is not clear that this represents an increase in abundance and wider distribution. Populations are not considered to have undergone population reduction (Criteria A). The AOO = 492 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitat. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England. It is therefore not considered to meet the sub-criteria for geographic range (Criteria B): it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D), and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Modiolus adriaticus

Distribution: A southern species ranging into the English Channel, Irish Sea and SW Ireland. Offshore to moderate shelf depths. var. ovalis is restricted to the south coasts of Dorset and Cornwall (Oliver *et al.* 2016).

Habitat and ecology: Size to 50 mm. Found on the continental Shelf (to 200 m) (Oliver *et al.* 2016).

Population: The number of records on the National Biodiversity Network Atlas (online, checked December 2022) has increased between 1990–2019, reflected in changes in AOO from 28–132 km^2. This species is not subject to systematic monitoring and therefore it can only be suspected that the population has increased.

EOO: 211,816 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 132 km^2. Based on 33 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Modiolus adriaticus* is a southern species, apparently undergoing range expansion within GB waters. No evidence was found for population size or trends, but it is assumed that these are at least stable as records on the National Biodiversity Network Atlas (online) have increased from 1990, however, as monitoring and recording are not systematic it is not clear that this represents an increase in abundance and wider distribution. Populations are not considered to have undergone population reduction (Criteria A). The AOO = 132 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitat. The

wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland and England. It is therefore not considered to meet the sub-criteria for geographic range (Criteria B): it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Modiolus barbatus

Distribution: A southern species extending into the English Channel, Celtic and Irish Seas, and west of Ireland. Records in the North Sea are doubtful. Lives in the low intertidal and sublittoral but also recorded offshore (Oliver *et al.* 2016). Occurs south to the Mediterranean and north-west Africa (Hayward & Ryland 1996).

Habitat and ecology: This species is found among rocks and stones on the lower shore, extending into the sublittoral on coarse grounds to depths of around 100 m (Farrell 2006; Hayward & Ryland 1996). *M. barbatus* can grow up to 6 cm long, although individuals are usually smaller (Farrell 2006).

Population: No information on population size and structure. The number of records on the National Biodiversity Network Atlas (online, checked December 2022) has increased steadily since the 1950s, reflected in increased AOO and EOO. This species is not subject to systematic monitoring and therefore it can only be suspected that the population has increased.

EOO: 42,828 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 68 km^2. AOO based on 17 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Modiolus barbatus* is a southern species, apparently undergoing range expansion within GB waters. No evidence was found for population size or trends, but it is assumed that these are at least stable as records on the National Biodiversity Network Atlas (online) have increased from the 1950s, however, as monitoring and recording are not systematic it is not clear that this represents an increase in abundance and wider distribution. Populations are not considered to have undergone population reduction (Criteria A). The AOO = 68 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitat. It is therefore not considered to meet the sub-criteria for geographic range (Criteria B): it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Modiolus modiolus

Distribution: Recorded from the White Sea and Norway, off the Faroes and Iceland, south to the Bay of Biscay and occasionally North Africa, also from Labrador to North Carolina in the Atlantic and from the Bering Sea south to Japan and California in the Pacific (Tyler-Walters 2007). Found off all British coasts. Extensive beds of *Modiolus modiolus* are most common on northern or western coasts but absent south of the Irish Sea and Humber estuary. Records in the southwest and English Channel are likely to be single individuals or juveniles (Tyler-Walters 2007).

Habitat and ecology: Found part buried in soft sediments or coarse grounds or attached to hard substrata. Found from the intertidal to the Continental Shelf (to 200 m). *Modiolus modiolus* beds may occur as large and continuous banks (biogenic reefs) or as scattered clumps. Individuals may be found on the lower shore in rock pools or in laminarian holdfasts but more common sub tidally to ca 280 m. It grows to approximately 22 cm. Individuals over 25 years old are frequent in British populations, with occasional records of individuals up to 35 years old. However, maximum ages are thought likely to be more than 50 years (Anwar *et al.* 1990). Sexual maturity occurs at about 35–40mm according to Anwar *et al*. (1990) and reported ages at maturation vary from 3–8 years.

Population: No evidence for population size and structure, however this is a widespread common species, although both EOO and AOO have declined from 1990 (from 496 pseudotetrads to 328) based on National Biodiversity Network Atlas records. However, as habitats suitable for this species extend into the subtidal to 280 m they are unlikely to be reliably sampled and in the absence of systematic and repeated monitoring, records must be interpreted with caution.

EOO: 463,520 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1,312: km^2. AOO based on 328 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: *Modiolus modiolus* beds are potentially threatened by several climate change stressors including rising seawater temperatures, ocean acidification, changes in wave exposure and ocean currents (MCCIP 2018). Beds are sensitive to a range of human activities, including use of towed demersal fishing gear, scallop dredging, cable laying and other activities which cause seabed disturbance and will have led to historical declines (Tyler-Walters 2007). The loss of beds is also likely to reduce larval supply to maintain populations that are less aggregated. As individuals live for a long time, reduced recruitment may take some time to be noticeable and result in declines.

Threatened category: Least concern

Rationale: The assessment is based on *Modiolus modiolus* occurring as individuals. Individuals are relatively commonly recorded and widespread. Generation time is considered to be 8 years and the basis of the assessment to be three generations (i.e. 24 years). Over longer timescales, than the 24 years that represents three generations (the period of assessment), climate change is likely to become a more significant threat but extent of threats to individuals and the potential decline is not clear and deeper, more Northern habitats may provide a refuge. The biogenic habitats formed by aggregations of many individuals, are sensitive to physical disturbance and have been damaged and removed by bottom fishing gears, so that these are recognised as a threatened and declining habitat. The AOO = 1,312 which meet the criteria for VU for B2 (restricted geographic range). However, as habitats suitable for this species extend into the subtidal to 280 m, they are unlikely to be reliably sampled and in the absence of systematic and repeated monitoring, records must be interpreted with caution. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and populations are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Musculus costulatus

Distribution: Mostly found on the south and west coasts. Ranging south to the Mediterranean and north-west Africa (Hayward & Ryland 1996), not found further north than UK (Global Biodiversity Information Facility atlas online checked December 2022). In GB this is a range edge species, found as far north as Shetland. Based on National Biodiversity Network Atlas records online (checked November 2022) this is a widespread species found on all GB coasts but is not present on the east coast of England (reflecting lack of rocky shores).

Habitat and ecology: A small species (to 1.2 cm, Oliver *et al.* 2016). On rocky shores, lower shore and shallow sublittoral (Hayward & Ryland 1996) and down to 200 m, attached to rocks and algae (Oliver *et al.* 2016). No further life history information was found.

Population: No clear population trend was observed (based on NBN atlas online records) at an annual scale although records were greater between 2006–2008, the following years appear to return to similar abundances before that period. Area of occupancy (AOO) for the period 2010–2019 has decreased (from 23 to 10 pseudotetrads) but until then was steadily increasing from the 1960s. Extent of occupancy has increased to the assessed period

(2010–2019) which suggests range expansion. This is a small species and likely under reported. No information on threats, but as a southern range edge species it is likely to benefit from climate change. Planktonic larvae support population connectivity and dispersal.

EOO: 427,795 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 40.km^2. AOO based on 10 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Musculus costulatus* is a small species, found from the intertidal down to 200 m and likely to be under recorded. It is a southern species that may benefit from climate change. The population trend is not known, but the number of national records were increasing from the 1960s (based on National Biodiversity Network Atlas records available online, records checked up to 2022) until 2010. Populations are, therefore, not considered to have undergone population reduction (Criteria A), they are stable and there is no evidence for threats to the species or habitat. The AOO = 40 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitats and at 12 mm size, the species is unlikely to be conspicuous enough to be seen on drop down cameras especially in turbid areas and is small enough to pass through trawl meshes. Habitats in which it is found are generally unsuitable for bottom trawling and grab sampling, suggesting it may be under recorded. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Musculus discors

Distribution: The green crenella, *Musculus discors* is *c*ommon around most of the British Isles from Shetland to the Channel Isles. A panartic bivalve, it is found from the Arctic Circle south through the Bering Sea to Japan or to the Puget Sound in the Pacific or south to New York or Madeira in the Atlantic, including the western Baltic and Mediterranean (BIOTIC 2006). In the north east Atlantic it ranges south to the Mediterranean and Madeira (Hayward & Ryland 1996).

Habitat and ecology: On rocky shores from mid-tidal zone into shallow sublittoral (Hayward & Ryland 1996). *Musculus discors* usually occurs as distinct clumps but occasionally forms dense, extensive beds. Adults attach to their substratum using byssus threads. They then weave a 'nest' of several thousand of fine byssus threads around their shell, so that the shell is suspended in a network of byssus threads. The byssus threads are not attached to the

shell but only emanate from the byssal aperture. The nest completely encloses the adult so that the crenella is only visible when its valves are open and it is feeding with siphons extended (BIOTIC 2006).

Population: Records from NBN atlas show that reports of this species have been increasing since the 1960s up until 2010, with a drop in reports from 2010–2019 (from 217–76 occupied pseudotetrads (1990–1999 and 2010–2019 respectively). It is not clear if this reflects a change in abundance or differences in survey and reporting. The species is found throughout GB in a range of habitats (inshore and offshore).

EOO: 484,807 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 304 km^2. AOO based on 76 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Musculus discors* is a small species, found from the intertidal and shallow sublittoral and likely to be under recorded. The population trend is not known, but the number of national records were increasing from the 1960s (based on National Biodiversity Network Atlas records available online, records checked up to 2022) until 2010 with a drop in reports from 2010–2019 (from 217–76 occupied pseudotetrads (1990–1999 and 2010–2019 respectively). It is not clear if this reflects a change in abundance or differences in survey and reporting. The species is found throughout GB in a range of habitats (inshore and offshore) and populations are not considered to have undergone population reduction at the threshold level for Criteria A. The AOO = 304 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitats and at 12 mm size, the species is unlikely to be conspicuous enough to be seen on drop down cameras especially in turbid areas and is small enough to pass through trawl meshes. Habitats in which it is found are generally unsuitable for bottom trawling and grab sampling, suggesting it may be under recorded. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

BIOTIC. 2006. Biological Traits Information Catalogue. Plymouth: 01/11. Marine Life Information Network [online]. Marine Biological Association of the United Kingdom. Available from: www.marlin.ac.uk/biotic [Accessed 2022].

Hayward, P.J. & Ryland, J.S. 1996. *Handbook of the Marine Fauna of North-West Europe*. Oxford University Press, Oxford.

Musculus glacialis

Distribution: National Biodiversity Network Atlas provides one record for this species from North Wales (Anglesey). This is a Circumboreal species with majority of records on Global Biodiversity Information Facility from North America, Canada and Alaska.

Threatened category: Data Deficient

Rationale: Data Deficient, the National Biodiversity Network Atlas provides one record for this species from North Wales (Anglesey). This is a circumboreal species with many records on Global Biodiversity Information Facility from North America, Canada and Alaska. No information was found on native range or evidence to assess based on habitat preferences or other information on ecology or life history. There is no evidence for population size, declines, fragmentation and number of locations (Criteria A, C and D), geographic range (Criteria B) or analysis of extinction risk (Criteria E).

Musculus niger

Distribution: This species has a pan-boreal distribution, and it can be found in the Atlantic Ocean, eastern Pacific Ocean, and the Arctic Ocean (based on Global Biodiversity Information Facility online atlas). It is found on the continental shelf to 200 m, partly buried in soft but stable sediments. (Oliver *et al.* 2016) and is therefore likely to be under-recorded. There are no recent records for GB. This is a range edge species, that may decline, further with climate change in northern Britain. It is found down to 200 m so that offshore habitats outside the UK may offer habitat refuges.

Threatened category: Data Deficient

Rationale: *Musculus niger* has a pan-boreal distribution and it can be found in the Atlantic Ocean, eastern Pacific Ocean, and the Arctic Ocean (based on Global Biodiversity Information Facility online atlas). It is found on the continental shelf to 200 m, partly buried in soft but stable sediments. (Oliver *et al.* 2016) and is therefore likely to be under-recorded as it is too small at 5mm to be sampled by trawls and grab sampling effort is limited in these habitats. There are no recent records for GB. This is a range edge species, that may decline, further with climate change in northern Britain. It is found down to 200 m so that offshore habitats outside the UK may offer habitat refuges. There is no evidence to assess population trends, population size, geographic range or number of locations to assess Criteria A, B, C and D. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Musculus subpictus

Distribution: The marbled crenella *Musculus subpictus*, is widely distributed around all GB coasts (except for east coast of England), reflecting the lack of rock habitat). It is found from coasts of Norway to Mediterranean and northern Africa (based on Global Biodiversity Information Facility records online).

Habitat and ecology: A small species, up to 2 cm length. It is mostly recorded from the intertidal and sublittoral but also to moderate shelf depths. Often embedded in the tests of ascidians but not exclusively and can be found attached by the byssus in kelp holdfasts, crevices and on coarse offshore substrates (Fish & Fish 1996).

Population: Records from NBN atlas show that reports of this species have been increasing since the 1960s up until 2010, with a drop in reports from 2010–2019. It is not clear if this reflects a change in abundance or differences in survey and reporting. The species is found

throughout GB in a range of habitats (inshore and offshore) and in offshore habitats it is likely to be under-recorded.

EOO: 476,681 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 604 m^2. AOO based on 151 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Musculus subpictus* is widely distributed, from the intertidal to the intercontinental shelf with broad habitat preferences. In offshore habitats it is likely to be under-recorded. Its small size mean it is not retained in trawl sampled and grab sampling effort is limited and unsuitable for rock or coarse habitats in which this species is found. Suitable habitats are likely to be extensive. The population trend is not known, but the number of national records were increasing from the 1960s (based on National Biodiversity Network Atlas records available online, records checked up to 2022) until 2010 with a drop in reports from 2010–2019. It is not clear if this reflects a change in abundance or differences in survey and reporting. The species is found throughout GB in a range of habitats (inshore and offshore) and populations are not considered to have undergone population reduction at the threshold level for Criteria A. The AOO = 604 km^2 which meets the criteria for VU for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitats. Habitats in which it is found are generally unsuitable for bottom trawling and grab sampling, suggesting it may be under recorded. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Mytilus edulis

Distribution: Three species of the mussel, *Mytilus*, occur in the North Atlantic region, *M. edulis*, *M. galloprovincialis* and *M. trossulus*, and hybrid zones are present where their distributions overlap. *M. edulis* extends from Arctic waters to the Mediterranean (Hayward & Ryland 1996), occurring from the White Sea, south to southern France in the North East Atlantic. In the W. Atlantic, it extends from the Canadian Maritimes south to North Carolina. It occurs on the coasts of Chile, Argentina, the Falkland Islands and the Kerguelen Isles (Tyler-Walters 2008). At the present time *M. edulis* is probably the most abundant mussel in Europe and the north Atlantic. *M. galloprovincialis* has expanded northwards from the Iberian Peninsula and now exists in a patchy mosaic of pure species and hybrids with *M. edulis* along the west coast of Europe from France in the south to the Shetlands in the north (Gosling 1992).

Habitat and ecology: Occurs from the high intertidal to the shallow subtidal attached by fibrous byssus threads to suitable substrata. Found on the rocky shores of open coasts attached to the rock surface and in crevices, and on rocks and piers in sheltered harbours

and estuaries, often occurring as dense masses (Tyler-Walters 2008). Dispersal is dependent on the duration of planktonic life. Maintenance of their position in the water column by active swimming ensures that larvae can be potentially dispersed over great distances by currents. In addition, post-larvae can become bysso-pelagic up to 2–2.5 mm in size, which may take circa two months to achieve, during which time they may be transported significant distances by currents (Tyler-Walters 2008).

Population: Very common all around the coast of the British Isles, with large commercial beds in the Wash, Morecambe Bay, Conway Bay and the estuaries of south-west England, north Wales, and west Scotland. *M. edulis* is gregarious, and at high densities forms dense beds of one or more (up to five or six) layers, with individuals bound together by byssus threads (Tyler-Walters 2008).

EOO: 600,903 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 4,532 km^2. AOO based on 1,133 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Moderate warming events have led to mortalities of *M. edulis* in the eastern English Channel (Seuront *et al.* 2019). This species may be of concern over longer (50 year+ timescales) due to warming, increased storminess (which may remove beds – see also Mieszkowska *et al*. 2021) and increased predation. Hybridisation or replacement with the Mediterranean mussel *M. galloprovincialis* may occur but no evidence was found to categorise the potential loss. The timescale exceeds the next 10 years and 3 generations (this species reaches sexual maturity at 1–2 years).

Threat category: Least concern

Rationale: *Mytilus edulis* is is abundant and very common all around the coast of the British Isles, with large commercial beds in the Wash, Morecambe Bay, Conway Bay and the estuaries of south-west England, north Wales, and west Scotland due to broad habitat preferences and tolerances for a wide range of environmental conditions. Populations have not undergone population reduction (Criteria A), are considered stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of small number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C), and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Mytilus galloprovincialis

Distribution: Three species of the mussel, *Mytilus*, occur in the North Atlantic region, *M. edulis*, *M. galloprovincialis* and *M. trossulus*, and hybrid zones are present where their distributions overlap. *M. galloprovincialis* originated in the Mediterranean and southern parts of the North-east Atlantic (North Africa and Iberian Peninsula) but has expanded out of the Mediterranean and into the Black Sea. It now exists in a patchy mosaic of pure species and hybrids with *M. edulis* along the west coast of Europe from France in the south to the Shetlands in the north (Beaumont *et al.* 2008). *M. galloprovincialis* is considered the most warm-water-tolerant species of the three, with the most southerly distribution in Europe and North America and on the Atlantic coasts, in Portugal, north to France and the British Isles and Norway (Beaumont *et al.* 2008). Recently this species has also been found in the European Arctic including northern Norway and Svalbard (Mathiesen *et al.* 2017). It is known from identifiable populations in southwest England, southwest Ireland and south Wales (Oliver *et al.* 2016).

Habitat and ecology: Lives in the intertidal and sublittoral. Invasive species worldwide, difficult to differentiate in field without bar coding, freely hybridises with *M. edulis*, likely to be doing better with climate change. Likely to replace *M. edulis* if it declined, forms hybrid swarms.

Population: *Mytilus galloprovinciais* is widespread in the UK and population connectivity is supported by the long pelagic larval phase. and *M. galloprovincialis* will hybridize with the closely related *M. edulis* and *M. trossulus*, when they are found in the same locality. As it is difficult to differentiate in the field and may occur as a hybrid, the records on the National Biodiversity Network Atlas (available online, checked November 2022) are likely to reflect that it is under reported. This species may benefit from future climate change that leads to warming.

EOO: 1,985 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 32 km^2. AOO based on 8 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: Although there are relatively few records, *Mytilus galloprovincialis* has undergone range expansion in GB and further north. There are no known threats and populations may benefit from future climate warming. As it is difficult to differentiate in the field and may occur as a hybrid, the records on the National Biodiversity Network Atlas (available online, checked November 2022) are likely to reflect that it is under reported. This species may benefit from future climate change that leads to warming. It is not considered to be declining (Criteria A), although the AOO = 32 km^2 and EOO = 1,985 km^2 meet the criteria for EN under geographic range criteria (Criteria B), these figures are considered unreliable due to the identification difficulties. This species is not considered to be present at a small number of locations, likely to be undergoing ongoing decline or extreme fluctuations), and the population is not considered likely to be small and declining (Criteria C: small population size and declining). It does not have a very small and restricted population (Criteria D). No

quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Mytilus trossulus

Distribution: Three species of the mussel, *Mytilus*, occur in the North Atlantic region, *M. edulis, M. galloprovincialis* and *M. trossulus*, and hybrid zones are present where their distributions overlap (Beaumont *et al.* 2008). In GB, *Mytilus trossulus* is known from Loch Etive in Scotland (Beaumont *et al.* 2008). The population is suggested to be a post-glacial relict restricted to the low salinity area of the Loch. In addition, individual mussels of all three *Mytilus* species and their hybrids were detected amongst Loch Etive mussels. However, populations of *M. trossulus*, or with a strong *M. trossulus* genomic influence, occur widely throughout the northern parts of *M. edulis* range, from the North Sea (Bergen) and Western Scotland to the Barents Sea coast of Norway and Russia. This is based on data on allozyme, nuclear DNA and mitochondrial DNA markers and show that *Mytilus trossulus* is widespread on North European coasts, earlier thought to be inhabited only by *Mytilus edulis* (Väinölä & Strelkov 2011).

EOO: Not possible to calculate, only one record.

AOO: 4 km^2. AOO based on 1 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Data deficient

Rationale: This species has only been recorded recently in GB. There is no EOO calculated as there is only one recent record location. The AOO = 4 km^2 is based on one pseudotetrad. The degree to which hybrids exist can only be elucidated by genetic study. In GB, *Mytilus trossulus* was only recently identified and this was only possible because of genetic analysis. This species hybridises with *M. edulis* may be more established than expected as genetic testing is required to establish identity. Data on allozyme, nuclear DNA and mitochondrial DNA markers show that *Mytilus trossulus* is widespread on North European coasts, earlier thought to be inhabited only by *Mytilus edulis* (Väinölä & Strelkov 2011). An analysis of GB populations has not been undertaken but may show similar patterns. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Family: Onchidiidae

Onchidella celtica

Distribution: The Celtic Sea slug, *Onchidella celtica*, is abundant on the north coasts of Cornwall and Devon from St. Ives as far as Croyde Bay (Russell 1925; Tween 1987). A smaller isolated pocket occurs on the shores in eastern Cornwall centred on Whitsand Bay on the south coast. There are dubious records from Upper Loch Fyne, Scotland, the Farne Islands which are highly unlikely. It is a southern species common from North Africa, up to Brittanny and the Channel Isles. It is also in the Canaries, Madeira, and Azores.

Habitat and ecology: An air-breathing slug, it can be found on exposed rock, often on reefs emerging from sandy shores amongst mussels, barnacles and hiding in crevices feeding when the tide is out (Kent & Hawkins 2019). Mainly observed between April and November. The slugs live gregariously in the shelter of rock crevices where numbers vary from 2–3 to up to 60 individuals (Barfield 2003).

Population: Records on National Biodiversity atlas have increased since the 1990s. Population trends are considered stable with no evidence for decline, and it is likely to expand with climate warming.

EOO: 4,264km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 40km^2. Based on 10 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: There are no known threats to this species, it is not considered to be at risk of becoming extinct despite its relatively restricted regional distribution.

Threatened category: Least concern

Rationale: Least concern, in the GB region despite restricted South-west distribution. Population trends are considered stable with no evidence for decline. As there are no known threats to this species it is not considered to be at risk of becoming extinct despite its relatively restricted regional distribution. Records on the National Biodiversity Network Atlas have increased since the 1990s and therefore this species does not meet Criteria A (population decline). While the AOO of 40 km^2 and EOO of 4,264 km^2 meet the criteria for EN under geographic range criteria (Criteria B), it is abundant locally and there are no identified threats to the region that would affect this species. It is, therefore, not considered to meet the sub-criteria in terms of small number of locations, undergoing ongoing decline or extreme fluctuations. The population is not considered likely to be small and declining (Criteria C: small population size and declining) as locally it can be abundant, and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Family: Patellidae

Patella depressa

Distribution: *Patella depressa* is a southern species extending from Senegal to north Wales (Firth *et al.* 2009; Orostica *et al*, 2020). In SW Britain, it reaches its northern limit in north Wales and its eastern limit in breeding numbers on the Isle of Wight and until recently Southsea. Scattered individuals have been found in recent years as far east as Hastings. The artificial seashore at Southsea has been re-modelled as part of sea defence work and access was not possible on recent surveys in 2022 due to building work, so this population may have been wiped out.

Habitat and ecology: An intertidal species, occurring commonly on both open rock and in pools on more exposed shores.

Population: Long-term data sets from SW Britain (Crisp & Southward 1958) and subsequent surveys (see Hawkins *et al.* 2008,2009) have shown that the relative proportions of *P. depressa* and the common limpet *P. vulgata* fluctuate. *P. depressa* was more common in the warmer 1950s, while *P. vulgata* was more prevalent in the colder period of the 1960s to early 1980s. With the current trend in global climate change, P*. depressa* has continued to increase in abundance since the mid-1980s in Britain (see Hawkins *et al.* 2008) becoming dominant over the coldwater *P. vulgata* throughout southern England and Wales (Mieszkowska *et al.* 2013). Predictive modelling by Freitas *et al*. (2023), predicts the range of this species to increase under projected climate change.

EOO: 51,719 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 232 km^2. AOO based on 58 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019).

Threatened category: Least concern

Rationale: *Patella depressa* is common and undergoing range expansion. Populations are not considered to have undergone population reduction (Criteria A), as they have increased in abundance since the mid-1980s in Britain with predictive modelling indicating the range of this species will continue to increase under projected climate change. There is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 232 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this species is considered to be under reported and may be

confused with the common limpet *P. vulgata*. It is not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). The number of mature individuals exceeds the criteria for small populations (Criteria C and D), and the species is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Patella pellucida

Distribution: Occurs in Iceland and from north Norway to south Portugal. It is found on the west coasts of Denmark, and Sweden south to Oresund. However, it is absent from the Baltic Sea and the east coasts of Denmark, Belgium, and Holland. Found on all coasts of Britain and Ireland except the coast surrounding the Wash (southeast England between Hull and Margate).

Habitat and ecology: Widely distributed in north-west Europe and around Britain. It is found on rocky shores, typically on the kelps such as *Laminaria digitata, L.hyperborea* and *Saccorhiza polyschides* to a depth of 27 m (Tyler-Walters 2008).

Population: Populations have increased since the 1960s and 70s (Professor S.J. Hawkins, pers comm.). There are no concerns or threats to this species which is stable on most shores where there is suitable habitat (kelps and other seaweed). Populations are connected via pelagic larvae which supports recolonization locally. It is relatively short-lived (1–2 years) and reaches sexual maturity at around six months.

EOO: 537,166 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1,988 km^2. Based on 497 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019).

Threatened category: Least concern

Rationale: *Patella pellucida* is common and undergoing range expansion and is a widely distributed species within the middle of its geographic range. It does well on most southern kelp species such *Saccorhiza polyschides,* and is not at risk, therefore, if more northern species such as *Laminaria digitata* and *L. hyperborea* decline with climate warming. Populations are not considered to have undergone population reduction (Criteria A), as they have increased in abundance since the 1960s in Britain and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (less than 10 years). The AOO = 1,988 km^2 meets the criteria for Vu for B2 (restricted geographic range), however this species is considered under reported, as it is small and lives on kelp. The low shore habitats are only uncovered for a small period of time each day and subtidal populations are more inaccessible for recording and monitoring. It is small and translucent and may be over looked. It is not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). The number of mature individuals exceeds the criteria for small populations (Criteria C and D) and the species is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Patella ulyssiponensis

Distribution: *Patella ulyssiponensis* is found in the Mediterranean, Black Sea and North-east Atlantic from Morocco to Shetland and Bergen, Norway (Høisæter 2009; Weber & Hawkins 2005). It is found on most of the coast of the British Isles from the Isle of Wight up around the west coast and down the east coast to Flamborough Head (Southward *et al.* 1995). There has been some recent range extension east of the Isle of Wight as far as Beachy Head (last breeding population), with occasional individuals in Kent.

Habitat and ecology: Usually found in the low intertidal zone of wave-exposed sites on bedrock, and at higher shore levels but mainly restricted to crustose coralline dominated rock-pools (Firth *et al.* 2009; Seabra *et al.* 2009 and references therein).

Population: The population range has been increasing in GB since cold winters of 60s and 70s (Firth *et al.* 2009). This species is difficult to differentiate from *P. vulgata* without experience and is likely to be under recorded as a result. Populations are widespread around the coast of the UK but with few records on the east coast of England south of Flamborough where there are virtually no exposed bedrock habitats to support this species. Predictive modelling by Freitas *et al*. (2023), predicts the range of this species to increase under projected climate change.

EOO: 438,509 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 468 km^2. Based on 117 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Further south in its range this species is exploited in Portugal and its congeneric sister species is heavily overexploited in the Canaries, Madeira and Azores, where collection of larger individuals tends to target females of this protandrous species. Such exploitation is very limited in the GB region, but should it occur then populations would be vulnerable due to protandry.

Threatened category: Least concern

Rationale *Patella ulyssiponensis* is common and undergoing range expansion and is a widely distributed species Populations are not considered to have undergone population reduction (Criteria A), as they have increased in abundance since the 1970s in Britain and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (less than 10 years). Ecological modelling predicts the range of this species to increase under projected climate change. The AOO = 468 km^2 which meets the criteria for EN for B2 (restricted geographic range); however, this species is considered under reported as it is difficult to differentiate from other common limpets without experience and is likely to be under recorded as a result. It is not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). The number of mature individuals exceeds the criteria for small populations (Criteria C and D) and the species is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Patella vulgata

Distribution: The common limpet *Patella vulgata* occurs from the Arctic Circle to Portugal, where it reaches its southern distribution limit (Southward *et al*, 1995; Freitas *et al.* 2023). *P. vulgata* is widespread all around the UK with some gaps due to lack of suitable rocky habitat on the east coast of England.

Habitat and ecology: Occurs throughout the littoral zone on exposed and sheltered shores in the British Isles (Bowman & Lewis 1986).

Population: Populations increased in GB, benefitting from colder conditions in the 1960s and 70s. Predictive modelling by Freitas *et al*. (2023), predicts the northward range of this species to increase under projected climate change but with losses from Portugal at the southern range edge. Relative abundances of *P. vulgata* and *P. depressa* fluctuate according to warming and cooling periods. In GB the population and range of *P. depressa* is increasing however, it is considered unlikely that *P. depressa* would extirpate *P. vulgata* which is a superior competitor on open rock (Firth *et al.* 2009).

EOO: 539,617 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 2,604ckm^2. AOO based on 651 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Warmer climate has caused reproductive failure in some years within midshore habitats in south-west England, with *P. vulgata* being partially replaced by *P. depressa* on the upper-middle levels of more exposed shores. Many topographical and biologically generated refuges (Moore *et al.* 2007) are available particularly on sheltered shores and at lower tidal levels (Freitas *et al.* 2023, and references therein). There is likely a medium term (2050–2100) threat from climate change for populations in Portugal at the southern range edge. *Patella vulgata* has not been exploited in large amounts in recent times on GB shores.

Threatened category: Least concern

Rationale: *Patella vulgata* is widespread and common and abundant within its range where suitable habitats are present. Populations have not undergone population reduction (Criteria A), are considered stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). In GB the population and range of another limpet, *P. depressa*, is increasing however, it is considered unlikely that competition would extirpate *P. vulgata* which is a superior competitor on open rock. This species not facing immediate threats in response to climate change. The wide distribution of records from 2010–2019 on National Biodiversity Network Atlas show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of small number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C), and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Family: Pinnidae

Atrina fragilis

Distribution: Widely distributed in the Atlantic and the Mediterranean. In the UK, the fan mussel *Atrina fragilis* is recorded predominantly off southern and western shores (Seaward 1990). Global distribution is from northern Scotland to the Iberian Peninsula, including the Channel Isles and the Adriatic Sea. The UK population appears to be at the northern limits of the distributional range and populations are or have been much larger further south.

Habitat and ecology: The fan mussel *Atrina fragilis*, is one of the largest Pinnidae bivalves and its lifespan is greater than 12 years (Solandt 2003). *Atrina fragilis* is a highly 'recordable' species because of its attractiveness (historically) to shell collectors and its conspicuous appearance. Specimens occur as solitary individuals or localized patches of small groups of individuals (BIOTIC 2006).

Fertilization is external and dependent on the proximity of other individuals, and factors including water movement. When populations become very sparse, as is the case in the UK, fertilisation failure is likely to be significant. Stirling *et al*. (2018) found that *A. fragilis* in west Scotland exhibited peaks of spawning in summer and winter with low levels of spawning throughout the year. Dispersion is assumed to be possible over large distances due to the pelagic life history with up to four months larval duration (Stirling *et al.* 2018).

Population: Populations of *A. fragilis* have declined from inshore waters around the south west of England. Historic records are only available from UK waters referring to gregarious populations up to the middle of the 19th century (Jeffreys 1863, from Solandt 2003), while contemporary records reported scarce populations or individuals (Solandt 2003). The location for an individual *A. fragilis* in Plymouth Sound found in December 2003 (Dr K. Hiscock, own observations following report of several individuals being seen) is in an area of soft mud not subject to dredging.

However, records of occurrence of these species rely on anecdotal information, and there may still be areas of high population density in deeper waters that will be a considerable source of planktonic larvae (Solandt 2003). Targeted surveys based on species distribution models have discovered locations in Scotland where this species is still present, expanding the known distribution (Stirling *et al.* 2016). Tyler-Walters (2003), provides the following information: Solandt (2003) described two 'hotspots 'in UK waters; in Scotland and south-west coast of Cornwall. Solandt (2003) also noted that in recent years (the 1990s onwards) more records of were obtained from deep water. In Scotland, considerable populations were found in the deep tidal waters of The Minch and the Sound of Skye and in the waters between John O'Groats and the Shetland Isles. Atrina fragilis was also recorded from Melville Knoll and Haddock Bank seamounts, at depths of 50 m and 200 m ca 50 miles south-west of the Isles of Scilly (Solandt 2003). The largest known area of fan mussels in the UK, in the Sound of Canna, covered an area of at least 170 ha and the densest patches were estimated to be 2–4 /m^2 where the fan mussels occurred in clumps or scattered individuals at 102–274 m (Howson *et al.* 2012, cited from Tyler-Walters 2003). Nevertheless, the species has declined in abundance in the last 100 years, especially in inshore waters (Solandt 2003).

Threats: The fan mussel is ranked as a highly susceptible species to physical disturbance and bottom trawling due to its fragile shell, longevity, size, and inability to re-burrow into sediment after a disturbance event (Hall-Spencer *et al.* 1999; Solandt 2003; Hiscock & Jones 2004). Trawling has caused over 70% reduction in the *A. fragilis* population of the Adriatic (Gulf of Venice), whereas 90% of the specimens caught by trawlers were lethally damaged Hall-Spencer *et al*. (1999).

Observations from fisheries observers on trawler boats have seen considerable declines in populations from areas as widespread as the Nymphe Bank off County Cork in Eire to The Irish Sea (Cardigan Bay, Bristol Channel and the Lundy's). These trawlers regularly encountered shells of *A. fragilis* within their trawls, which they would sell on to shell collectors. Large individuals were caught in the Celtic Sea in the 1970's and one comment was of "decks being covered with the broken fragments of this species" (Francis Kerkhof, personal communication, cited from Solandt 2003).

EOO: 252,044 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 56 km^2. AOO based on 14 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: The assessment draws on a range of sources and balances a number of considerations. It is important to recognise that the Red Listing categories assess the risk of extinction and do not necessarily reflect conservation priorities. A species can be Least Concern but still a conservation priority. *Atrina fragilis* has undergone significant historic declines from fishing to which it is highly susceptible due to its fragile shell, longevity, size, and inability to re-burrow into sediment after a disturbance event. There have been considerable declines in populations from the Irish Sea (Cardigan Bay, Bristol Channel and the Lundy's). These declines are considered historical. The continuing pressure from fishing will prevent recovery in shallow and inshore habitats but may not be leading to further declines as the populations have already been removed over a time period longer than 10 years or three generations, thus the thresholds for Criteria A are not met.

The EOO = 252,044 km^2 and exceeds the geographic range criteria for B1, however the AOO = 56 km^2, meets the threshold for EN for Criteria B2. Having been extirpated from suitable areas that are repeatedly trawled, there is no evidence that this species has undergone further declines (Criteria Bb) and there may still be areas of high population density in deeper waters that will be a considerable source of planktonic larvae (Solandt 2003). Recent surveys, of deeper areas including those targeted by habitat models, indicate that individuals and populations persist, particularly in more rugged areas unsuitable for fishing by mobile gears. Targeted surveys based on species distribution models have discovered locations in Scotland where this species is still present, expanding the known distribution (Stirling *et al.* 2016). The pelagic larvae support population connectivity and this species is not considered to be severely fragmented (Criteria Ba) or to undergo extreme fluctuations (Criteria Bc). There is no evidence to assess population size for Criteria C or D and the sub-criteria for subpopulations (Criteria C) or small number of locations. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

Populations are likely to be well connected by the extended period of the pelagic larval phase. Individuals need to be close together for fertilization to occur and further declines in population density in the remaining strongholds would be of concern. There is no evidence that fertilizations rates are so low as to result in extinction and that populations are

undergoing current declines, instead it is assumed that the much-reduced population, compared to historic baselines, is relatively stable. Changes in fishing activity in the last remaining, deeper, rugged habitats, would require this assessment to be updated. Climate warming may benefit this species, which reaches its northern range edge in the UK but only where physical disturbance pressures on the seabed are reduced.

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Family: Trochidae

Clelandella miliaris

Distribution: Atlantic Ocean, from Iceland and Norway to West Africa, and throughout the Mediterranean (Gofas 2005). Records on National Biodiversity Network Atlas (checked May 2023) show that this species is widespread on western coasts of GB.

Habitat and ecology: There is very little evidence on the ecology of this species. Offshore it usually occurs in in 100–300 m depth (Gofas 2005) although records from GB, reported on NBN atlas are from shallower waters. Life cycle: Embryos develop into planktonic trochophore larvae and later into juvenile veliger before becoming fully grown adults.

Population: No evidence for extreme fluctuations. Between 1990–2019, there are differences in number of records with much fewer reported between 2000–2009 but whether this represents actual fluctuations is unknown. EOO (based on National Biodiversity Network Atlas records) has expanded rather than contracted between 1990–2019. However, this may represent changes in survey location and intensity rather than population changes. AOO is restricted but records on National Biodiversity Network Atlas (1990–2019) suggest that suitable habitats are widespread. Populations are not fragmented as species records are widespread and planktonic larvae support dispersal.

AOO: 344 km^2. Based on 86 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

EOO: 406,267 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

Threats: Not commercially targeted or exploited. Deep waters may provide a refuge from climate change but the distribution of this species in the Mediterranean suggests that it may be resilient to increased water temperatures.

Threatened category: Least concern

Rationale: *Clelandella miliaris*, is widely distributed with no evidence of population decline (Criteria A) and no identified threats to the species or habitat. Populations are not fragmented as species records are widespread and planktonic larvae support dispersal. The AOO = 344 km^2 and meets the criteria for EN (B2). Populations are not fragmented as species records are widespread and planktonic larvae support dispersal. The wide distribution of records from 20102019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of number of locations or population fragmentation (Criteria Ba), or to have few mature adults. It is not known to be undergoing ongoing decline (Criteria Bb) or extreme fluctuations (Bc), and the population is not considered likely to be small and declining (Criteria C: small population size and declining) and does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Gibbula magus

Distribution: A southern species found in the North Sea, the North Atlantic Ocean (Azores, Morocco) and in the Mediterranean Sea. It is widespread around GB, present on all coasts except the east coast. It is mainly sublittoral (and hence likely to be under recorded) but is locally common at the subtidal/intertidal fringe in favoured sheltered sites in Scilly Isles, Cardigan Bay, Connemara, and Orkney (Smith 2015).

Habitat and ecology: Found to depths of about 70 m on rocky substrata and present on stable sand, muddy sand, maerl, gravel, and sometimes on rock (Smith 2015). The habitats it can use are therefore widespread.

Population: The number of records held on National Biodiversity Network Atlas available online, for this species are increasing (records checked up to 2022).

EOO: 317,151 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 744 km^2. Based on 186 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Gibbula magus* is widespread, common and abundant within its range where suitable habitats are present. The population trend is not known, but the number of national records are increasing (based on National Biodiversity Network Atlas records available online, records checked up to 2022). Populations are, therefore, not considered to have undergone population reduction (Criteria A), they are considered to be stable and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 744 km^2 which meets the criteria for VU for B2 (restricted geographic range); however, this is likely to be an underestimate due to limited sampling of subtidal habitats and at 3.1 cm breadth and 2.5 cm length, the species is unlikely to be conspicuous enough to be seen on drop down cameras especially in turbid areas and is small enough to pass through trawl meshes. The wide distribution of records from 2010–2019 on National Biodiversity Network Atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range: it is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations. The number of mature individuals is likely to exceed the criteria for small populations (Criteria C and D) and the population is not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Jujubinus exasperatus

Distribution: Eastern Atlantic, from the British islands to Morocco; Mediterranean, usually in 0–30m. Gorringe, Seine and Ampère seamounts (common in 82–325 m, the deeper occurrences probably resulting of downslope transport) (cited from World Register of Marine Species, no attribution).

Habitat and ecology: A small species (8–10mm), considered sensitive to disturbance (Borja *et al.* 2000) but without specific information detailing threats. It is present on seamounts and knolls but also found in shallower habitats with seagrass (Donnarumma *et al.* 2018) and maerl beds. In the Gulf of Naples, individuals lived to around two years and spawned once in their lifetime (Donnarumma *et al.* 2018).

Population: Hayward and Ryland (1996) state that this species is 'not common'. Population decline is inferred on the basis that this species has only been recorded once in the last decade on National Biodiversity Network Atlas, although species records can only be used as a proxy for population changes as they are not subject to systematic monitoring and survey. This is a southern range edge species that may benefit from climate change and current seagrass restoration. As this species is likely to have a pelagic larval stage, populations are assumed to have some degree of connectivity supporting population resilience.

EOO and AOO: No recent records (2010–2019).

Threatened category: Data deficient

Rationale: Given the small size, and likely presence in offshore habitats, *Jujubinus exasperatus* is likely to be under reported, with habitat, ecological and population information data deficient. While no threats were identified there is no evidence to support assessment. The lack of records may indicate that the species is rare or that it is under sampled and under reported as it is too small to be sampled using trawls. Grab sampling is suitable for this species but effort and coverage in deep water areas in GB is very limited with less than 0.01% of habitat sampled. No information was available on threats to this species, and it is not clear whether fishing or other environmental changes may impact this species. There is no evidence to assess population trends, population size or number of locations. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Jujubinus montagui

Distribution: North and South Europe and Mediterranean (most records UK) (based on Global Biodiversity Information facility (GBIF) online atlas and National Biodiversity Network online atlas, checked March 2023).

Habitat and ecology: Almost no information for this species other than small size (3–9 mm).

Population: Has been recorded since the 19th Century, with an increase in records since 1990. National Biodiversity Network online atlas records for the last 10 years (checked 2023) show species is widespread around UK. This is a small species and likely to be under recorded. As this species has a pelagic larval stage populations are assumed to have some degree of connectivity supporting population resilience.

EOO: 523,015 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 192 km^2. Based on 48 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Jujubinus montagui* is widespread and likely under reported. Populations have not undergone population reduction (Criteria A) are considered stable with an increase in records since 1990 on National Biodiversity Network Atlas. There is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The AOO = 192 km^2 which meets the threshold for CR under geographic range criteria (Criteria B); however, this is likely to be an under estimate as this is a small species and likely under recorded. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered likely to be small and declining (Criteria C: small population size and declining) and does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

Jujubinus striatus

Distribution: Distributed from the Mediterranean northward to south-west Britain. Locally abundant in the Channel Islands but rare on the British and Irish coasts. There are records from south Devon, the Isle of Man and the Isles of Scilly, but recent records only from Bognor Regis, Falmouth, and Bryher in the Isles of Scilly (Neish 2005). This is a range edge species, that is most likely under studied in GB and that may benefit from climate change.

Habitat and ecology: At low water spring tides down to 300 m. Usually found around plants and seaweed especially *Zostera marina*, and on stones among *Ulva* and *Codium* species. A pyramidal shaped top shell up to 10 mm high and 8 mm broad.

Population: Has apparently disappeared from many sites where it was formally common as there are no recent records (Neish 2005). A southern species (GBIF) associated with seagrass that may benefit from *Zostera* restoration. There is no clear trend on National Biodiversity Network Atlas but there are few records for the last 10 years. EOO has expanded since 2019 due to new records, but it is not clear this represents an increase in population abundance.

EOO: 2,263 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 32 km^2. Based on 8 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Vulnerable D2

Rationale: The population trend is not known for *Jujubinus striatus* to assess against Criteria A. There is no clear trend on National Biodiversity Network Atlas but there are few records for the last 10 years. The AOO = 32 km^2 and EOO = 2,263 km^2 meet the criteria for EN for B, but there is no information to assess whether it meets the sub-criteria for geographic range: undergoing ongoing decline (Bb) or extreme fluctuations (Bc). It is present at a small number of locations (Ba) and therefore meets the criteria for NT (BT + one sub-criteria). There is no information to assess population size or to support an estimate as there is no density information. It is assessed as Vulnerable (D2), based on the small number of locations (3) on the National Biodiversity Network Atlas (online) in which it has been reported from southwest England (Bognor Regis, Falmouth, and Bryher in the Isles of Scilly, Neish 2005). These are considered separate locations as they are dispersed and due to the dependence of this species on seagrass (*Zostera*) which are sensitive to a range of pressures including disease and physical disturbance and changes in water quality. In the future it may benefit climate change and seagrass restoration. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Phorcus lineatus

Distribution: Found in the northeastern Atlantic from Morocco to Cap de la Hague, France on mainland Europe. Northern limits reached in North Wales and North Ireland. A southern species, found on upper rocky shores between Isle of Wight and Llandudno, and most of Ireland except the region between Carnsore Head and Strangford Lough (Mieszkowska 2008).

Habitat and ecology: Occurs in the midshore region of moderately exposed rocky shores in England and Wales. Requires a stable boulder field or broken shore with available bare rock (Mieszkowska 2008).

Population: The topshell *Phorcus (osilinus) lineatus* continues to colonise shores along the rocky coastline of North Wales beyond recent range limits, where it has not previously been recorded (Mieszkowska *et al*. 2013) and numbers are increasing along the coastline of south England with recent advances since 2020 beyond the last major breeding population at Kimmeridge to the Isle of wight and beyond with likely breeding populations in Brighton and at Beachy head with individuals found as far east as Folkestone in 2023 (Mieszkowska, Herbert & Hawkins, unpublished).

EOO: 86,046 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 660 km^2. Based on 165 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Phorcus lineatus* is a southern species with an expanding range throughout Wales and South and southeast England. Numbers of individuals continue to increase within populations around the Welsh and English coastlines each year (Mieszkowska *et al.* 2013). It therefore does not meet the criteria for population decline (Criteria A). The AOO = 660 km^2 which meets the criteria for VU for B2 (restricted geographic range). The wide distribution of records from 2010–2019 on National Biodiversity Network Atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). This species is typically present at high densities, and the number of mature individuals exceeds the criteria for small populations (Criteria C and D) and are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Mieszkowska, N., Firth, L. & Bentley, M. 2013. Impacts of climate change on intertidal habitats. *MCCIP Science Review 2013*, 180-192.

Steromphala cineraria

Distribution: The geographical distribution of *Steromphala cineraria* ranges from southern Portugal and north to the White Sea in northern Russia, becoming rarer at its range edges as thermal limits are approached (Nekhaev 2013). It is widely distributed in north-west Europe and around Great Britain on sheltered rocky shores. It is common to all British and Irish coasts.

Habitat and ecology: Typically occurs among boulders and cobbles on the lowshore and sub-tidally, where it grazes among *Fucus* and Laminaria species. Intertidally, it is most common on the lower shore but can also be found in pools higher on the shore. Subtidally, it extends to depths of 130 m, although it is most common in the kelp forests between 30 m and low water spring tide (Fretter & Graham 1976).

Population: Records from the National Biodiversity Network Atlas (online) indicate decadal increase in reported occurrence records from the 1960s. It has been found that warm water adapted kelps *Laminaria ochroleuca* that are spreading in the English Channel have been found to support higher densities of *S. cineraria* compared to *L. digitata and L. hyperborea* (Gilson *et al.* 2021).

EOO: 562,612 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 4,908 km^2. Based on 1,227 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Steromphala cineraria* is widely distributed in north-west Europe and around Britain on sheltered rocky shores where it is a common species and the number of records on National Biodiversity Network Atlas show a continued increase rather than population decline (Criteria A) and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The wide distribution of records from 2010–2019 on National Biodiversity Network Atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the geographic range sub-criteria in terms of small number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C), and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Steromphala tumida

Distribution: Iceland and north Norway south to British, Irish, French and Iberian coasts (Hayward & Ryland 1996) with a few records from the Mediterranean basin (Global Biodiversity Information Facility atlas, online).

Habitat and ecology: Sublittoral only, found on kelp, occurs down to 1,200 m on stones on sandy-muddy bottoms (Hayward & Ryland 1996), occasionally found low in the intertidal zone in Iceland.

Population: Widely distributed in north-west Europe and around Britain on sheltered rocky shores and the shallow subtidal zone. Common to all British and Irish coasts and number of records on the National Biodiversity Network Atlas show a continued decadal increase since the 1960s, although it is likely to be under recorded as it is present in the subtidal.

EOO: 657,539 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 804 km^2. AOO based on 201 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Steromphala tumida* is widely distributed in north-west Europe and around Britain on sheltered rocky shores and the shallow subtidal zone. Common to all British and Irish coasts and number of records on the National Biodiversity Network Atlas show a continued decadal increase since the 1960s, although it is likely to be under recorded as it is present in the subtidal. It therefore does not meet the criteria for population decline (Criteria A). The AOO = 804 km^2 which meets the criteria for VU for B2 (restricted geographic range). The wide distribution of records from 2010–2019 on National Biodiversity Network Atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). This species is typically present at high densities, and the number of mature individuals exceeds the criteria for small populations (Criteria C and D) and are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

References

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Steromphala umbilicalis

Distribution: The recorded range of extends from north-west Scotland and the southern Orkney Islands of mainland and Hoy (Mieszkowska *et al*. 2013) to Morocco (Southward *et al.* 1995). Found on western shores of UK as far north as Scotland and on all suitable shores in Ireland and the Isle of Man. This is a warm water species previously found until the early 2000s as far east as the Isle of Wight, since spreading along the into far eastern English Channel and around into the southern North Sea (Mieszkowska *et al.* 2013). Also recently recorded in Alnwick and Orkney.

Habitat and ecology: A habitat generalist, found within the mid to low-intertidal zone in rockpools, cracks, above and under boulders/rock ledges/platforms, and the fucoid zone (Mieszkowska *et al.* 2013).

Population: Numbers of individuals continue to increase within populations around the Welsh and English coastlines each year. It is considered to be doing exceptionally well, everywhere, with abundance and range continuing to expand (Mieszkowska *et al.* 2013).

EOO: 406,215 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1,616 km^2. AOO based on 404 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Steromphala umbilicalis* is widely distributed in north-west Europe and around Britain on sheltered rocky shores and the shallow subtidal zone. Numbers of individuals continue to increase within populations around the Welsh and English coastlines each year. It is considered to be doing exceptionally well, everywhere, with abundance and range continuing to expand (Mieszkowska *et al.* 2013). It therefore does not meet the criteria for population decline (Criteria A). The AOO =1,616 km^2 which meets the criteria for VU for B2 (restricted geographic range). The wide distribution of records from 2010–2019 on National Biodiversity Network Atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria for geographic range (Criteria B). It is not present at a small number of locations (sub-criteria Ba), undergoing ongoing decline (sub-criteria Bb), or extreme fluctuations (sub-criteria Bc). This species is typically present at high densities, and the number of mature individuals exceeds the criteria for small populations (Criteria C and D) and are not restricted to a small number of locations (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Echinoderms

Brissopsis lyrifera

Distribution: *Brissopsis lyrifera* may be found in offshore or inshore stable sediments from Norway and Iceland to South Africa and the Mediterranean. Also present on the east coast of North America but not Greenland. Recorded off the west, north and east coasts of the British Isles, but not off the south coast (Budd 2004). Common in deep water. *B. lyrifera* typically co-occurs with the brittle star, *Amphiura chiajei*, on muddy, soft bottom areas of the North Sea, the Skagerrak and the Kattegat (Hollertz *et al.* 1998).

Habitat and ecology: Found in muddy sediments in areas sheltered from currents and wave exposure. It occurs from 5–500 m, (the lower circalittoral to Bathyal habitats). From observations made along the Northumbrian coast, Buchanan (1967), described *B. lyrifera* as a highly productive, short lived but fast growing species. The population he studied showed clear evidence of successful and consecutive annual recruitment. Specimens became sexually mature when 'test' length was greater than 60 mm, they spawned in the summer towards the end of their 4th year and died shortly afterwards. No individuals were observed to survive to breed for a second time.

Population: *Brissopsis lyrifera* is a gregarious species. Tunberg (1991) found up to 30 individuals per m² at various locations along the Swedish coast. However, in the North Sea densities of up to 60 individuals per m² have been reported (Ursin 1960). Fishing is likely to

have resulted in historical population declines as towed gears damage and remove individuals (see Threats section for evidence). The decline has not been quantified. Adults of *B. lyrifera* are burrowers, so the larval phase is the main mechanism for dispersal which is likely to be long ranging.

EOO: 338,907 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 172 km^2. Based on 43 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Available evidence suggests that there may have been historical declines in populations of *B. lyrifera* resulting from fishing using gears that are towed across the seabed. These have not been quantified. *B. lyrifera* has a fragile test and individuals brought up in trawls as by-catch are frequently severely damaged and would not survive when discarded back to the sea (H. Tillin, personal observation). Comparison with historical samples have found that *B. lyrifera* are no longer found in muddy-sands around the Isle of Man where scallop-dredging has occurred since the 1950s (Hill *et al.* 1999). Studies have recorded substantial reductions in the numbers of *B. lyrifera* due to physical damage from scallop dredging (Eleftheriou & Robertson 1992). However, in the southern North Sea, comparison of samples from 1902–1912 with the North Sea survey data (1986) found an increase in frequency of occurrence of *B. lyrifera* from stations greater than 50 m (Rumohr & Kujawski 2000). Trawling effort is patchy, so that even in areas with relatively high level of exposure to towed bottom gears, some parts of the habitat will remain unimpacted. Losses from towed gears will also depend on the type of gear used, heavy gears such as scallop dredges will penetrate further into the sediment, than lighter gears. Otter trawl doors are heavy, but the foot print is limited, and the ground rope penetrates less deeply than beam trawls. Impact from fishing will therefore be variable and individuals that are buried deeply may escape damage. Scallop dredges may severely reduce *B. lyrifera* populations but the overlap between the fishery and suitable habitats for the urchin are limited (based on National Biodiversity Network Atlas distribution records, *B. lyrifera* versus scallop habitat preferences and scallop fishery maps in Cappell *et al.* 2018). Suitable habitats around the Scottish coast, and southern and North Sea are likely to provide refugia for this species where fishing intensity is either low or patchy.

Threatened category: Least concern

Rationale: Least concern in the GB region. Although there are likely to have been historical declines in some areas from towed fishing gears, and every year some proportion of the population is likely to be removed by fishing gears, this is balanced by annual recruitment over wide areas supported by the larval dispersal phase and does not meet the threshold for decline for Criteria A. While the AOO of 172 km^2 meets the criteria for EN under geographic range criteria (Criteria B), it is considered unreliable due to sampling difficulties. This species is found buried in offshore sediments and is therefore not reliably sampled by mobile trawls, grab samples or drop down camera. Subtidal monitoring is limited and the number of reported records under-estimate the population size. The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland and England, and it is therefore not considered to meet the sub-criteria in terms of number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations, and the population is not considered likely to be small and declining (Criteria C: small population size and declining) and does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Echinus esculentus

Distribution: Abundant in the Northeast Atlantic from Iceland, north to Denmark, Norway and south to Portugal. Absent from the Mediterranean. Common on most coasts of the British Isles corresponding to the distribution of suitable hard substratum habitats but with fewer records for the east coast of England, the eastern English Channel, and some parts of north Wales (Tyler-Walters 2008, supported by Global Biodiversity Information Facility online atlas, records up to 2023).

Habitat and ecology: *Echinus esculentus* is estimated to have a lifespan of 8–16 years (Nichols 1979; Gage 1992) and reach sexual maturity within 1–3 years (Tyler-Walters 2008).

Found in the subtidal from 0–1,200 m, this species is epifaunal and typically found on rock, boulders or in caves and other hard substratum features. It is an omnivorous grazer feeding on seaweeds (e.g. *Laminaria* spp. sporelings), bryozoa, barnacles and other encrusting invertebrates. Size range varies depending on age and locality, but maximum size is

approximately 16 cm. This species may hybridize with *Echinus acutus* if sympatric (all information from the BIOTIC Traits catalogue, online).

Population: Occurrence records from the National Biodiversity Network Atlas have increased between 1990–2019 and this is a common, widespread species with population connectivity supported by a pelagic larval phase. This species has a high reproductive capacity as the number of eggs produced by individuals is likely to be high. Maximum spawning occurs in spring although individuals may spawn over a protracted period. Recruitment is sporadic or variable depending on locality, for example, Millport populations showed annual recruitment, whereas few recruits were found in Plymouth populations during Nichols studies between 1980–1981 (Nichols 1984).

Threats: *Echinus esculentus* can be irreparably damaged by towed gears used by fishers (Bradshaw *et al.* 2000; Hall-Spencer & Moore 2000). Kaiser *et al*. (2000) reported that *E. esculentus* were less abundant in areas subject to high trawling disturbance in the Irish Sea. Jenkins *et al*. (2001) conducted experimental scallop trawling in the North Irish Sea and recorded the damage caused to several conspicuous megafauna species, both when caught as bycatch and when left on the seabed. The authors recorded 16.4% of *E. esculentus* were crushed/dead, 29.3% would have greater than 50% spine loss/minor cracks, 1.1% would have less than 50% spine loss and the remaining 53.3% would be in good condition. Although fishing may have led to historical declines and continue to impact some populations, fishing effort is likely to be patchy, with the majority of individuals surviving encounters with mobile gear and with many suitable rock habitats unsuitable for fishing with mobile gears. In the 1970s, large numbers of *E. esculentus* were removed from sites such as Skomer in Wales for the curio trade, however this trade appears to have largely ceased, and populations persist at exploited sites. (Lock *et al.* 2020).

Urchins were also exploited as food, but the quality was poor, and no information could be found on the commercial harvest of *E. esculentus* in the British Isles. Kelly *et al*. (2001) investigated the commercial potential of *E. esculentus* and found that the wild capture of this urchin for commercial gain would be ‘impractical economically’.

Although susceptible to 'Bald-sea-urchin disease', no evidence of mass mortalities of *E. esculentus* associated with this disease have been recorded in Britain and Ireland (Tyler-Walters 2008) and Lock *et al*. (2020) recorded bald urchins at low densities in Skomer.

EOO 609,565 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 7,540 km^2. Based on 1,885 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Echinus esculentus* is a common, widespread species in the GB region. Key threats around harvesting and the curio trade appear to have ceased, with populations in impacted areas recovering. Although there are also likely to have been historical declines in some areas from towed fishing gears, and every year some proportion of the population is likely to be removed by fishing gears, this will represent only a small proportion of the population. Populations have not undergone population reduction (Criteria A), are considered stable or increasing based on National Biodiversity Network records and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 12 years). The wide distribution of records from 2010–2019 on NBN atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of small number of locations, to be fragmented, or to have

few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C) and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Paracentrotus lividus

Distribution: The distribution of *Paracentrotus lividus* is largely southern with records throughout the Mediterranean basin, Portugal, Spain, and France (Global Biodiversity Information Facility online atlas, checked March 2023). It is found in the Channel Islands, in a few areas in western Scotland and occasionally on the south west coasts of England. It is common on the west coast of Ireland and is abundant in areas such as County Clare (Pizzola 2007).

Habitat and ecology: *Paracentrotus lividus* has complex habitat requirements including clean

rocky shore pools with wave action or clean sub-littoral shell gravel with less wave action. The species occurs in the intertidal in rockpools on calcareous (soft) substrata and may be particularly extensive where there are large numbers of such pools. The urchin uses its spines and teeth to bore into soft rocks, its burrow providing protection from both wave action and desiccation at low tide (Hiscock *et al.* 2001). The urchin increases the size of its burrow as it grows. However, encrusting coralline algae provide such substrata and rock type does not necessarily need to be limestone or chalk. *Paracentrotus lividus* is found on the lower rocky shore in rock pools and into the shallow sublittoral are also sometimes found in beds of the seagrass *Zostera* spp. (Pizzola 2007).

Population: Populations in Europe have suffered large declines linked to overfishing and climate change (see threats). The occurrence records for this species are not considered to be complete, and it is likely that the records for GB do not represent the full number of locations at which this species occurs, as records earlier than 2010 on the National Biodiversity Network Atlas are found in different areas of the Scottish Coast. However, its distribution is limited to a small number of isolated populations (Kelly *et al.* 2015), and it is likely that this species has never been abundant throughout GB as records refer to occasional occurrences in Devon and Cornwall and the first three records from Scotland were reported in 1939 (MacEwen & Hobson 1939).

Little evidence was found for *P. lividus* in GB and this assessment references work on populations in Ireland which provide some indication of factors affecting populations. In Ireland *P. lividus* was a commercially important species and following harvesting in the 1970s a rapid decline in the abundance of *P. lividus* has occurred. This decline is believed to be due to a combination of the over-exploitation and the slow growth rate of the species (Southward & Southward 1975). Comparison between a 1958 survey of Ireland with a re-survey of 63 sites in 2003 confirmed that there had been a significant decline in the urchin (Simkanin *et al.* 2005). Populations in Lough Hyne in southern Ireland, where fishing is prohibited, have been observed to undergo extreme population fluctuations (greater than four orders of magnitude) over 40 years linked to sea surface temperatures and population fragmentation (Barnes *et al.* 2001) and have not recovered abundances observed in the 1980s and 1990s (Barnes *et al.* 2001). Within Lough Hyne, increased predation by crabs following site designation may be restricting population increase (Sulivan & Emerson 2011) but other factors include disease, reduced fertilisation, poor water quality and possibly poaching (Trowbridge *et al.* 2019).

EOO: Not possible to estimate EOO as there are only two records for 2010–2019 on the National Biodiversity Network Atlas.

AOO: 8 km^2. Based on two GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Population reductions have been observed following harvesting in Ireland (Simakin *et al.* 2005) and population collapses associated with climate change have been observed in the Mediterranean (Yeruham *et al.* 2015). Toxic dinoflagellate blooms have caused mass mortalities (Cross & Southgate 1980). Populations in the Hebrides in Scotland are the northern range edge for this species, probably dependent on recruitment from further south on the west coast of Ireland. While climate change resulting in warming may enhance reproductive success and larval arrival, it is unlikely that habitats in GB are as optimal as the soft rock habitats where this urchin is abundant in Ireland. Under climate change scenarios it is likely to occur more widely in areas where it is currently found but remain very localised (Hiscock *et al.* 2001, 2004). As there are only a few isolated populations in Scotland, a fishery is not viable and so a fully farmed approach is the only option for its production. Cultivation of *P. lividus* in Scotland is of commercial interest and depending on systems used may lead to escapes supporting wild populations (Kelly *et al.* 2015). No discussion was found for potential genetic flow impacts.

Threatened category: Vulnerable D2

Rationale: No estimates for population size of *Paracentrotus lividus* were possible as the species may be locally abundant in suitable habitats, but suitable habitats are restricted, and no map is available for the intertidal soft rock habitats that support this species. There is no evidence for population trend or to suggest that this species has declined in GB in the same way as Irish and European populations as fisheries are not viable. However, the AOO at 8km^2 is very small and meets the threshold for CR under Criteria B2. There is no evidence to suggest that the sub-criteria of population decline (Bb) or extreme fluctuations (Bc) are met. However, it was considered to be present at a small number of locations (less than five) which would suggest it meets the criteria for EN and overall would be assessed as NT based on geographic range (Criteria B). There is no evidence for population size (Criteria C), but it has a restricted population (Criteria D) and meets the criteria for VU for criterion D2 based on the small AOO (8 km^2) and restricted number of locations. This species is found in a few places in western Scotland and occasionally on the south west coasts of England. Disease outbreaks may affect populations within regions so that a regional population may be considered to represent a single location. The species population is limited by the availability of habitats and while climate change may improve conditions for reproduction, populations are likely to remain small and isolated due to the lack of suitable habitats. These isolated populations will be vulnerable to harvesting and disease. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Psammechinus miliaris

Distribution: The green sea urchin *Psammechinus miliaris* is found from Trondheim Fjord in northern Norway, inner Danish waters from the Skaw into the western Baltic, Iceland, British Isles, south to the Atlantic coast of Morocco and the Azores. Not in Greenland, the Mediterranean, or Atlantic coasts of America. All British and Irish coasts. Evenly distributed in the southern North Sea but scarce in the northern North Sea (BIOTIC 2016).

Habitat and ecology: Habitats are described in BIOTIC (2016) as follows. The species is found in the intertidal and subtidal, occasionally as deep as 100m but more commonly between in shallower habitats. A typical species of sheltered shores with boulders, it is also found sublittorally in shallow water in sheltered or slightly brackish sites such as sea lochs. In Scotland, *Psammechinus miliaris* is found on sheltered shores with boulders of the west coast, occasionally in the intertidal and shallow subtidal, and it can be locally very abundant (Kelly 2000). It is common in the circalittoral on exposed shores in Shetland. Its distribution frequently coincides with that of the brown seaweed *Laminaria saccharina*, with the urchins occurring on the fronds as well as on rock surfaces below the fronds. It is also found in seagrass habitats and artificial structures such as bridge supports and wrecks (BIOTIC 2016).

Maximum size varies with location from less than 20 mm up to 57.5 mm (BIOTIC 2016). The minimum diameter at maturity recorded is 6–7 mm but more usually 8–10 mm. Longevity references vary from six years, up to 10 or 12 years. Maturity may be reached in the first year although sexual maturity by the second year may be more common (BIOTIC 2016).

Psammechinus miliaris is a broadcast spawner, so that pelagic larvae support population connectivity and recovery.

Population: Records from National Biodiversity Network Atlas show that reports of this species have been increasing since the 1970s to a peak in 2010–2019. It is not clear if this reflects a change in abundance or differences in survey and reporting. The species is found throughout GB, in a range of habitats (inshore and offshore). *Psammechinus miliaris* typically occurs in dense, localized populations in sheltered areas of sea lochs on the west coast with 352 individuals per/m² for littoral populations (Kelly 2000) where individuals in one 0.25 m² quadrat ranged from 3.7 to 24.2 mm horizontal test diameter. Densities in deeper waters and on sediments are lower (BIOTIC 2016). In areas of trawling, Rumohr and Kujawski (2000) found the frequency of occurrence of *Psammechinus miliaris* increased markedly from historical records (1902–1912) to 1986 in the southern North Sea.

EOO: 566,173 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 1,924 km^2. Based on 481 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threatened category: Least concern

Rationale: *Psammechinus miliaris* is a widespread, common species. Records from the National Biodiversity Network Atlas show that reports of this species have been increasing since the 1970s to a peak in 2010–2019. It is not clear if this reflects a change in abundance or differences in survey and reporting. widespread and common and abundant within its range where suitable habitats are present. Populations have not undergone population reduction (Criteria A) and there is no evidence for threats to the species or habitat that will cause decline within the next three generations (around 10 years). The species is found throughout GB, in a range of habitats (inshore and offshore). The wide distribution of records from 2010–2019 on National Biodiversity Network Atlas, show it is present in Scotland, Wales and England, and it is therefore not considered to meet the sub-criteria in terms of small number of locations, to be fragmented, or to have few mature adults. It is not present at a small number of locations, undergoing ongoing decline or extreme fluctuations), and the population is not considered to be small and declining (Criteria C), and it does not have a very small and restricted population (Criteria D). No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Strongylocentrotus droebachiensis

Distribution: The green sea urchin, *Strongylocentrotus droebachiensis*, is a cold-water, pan-boreal species, found in the Northern Atlantic and Pacific Oceans as well as the Arctic Ocean. Its southern distribution limit is New Jersey USA in the Northwest Atlantic and Northern Denmark in Northeast (Nyhagen *et al.* 2015 and references therein). In GB it has been found only in Northern Scotland, Orkney, and Shetland.

Habitat and ecology: *Strongylocentrotus droebachiensis* is found on the lower shore and infralittoral fringe down to 1200 m on rocky grounds browsing on algae. In the few locations, where it is found in Britain, it occurs in the lower infralittoral and upper circalittoral. It exhibits an annual reproductive cycle and has planktotrophic larval development (Scheibling & Hatcher 2013). Growth and reproductive rates are largely dependent on the quantity and quality of available food. Larval behaviour can influence patterns of dispersal in the plankton and settlement on the seabed, but the importance of predation or other agents of mortality at early life history stages is poorly understood. Age estimates in Greenland suggest this species is long lived with individuals aged up to 45 years (Blicher *et al*. 2007) and it grows up to 8 cm.

Population: Kelly *et al*. (2015) reported that they have no knowledge of confirmed positive identifications in recent years, but National Biodiversity Network Atlas (online) shows a few records from the last 10 years around mainland Scotland. *Strongylocentrotus droebachiensis* has a long lived (~2.5 months) planktotrophic larva (Thorson 1946). This species is unlikely to reproduce in Shetland as embryos (which are produced in early spring) have an upper temperature limit of 8ºC (Strathmann 1987). The current records of this species on the east coast of Shetland are probably not from a self-recruiting population and may rely on larval input from elsewhere (e.g. Norway). It may be that populations in the relevant part of Norway may cease to produce larvae or significant numbers of larvae because of seawater warming there and collapse of populations (Hiscock *et al.* 2001).

EOO: 188,444 km^2. EOO estimate based on the minimum convex hull, using GB records from National Biodiversity Network Atlas available online (records from 2010–2019).

AOO: 48 km^2. Based on 12 GB unique pseudotetrads from National Biodiversity Network Atlas (online) using records from 2010–2019.

Threats: Fish and decapod crustaceans are major predators of larger juveniles and adults and may play an important role in population regulation (Scheibling & Hatcher 2013). *Strongylocentrotus droebachiensis* is susceptible to acute and chronic infections by microbial pathogens and parasitic nematodes. In the northwest Atlantic, mass mortality during outbreaks of an amoebic disease can have profound impacts on sea urchin populations (Scheibling & Hatcher 2013). Green sea urchins have been extensively fished or cultured for roe since the late 1980s (Scheibling & Hatcher 2013). Rising water temperatures may cause this species to retreat further north. In Norway populations are collapsing allowing the regrowth of kelp in former urchin barrens, these changes are linked to increasing predation by *Cancer pagurus* and environmental factors. *Strongylocentrotus droebachiensis* will most likely persist in Shetland if seawater temperatures rise by 1ºC but recruitment and survival may cease leading to loss from Scotland following a 2ºC rise in temperature (Hiscock *et al.* 2004). In terms of climate change threats, the entire Scottish population can be considered to represent one location.

Threatened category: Vulnerable D2

Assessment: *Strongylocentrotus droebachiensis* is a northern species present at only a few and isolated sites off mainland Scotland, Orkney and Shetland. Scottish populations are at

its equatorward range edge, and it is likely to be dependent for recruitment on larval supply from populations that are significantly declining in Norway. There is no evidence for population size or trends to assess against Criteria A, C and D1. The AOO = 48 km^2 which meet the criteria for EN for B2 (restricted geographic range) and it is present at a small number of locations (1), criterion Ba, as the entire population may be threatened by changes in larval supply or disease. There is no evidence this species is undergoing ongoing decline (Bb) or extreme fluctuations (Bc). Based on the AOO and single criterion (Ba) this species meets the criteria for NT. The restricted number of locations qualifies this species as VU under Criteria D2. No quantitative analysis of extinction risk has been undertaken for this species and hence criterion E could not be used in this assessment.

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Appendix 2. Species that were not assessed and the supporting rationale

The species that are not assessed and the rationale for not assessing them are outlined below. For families with more than one species that are not assessed the rationale are provided in tables.

Family: Haliotidae

Haliotis tuberculata

The green ormer (*Haliotis tuberculata*) is a northeast Atlantic and Mediterranean species, it is harvested for food, and this has led to declines in some areas. Its northern range edge has typically been the Channel Islands, however there are some escapes in Ireland from aquaculture and very occasional records in southern England including the Scillies. This species is not considered to be established in the GB region and is, therefore, considered a vagrant and is **'Not assessed'.**

Table 2. Members of the Littorinidae that have not been assessed and the supporting rationale.

Not Assessed	Rationale
EchinoLittorina punctata	Not assessed: possible vagrant, or range expansion, no records on National Biodiversity Network Atlas or Global Biodiversity Information Facility for this species in GB region. Found in the Mediterranean and North Africa, this southern species is steadily expanding northwards, having been reported from Puglia, Italy in 2008 (Albano & Trono 2008). Albano, P.G. & Trono, D. 2008. On the occurrence of Echinolittorina punctata (Gmelin, 1791) (Gastropoda: Littorinidae) in Puglia, South-Eastern Italy. *Bollettino Malacologico*, **44**(9-12), 123-126.
Tectarius striatus-	Not assessed: possible vagrant, or range expansion, no records on National Biodiversity Network Atlas. *Tectarius striatus*, is endemic to Macaronesia (i.e. Azores, Madeira, Canary Islands and Cape Verde Islands) (Van den Broeck *et al.* 2008). Van den Broeck, H., Breugelmans, K., De Wolf, H. & Backeljau, T. 2008. Completely disjunct mitochondrial DNA haplotype distribution without a phylogeographic break in a planktonic developing gastropod. *Marine Biology*, **153**, 421-429.

Table 3. Members of the Muricidae that are not assessed and the supporting rationale.

Not Assessed	Rationale
Bedeva paivae	Not applicable: non-native. No records for Great Britain, this species is native to Australia and reported to be invasive in Portugal (based on the National Biodiversity Network Atlas and Global Biodiversity Information facility online atlas, both checked December 2022).
Bolinus brandaris	Not applicable: non-native. Native to Mediterranean area, (based on the National Biodiversity Network Atlas and Global Biodiversity Information facility online atlas, both checked December 2022).
Boreotrophon clavatus	Not applicable: non-native. No records for UK, this northern species is found around Norway and Sweden, with a record from (based on the National Biodiversity Network Atlas and Global Biodiversity Information facility online atlas, both checked December 2022). Not applicable, species is not native to GB and there are no records to suggest this species is present or has become naturalised.
Boreotrophon dabneyi	Not applicable: Not present in UK (Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022).
Coralliophila meyendorffii	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Cytharomorula grayi	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Coralliophila sofiae	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Hexaplex trunculus	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Hirtomurex squamosus	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Murexsul aradasii	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Muricopsis cristata	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Nodulotrophon scolopax	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.

Not Assessed	Rationale
Ocenebra edwardsii	Not applicable: non-native. Not present in UK (Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas). This species is distributed in European waters and in the Mediterranean Sea along Greece and Apulia, Italy; in the Atlantic Ocean along western Africa.
Ocinebrellus inornatus	Not assessed: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Pagodula echinata	Not applicable: Non-native. Not present in UK (Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas). Found offshore in the Eastern Atlantic, from Bay of Biscay to Morocco; Mediterranean, usually in 100–300 m depth. Gorringe seamount, moderately common in 330–830 m, but not found on the other Lusitanian seamounts (WoRMS no source).
Rapana venosa	Not applicable: Non-native. There is currently no evidence that R. venosa has established populations or shows active breeding or multiple year classes in GB waters (NNS 2022). A small but stable reproducing population is established in the Bay of Quiberon, Brittany, and recent sightings have been reported from the Dutch coast (NNS 2022). NNS. 2022. Veined rapa whelk *Rapana venosa* [online]. Non-native Species Secretariat. Available from: https://www.nonnativespecies.org/non-native-species/information-portal/view/2972
Scabrotrophon fabricii	Not assessed. Not present in UK (Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022).
Semiricinula konkanensis	Not assessed. Not present in UK (Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022).
Stramonita haemastoma	Not applicable: Non-native. Based on the GB Non-native Species Secretariat (GBNSS), this species is considered to be introduced, and the IUCN red list assessment is 'not applicable'. There are 5 records for this species in England on the National Biodiversity Network Atlas (online).
Stramonita floridana	Not applicable: Non-native. Based on the GB Non-native Species Secretariat (GBNSS), this species is considered to be introduced, and the IUCN red list assessment is 'not applicable'.
Trophonopsis droueti	Not assessed. Not present in UK (Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022).

Not Assessed	Rationale
Urosalpinx cinerea	Not applicable: Non-native. The American sting winkle, *Urosalpinx cinerea*, was an unintentional introduction to GB from the USA with American oysters *Crassostrea virginica* (Oakley 2006). It has limited adult mobility, and the lack of a free-swimming larval stage prevents it spreading quickly (Oakley 2006). It is found on the Essex and Kent coasts, especially in estuaries and is associated with oysters. It is also recorded from the south coast, around Plymouth and North Devon (National Biodiversity Network, online atlas, checked 2023). The southwest records should be treated with caution. Oakley, J.A. 2006. *Urosalpinx cinerea* American oyster drill. In: Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews [online]. Plymouth, Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/2182 [Accessed 25 March 2023].

Table 4. Members of the Mytilidae that are not assessed and the supporting rationale.

Not Assessed	Rationale
Amygdalum peasei	Not assessed: possible vagrant, or range expansion, no records on National Biodiversity Network Atlas or Global Biodiversity Information Facility (GBIF) for GB for this species (checked 2023). This species was originally described from the Hawaiian Islands, but is also known from the Philippines, Society Islands, Marquesas Islands, Japan and Easter Island (Raines & Huber 2012). Raines, B. & Huber, M. 2012. *Biodiversity quadrupled revision of Easter Island and Salas y Gómez bivalves*. Volume 3217. Magnolia Press.
Arcuatula perfragilis	Not assessed: Presence in the UK is uncertain. *Arcuatula perfragilis* has an Indo-Pacific distribution including the Red Sea. It has invaded the eastern Mediterranean from the Red Sea by way of the Suez Canal. This species has been recorded in Turkey (Çinar *et al*. 2021) and potentially is still present in Israel as part of its invaded range (Albano *et al*. 2021). The status of this species in the UK is uncertain with no records shown on the National Biodiversity Network Atlas.

Not Assessed	Rationale
Arcuatula senhousia	Not assessed: Native range extends north to Kuril Islands in NW Pacific and southwards through Sea of Japan, Yellow Sea, East China Sea and South China Sea to Singapore. Outside its natural range it is recorded in British Columbia, Canada and southwards to Mexico. Also recorded in New Zealand, Australia, Mediterranean, Bay of Biscay, Netherlands and now UK. First recorded in the UK in the Solent (discovered in 2017) by Barfield *et al* (2018), this record has since been superseded by Worsfold *et al* (2020) with previously unpublished survey records from 2011 in Southampton Water. Barfield P., Holmes A.M., Watson G. & Rowe G. 2018. First Evidence of *Arcuatula senhousia* (Benson 1842) the Asian date Mussel in UK waters. *Journal of Conchology*. **42**(2), 217-222. Worsfold T.M., Pennisi N. & Ashelby C.W. 2020. *Theora lubrica* Gould, 1861 (Bivalvia: Semelidae), new to the U.K. with notes on associated non-native species and an earlier date of introduction for *Arcuatula senhousia* (Bivalvia: Mytilidae) to the U.K. *Journal of Conchology*, **43**(6), 665-674.
Aulacomya atra	Not applicable: non-native. *Aulacomya atra* is native in South America - in Peru, Chile, Patagonia, the Falkland Islands and Argentina. It is also found on the coasts of New Zealand and southern Africa, from Namibia to Port Alfred, South Africa, from the intertidal to 40 m (Branch *et al.* 2005). Introduced specimens have been found in Moray Firth, Scotland (McKay 1994), where it was believed to have fallen from a barge (Eno *et al*. 1997). Branch, G.M., Branch, M.L, Griffiths, C.L. & Beckley, L.E. 2005. *Two Oceans: a guide to the marine life of southern Africa*. 2nd Edition. David Philip Publishers, ISBN 0864866720. Eno, N.C., Clark, R.A. & Sanderson, W.G. (eds). 1997. Non-native marine species in British waters: a review and directory, JNCC, Peterborough, ISBN 1861074425. McKay, D.W. 1994. *Aulacomya ater* (Molina, 1782) (Mollusca: Pelecypoda) collected from the Moray Firth. *Porcupine Newsletter*, **5**, 23.
Brachidontes exustus	Not applicable: Non-native (National Biodiversity Network): New Jersey south throughout the Caribbean and south to Argentina in the intertidal attached to rocks. In Britain and Ireland, it has been found in Gwithin Cornwall (NHMW). Anonymous. *Brachidontes exustus* (Linnaeus, 1758) | Marine Bivalve Shells of the British Isles [online]. Available from: https://naturalhistory.museumwales.ac.uk/britishbivalves/browserecord.php?-recid=720 [Accessed 1 December 2022].
Brachidontes pharaonis	Not applicable: Non-native..Part of the Brachidontes complex identified by Terranova *et al*. (2007) and believed to be native to the Red Sea. Not currently believed to be established in the UK (based on no records from the National Biodiversity Network Atlas, or Global Biodiversity Information Facility (GBIF), checked March 2023). Da Costa Fernandes, F. 2022. '*Brachidontes pharaonis'*, CABI Compendium. CABI International. doi: 10.1079/cabicompendium.109127. Terranova, M.S., Lo Brutto, S., Arculeo, M. & Mitton, J.B. 2007. A mitochondrial phylogeography of *Brachidontes variabilis* (Bivalvia: Mytilidae) reveals three cryptic species. *Journal of Zoological Systematics and Evolutionary Research*, **45**(4), 289-298.

Not Assessed	Rationale
Brachidontes ustulatus	Not applicable: Non-native. *Brachidontes ustulatus* is native to the west coast of Western Australia (Colgan, 2019) and is related to the global *Brachidontes* species complex studied by Terranova *et al*. (2007). Not considered established in the UK (Based on NBN atlas and Global Biodiversity Information Facility (GBIF) checked March 2023). Colgan, D.J. 2019. Population genetic instability and the phylogeography of the mussel *Austromytilus rostratus* (Dunker 1857) (Bivalvia: Mytilidae). Marine Biodiversity, 49, pp.887-896. Terranova, M.S., Lo Brutto, S., Arculeo, M. & Mitton, J.B. 2007. A mitochondrial phylogeography of *Brachidontes variabilis* (Bivalvia: Mytilidae) reveals three cryptic species. *Journal of Zoological Systematics and Evolutionary Research*, **45**(4), 289-298.
Brachidontes variabilis	Not applicable: Non-native. Related to the global *Brachidontes* species complex studied by Terranova *et al*. (2007) with two distinct genetic clades identified, *B. variabilis* from the Indian Ocean and *B. variabilis* from the western Pacific Ocean. Not considered established in the UK (Based on National Biodiversity Network Atlas and Global Biodiversity Information Facility (GBIF) checked March 2023).
Crenella pellucida	Not assessed: Known only from a few valves found in shell sand and from the Channel Islands only. It remains possible that this is a post larval shell of a much larger species but the prodissoconch size and sculpture does not match any other British species (Marine Bivalve Shells of the British Isles, Natural History of Museum Wales webpage). Anonymous. *Crenella pellucida* (Jeffreys 1859), Marine Bivalve Shells of the British Isles [online]. Natural History Museum of Wales. Available from: https://naturalhistory.museumwales.ac.uk/britishbivalves/browserecord.php?-recid=153
Dacrydium ockelmanni	Not assessed: No current records for GB (based on no records from the National Biodiversity Network Atlas, or Global Biodiversity Information Facility (GBIF), checked March 2023) and is not assessed. Occurs along the Atlantic Margin and is typically found on the upper slope but has a shallower range further north and a deeper range further south. It is found on the continental margin (200–500 m) and bathyal zone (500–2,000 m), therefore suitable habitats in GB waters are restricted Anonymous. 2016. *Dacrydium ockelmanni* (Mattson & Warén 1977). Marine Bivalve Shells of the British Isles [online]. Natural History Museum of Wales. Available from: https://naturalhistory.museumwales.ac.uk/britishbivalves/browserecord.php?-recid=154
Gregariella petagnae	Not assessed: may be vagrant or range expansion. No National Biodiversity Network Atlas (available online) records but there are two in the Global Biodiversity Information facility online atlas (checked, December 2022) from the east coast of England. This is a southern species, mostly found in the Mediterranean and North Africa so the range may be shifting northwards. Not assessed due to lack of records and uncertainty around establishment.
Gregariella semigranata	Not assessed. Native range appears to be North East Atlantic and the Mediterranean, but it is not reported present in GB (based on no National Biodiversity Network Atlas records (online) and the Global Biodiversity Information facility online atlas).

Not Assessed	Rationale
Lithophaga lithophaga	Not applicable: Non-native. The date mussel, *Llithophaga llithophaga* is, distributed along the whole Mediterranean coastline, throughout the Atlantic Ocean, from Portugal down to Senegal and the northern coast of Angola but also reported in the coast of Mozambique, albeit Indo-Pacific records of the species should possibly be revised (Colleti *et al.*2020 and references therein). It is not present in GB (based on the National Biodiversity Network Atlas (available online) and the Global Biodiversity Information facility online atlas, checked March 2023). Colletti, A., Savinelli, B., Di Muzio, G., Rizzo, L., Tamburello, L., Fraschetti, S., Musco, L. & Danovaro, R. 2020. The date mussel *Lithophaga lithophaga*: Biology, ecology and the multiple impacts of its illegal fishery. *Science of the Total Environment*, **744**, 140866.
Musculus viridulus	Not applicable: Non-native. An Indo-Pacific species that is not present in GB (based on the National Biodiversity Network Atlas (available online) and the Global Biodiversity Information facility online atlas, checked March 2023). There are recent reports of this species from the Mediterranean, but these have not been conclusively identified (Albano *et al.* 2021). Albano, P.G., Steger, J., Bakker, P.A., Bogi, C., Bošnjak, M., Guy Haim, T., Huseyinoglu, M.F., LaFollette, P.I., Lubinevsky, H., Mulas, M. & Stockinger, M. 2021. Numerous new records of tropical non-indigenous species in the Eastern Mediterranean highlight the challenges of their recognition and identification. *ZooKeys*, **1010**, 1.
Mytilaster lineatus	Not applicable: non-native. *Mytilaster lineatus* is native to the Mediterranean, it is an introduced species in the Caspian Sea (Malinovskaya and Zinchenko, 2010). It is not present in GB (based on the National Biodiversity Network Atlas (available online) and the Global Biodiversity Information facility online atlas, checked March 2023). Malinovskaya, L.V. & Zinchenko, T.D. 2010. *Mytilaster lineatus* (Gmelin): long-term dynamics, distribution of invasive mollusk in the Northern Caspian Sea. *Russian Journal of Biological Invasions*, **1**(4), 288-295.
Mytilaster solidus	Not applicable: non-native. *Mytilaster solidus* is native to the Mediterranean, it is not present in GB (based on the National Biodiversity Network Atlas (available online) and the Global Biodiversity Information facility online atlas, checked March 2023).
Septifer bilocularis	Not applicable: non-native. Native to the Indo-West Pacific (Morton 2019), Septifer bilocularis is not present in GB (based on the National Biodiversity Network Atlas (available online) and the Global Biodiversity Information facility online atlas, checked March 2023). Morton, B. 2019. The biology and functional morphology of *Septifer bilocularis* and *Mytilisepta virgata* (Bivalvia: Mytiloidea) from corals and the exposed rocky shores, respectively, of Hong Kong. *Regional Studies in Marine Science,* **25**, 100454.

Not Assessed	Rationale
Xenostrobus securis	Not applicable: non-native. The black pygmy mussel, *Xenostrobus securis* is endemic to the brackish waters of New-Zealand and Australia. It is highly invasive, having been recorded inhabiting the Central Tyrrhenian Sea, Italian coastal lagoons, delta of the river Po, French Mediterranean lagoons and Japan (Pascual *et al.* 2010 and references therein). It is not present in GB (based on the National Biodiversity Network Atlas (available online) and the Global Biodiversity Information facility online atlas, checked March 2023). Pascual, S., Villalba, A., Abollo, E., Garci, M., González, A.F., Nombela, M., Posada, D. & Guerra, A. 2010. The mussel *Xenostrobus securis*: a well-established alien invader in the Ria de Vigo (Spain, NE Atlantic). *Biological Invasions*, **12**, 2091-2103.
No specific species	Albano, P.G., Steger, J., Bakker, P.A., Bogi, C., Bošnjak, M., Guy-Haim, T., Huseyinoglu, M.F., LaFollette, P.I., Lubinevsky, H., Mulas, M. & Stockinger, M. 2021. Numerous new records of tropical non-indigenous species in the Eastern Mediterranean highlight the challenges of their recognition and identification. *ZooKeys*, **1010**, 1. Çinar, M.E., Bilecenoğlu, M., Yokeş, M.B., Öztürk, B., Taşkin, E., Bakir, K., Doğan, A. & Açik, Ş. 2021. Current status (as of end of 2020) of marine alien species in Turkey. *PLoS One,* **16**(5), p.e0251086. GBIF Secretariat 2022. *Arcuatula perfragilis* (Dunker 1857) GBIF Backbone Taxonomy [online]. Available from: https://doi.org/10.15468/39omei [accessed via GBIF.org on 2023 May 2024]

Table 5. Members of the Trochidae that are not assessed and the supporting rationale.

Not Assessed	Rationale
Callumbonella suturalis	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Clanculus berthelotii	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Clanculus cruciatus	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Gibbula ardens	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Gibbula candei	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Gibbula fanulum	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Gibbula spurca	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.

Gibbula turbinoides	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Jujubinus gravinae	Not applicable: No UK records. Based on National Biodiversity Network Atlas, Global Biodiversity Information facility online atlas, both checked December 2022.
Phorcus atratus	Not applicable: non-native. No UK records. Based on National Biodiversity Network Atlas, GBIF). Phorcus atratus, is native to the Canary Islands and Cape Verde (Templado & Rolán, 2012). Templado, J. & Rolán, E. 2012. A new species of *Phorcus* (Vetigastropoda, Trochidae) from the Cape Verde Islands. *Iberus*, **30**(2), 89-96.
Phorcus sauciatus	Not present in UK (Based on National Biodiversity Network Atlas available online (GBIF). The marine topshell *Phorcus sauciatus* is currently found along the temperate–subtropical shores of the Northeast Atlantic Ocean. Although present in the Iberian Peninsula, Madeira, and Canaries for centuries.
Steromphala divaricata	Not applicable: Non-native. Not present in UK (Based on National Biodiversity Network Atlas available online, GBIF). It is found in the Mediterranean Sea, the Adriatic Sea and the Black Sea (based on records from OBIS and GBIF). Records for GB may be introduced or misidentified or represent range expansion.
Steromphala pennanti	Not assessed: Not present in UK (Based on National Biodiversity Network Atlas available online, GBIF). *Steromphala pennanti* is distributed from the Cherbourg peninsula in northern France to Morocco (Southward *et al.* 1995). Records for GB may be introduced or misidentified or represent range expansion. Southward, A.J., Hawkins, S.J. & Burrows, M.T. 1995. Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. *Journal of Thermal Biology*, *20*(1-2), 127-155.
Steromphala rarilineata	Not assessed. A southern species with no records on National Biodiversity Network Atlas available online for GB. *Steromphala rarilineata* has a southern distribution and is found throughout the Mediterranean (based on GBIF and OBIS records). Records for GB may be introduced or misidentified or represent range expansion.
Umbonium vestiarium	Not applicable: Non-native. A tropical species with no records on National Biodiversity Network Atlas available online for GB. Distribution maps based on GBIF and OBIS show this species has an Indo-West Pacific distribution: from East Africa to eastern Indonesia; north to the Philippines and south to northern Queensland. Records for GB may be introduced or misidentified.

Table 6. Members of the Echinodermata that are not assessed and the supporting rationale.

Not Assessed	Rationale
Echinus melo	Not assessed Not present in GB (Based on National Biodiversity Network Atlas available online GBIF).
Strongylocentrotus pallidus	Not assessed Not present in GB (Based on National Biodiversity Network Atlas available online GBIF).