Developing Essential Fish Habitat maps for fish and shellfish species in Scotland
Annex 1. Literature review

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A1.1 Methods

In order to inform several aspects of this project, a literature review was conducted. Aspects of the project that were informed by the literature review process included:

- Species selection: The final list of species and their key life stages to be mapped in this project was established as part of the literature review. The review allowed to establish which species were well studied in both scientific and grey literature and which species had large gaps in knowledge. Species that have been poorly studied and hence had poor data and information availability could not be processed further and were excluded from the project, but were noted as data gaps requiring further study in the future.
- Data processing choices – data-based models or habitat proxies: Some species and their key life stages were well studied in the scientific literature, whilst others, as previously noted, were considered as too deficient in knowledge to be able to process. In situations where a species did not have survey or catch data sets available these species could not be assessed via a data-based model. However, if the same species and key life stages were well represented by the literature review, this information was used to identify habitat proxies to map the EFH (see section 2.3 of the main report). Species that had no survey/catch data, and were also poorly represented in the literature were excluded from the project but noted as data gaps.

A list of suggested species was provided by Marine Scotland as part of the tendering process and shortly after commencement of the project this list was expanded through consultation with representatives from Marine Scotland, and the Project Steering Group (PSG). This expanded list covered 34 marine species including fish (16 bony fish and 5 elasmobranch species) and shellfish (4 crustaceans and 9 molluscs). These included Priority Marine Features in Scotland Seas as well as species of commercial interest (e.g. gadoids, crustaceans). See Table 1 in section 2.1 of the main report for a full list of the species considered.

To guide the collation of evidence through the literature review, a template was created in Microsoft Excel (Table A1.1). This tabular format ensured that every species and relevant key life stages were reviewed in the same manner, and ensured presentation of results in an orderly and repeatable format. One table was used for each species studied. The tabular layout also had the purpose of aiding the consultation and extraction of relevant information throughout the project.

Table A1.1. Tabular template for the literature review.

Species name:				
Habitat function	Relevance to the species	Inshore/ offshore	Environmental/habitat requirements	Species indicators
Refugia				
Nursery				
Spawning				
Feeding				
Migratory routes				
Occurrence (aggregations, generic, etc)				
References:				
Notes:				

The literature search was structured by species and EFH function (e.g. as refugia, spawning grounds, nursery, etc.), and the review examined the available literature to characterise the association of different life stages with different habitats and their environmental characteristics accounting for their potential functioning as EFH. In particular, available evidence was reviewed against the following criteria: (columns in the tabular template, Table A1.1)

- Relevance to the species: whether a specific habitat function is relevant for the species in question, i.e. the species has particular habitat preferences/requirements associated with a particular habitat function, other than the generic environmental/habitat where the species occur as a whole. For example, the refuge function may be particularly relevant to species which select a particular habitat for shelter (e.g. to create burrows) but not for other species.
- Inshore/offshore: where the essential habitats (if any) occur for the species in question. This helped determine the relevance of different approaches (data-based model v. habitat proxy) for identifying and mapping the species habitat.
- Environmental/habitat requirements: environmental requirements for a habitat to perform the specific function for the species (e.g. as nursery, refuge). Such information was inferred from literature reporting environmental tolerances, preferences and associations of the species (at the life stage relevant to the specific EFH function), with information being collated as detailed as possible (e.g. salinity range, substrate type

preferred). Where there were no known specialist habitat requirements for a species, this was also noted here. Where differences in requirements occurred between offshore and inshore areas, this was also noted (where applicable).

- Species indicators: which components of the species population are particularly associated with the specified habitat function and associated environmental characteristics (specific life stages / behaviour). Characteristics of these components were also recorded here where relevant for identifying suitable population indicators for the habitat function (e.g. size of juveniles, seasonality of spawning).

The literature search was performed using online search engines (Google, Google Scholar, Scopus, ISI Web of Science) using combinations of keywords to obtain relevant and appropriate results. For example, a search string entered could be “European lobster AND juvenile habitat AND sediment”, or “herring spawning environmental parameters”. Both the scientific and common names of the species were entered in order to maximise results found. Results were considered if they appeared on the first three pages listed by the search engine (30 results in total) for the specific search string entered. In cases where there were few results (e.g. the dog cockle) an extra page was checked (making 40 results in total) to ensure that no key literature had been missed. A hierarchical filtering of the search results for relevance was undertaken, with the first screening based on the title, followed by examination of the abstract, and of the article text as a whole.

In addition to the search engine, specific websites known to list key facts about each marine species were also consulted for general species information. These included www.marlin.ac.uk, www.fao.org, www.fishbase.org, www.sealifebase.ca. Where these sites also provided a reference list, the relevant citations were also consulted directly.

The literature review considered scientific and grey literature by preference, but also included searching for any relevant licensing or policy documents/reports and local bylaws (although please note that no licencing/policy documents or local bylaws were found relevant to this project during the search process), as well as more trustworthy websites (e.g. those run by academic institutions) such as those mentioned above. On occasion other websites were consulted, for example, Orkney Sustainable Fisheries had performed tagging studies on *Cancer pagurus* that were not published in the scientific literature, but were reported on their website and were useful for informing about the crabs’ potential migrations in Scottish waters. In cases like this, the authors used their expert judgement in deciding which other literature sources were appropriate.

The literature review covered topics including (but not limited to) the examination of information regarding habitats associated with the presence of spawning individuals or spawn products (e.g. eggs, egg cases, larvae (or equivalent “hatchling” stage) aggregations, the presence of juvenile aggregations, the seasonality of habitat use, habitat structure/characteristics granting shelter/protection (refugia) from predators (e.g. submerged vegetation, shallow depth, rocks and crevices), local retention of spawn/juveniles (e.g. low hydrodynamic conditions), rapid growth of juveniles (e.g. abundance of food resources available to juveniles), specific substrata required by a species for a specific life stage or in general (e.g. sediment characteristics) and environmental tolerances for the different life stages (e.g. salinity, temperature, flow/energy, depth, light penetration). The relevance of the different EFH functions to a specific EFH type (e.g. nursery habitat of a given species) was also compiled.

Where relevant information, such as described above, was discovered for a species, it was recorded in that species' table and the source was cited.

A1.2 Literature review tables

The results of the literature review are reported for each of the 34 marine species considered in Table A1.2 to Table A1.34. Fish species can be easily distinguished by the table having a blue background, and shellfish species having a green background. Please note that some of the species have a lot of information and so their tables break across two or three pages. In these cases, the table header is repeated to aid clarity. Citations in each species table are provided in a short format for ease of reading. The short format can be used to look up the full reference, which is provided at the end of this document.

Of the 34 marine species reviewed, only 29 were considered as having sufficient information available in the literature (e.g. with sufficient detail to identify environmental/habitat characteristics associated with particular EFH functions). Therefore, these were taken forward to the next stage of the project.

The literature review allowed the determination of which life stages of a species had specific habitat requirements (if any). Please note that for some species there was a lack of suitable survey data or sufficient information on the habitat preferences of life stages that may be indicators of EFH (e.g. juveniles for nursery, spawning adults or eggs for spawning grounds). In these cases, it was not possible to discriminate between specific EFH due to the high overlap in habitat use by different life stages and for different functions. Furthermore, for some of the mollusc species, a sedentary or sessile lifecycle means that all life stages take place within a certain area, for example, Dog whelk (*Nucella lapillus*) live their entire lives within a few meters on rocky intertidal shores, therefore the spawning, juvenile, feeding and adult habitats are all the same. In such cases, instead of taking forward a specific habitat and/or life stage for that species, the general/generic habitat for the species as a whole was assessed.

Lack of or poor knowledge on specific habitat preferences existed in the literature examined for five of the species reviewed, despite most of these species being of commercial relevance as food products (e.g. scallops) or of conservation importance (e.g. endangered/critical state of ray and skates as per IUCN red list). These species included:

- Common skate (former *Dipturus batis* complex, including incl. flapper skate *D. intermedius* and blue skate *D. flossada/batis*)

- Sandy ray (*Leucoraja circularis*)
- Queen scallop (*Aequipecten opercularis*)
- King scallop (*Pecten maximus*)
- Surf clam (*Spisula solida*)

Table A1.2. Sandeels (N/A is indicated where the habitat function is not relevant to the species).

Lesser sandeel (*Ammodytes marinus*, A.m., offshore); Small sandeel (*Ammodytes tobianus*, A.t., inshore) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	Yes (refuge function can be associated to all sandeel habitat due to its burrowing behaviour)	inshore & offshore	A.t. - schooling species, hibernate in winter buried in sand at depths of 20-50 cm [10] A.m. - schooling species, during low light intensity (night and winter) they bury in the bottom [10]; High habitat specificity and site fidelity [10] and predominantly found in offshore waters (Reay, 1970) [11]. Inshore/offshore: Close association with substratum due to burrowing behaviour. Preferred substratum is medium to very coarse sands (median particle size of 0.25 to 2.0 mm), with silt content <4% (species rare occurrence with 4-10% silt, absence/avoidance with >10% silt) [4,5,6]. Model result show preference for low silt fraction (model result: <15%; most important variable) and high sand fraction (model result: >70% on average, higher as silt content decreases) + Depth & slope also relevant (see 'occurrence') [7]. Marginal habitat has been classed as sandy gravel, and preferred habitat is classed as gravelly sand, slightly gravelly sand, sand [10, 12, 13, 14]. Juvenile and adult lesser sandeels are largely resident and rarely disperse over distances greater than 30 km [10], and occupy turbulent, fairly shallow waters bottom temperature of 8.5-9.0°C and a surface salinity of 34.9-35.0 ppt [9,11].	Aggregations of sandeels while buried in sediment (from grab or dredge surveys)
Nursery	Nursery (+Spawning) (Given demersal egg stage and sediment preferences, likely overlap between larvae and juveniles on	inshore & offshore	Inshore (coastal): A.m. - Subtidal soft bottom [3] Offshore (poss. inshore): Given demersal egg stage and sediment preferences, likely overlap between larvae and juveniles on spawning grounds [2] Juvenile and adult lesser sandeels are largely resident and rarely disperse over distances greater than 30 km [10], and occupy turbulent, fairly shallow waters bottom temperature of 8.5-9.0°C and a surface salinity of 34.9-35.0 ppt [9,11]. After pelagic larval phase (33-90 days duration), 0-group fish	Juvenile size: <13cm first main cohort but also ages 0-3 (all sandeel species grouped) [2] Overall distribution of adult sandeels would broadly include both spawning & nursery grounds [2] Metamorphosis of larvae to juvenile fish typically occurs in late May to early June or 33-90 days after hatching (Wright and Bailey, 1996). [11].

Lesser sandeel (*Ammodytes marinus*, A.m., offshore); Small sandeel (*Ammodytes tobianus*, A.t., inshore) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
	spawning grounds [2])		actively search for areas with suitable substrate into which they can burrow and remain hidden when not foraging (Macer, 1965; Proctor et al., 1998) [11].	
Spawning	Nursery (+Spawning) (Given demersal egg stage and sediment preferences, likely overlap between larvae and juveniles on spawning grounds [2])	inshore & offshore	Sandeel emerge into the water column only briefly in winter for spawning (to lay demersal eggs; larvae are pelagic) [8, 9] Offshore (poss. inshore): Given demersal egg stage and sediment preferences, likely overlap between larvae and juveniles on spawning grounds [2] Inshore (coastal): A.m. - Subtidal soft bottom [3]	Spawning period: Nov-Feb (Jan-Feb peak) [1] Sandeel larvae (and eggs) from ichthyoplankton surveys. Overall distribution of adult sandeels would broadly include both spawning & nursery grounds [2] Length at maturity range 11-15cm A.t., 11-? cm A.m. [10] Age at maturity around 2 years, but with reginal variability [11] Larvae are planktonic, until reaching a length of 25 mm (Nichols et al., 1993; Wright and Bailey, 1996). [13] Larval and juvenile period has relatively low survival, with the natural mortality rates of average 4 times higher than 2-year-old fish (Cook, 2004). [11].
Feeding	Yes	inshore & offshore	Inshore/offshore: Diurnal feeding migrations between the seabed where they are buried (at night) and water column where they feed on plankton [8,9] Offshore (poss. inshore): A.m. - species aggregates to feed (plankton foraging schools) usually at the edge/side (higher slope) of the sandbanks (may be several km from the areas where they bury each day) [7 & references therein]. During the feeding season sandeel form dense schools whose size range from a few metres to >1km (Johnsen et al. 2017). Frequently, parts of the schools are connected to favourable sandy substrata, whereas the pelagic part seem to feed closer to the surface (Johnsen et al. 2017). [15] Inshore (coastal): A.m. - Subtidal soft bottom, shallow (<30m) open water [3]	Feeding during spring and summer, during the day [8,9] Aggregations of (adult) sandeels in the water column as possible indicator of foraging schools
Migratory routes	N/A (not migratory)	N/A	N/A	N/A

Lesser sandeel (*Ammodytes marinus*, A.m., offshore); Small sandeel (*Ammodytes tobianus*, A.t., inshore) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Occurrence (aggregations, generic)	Yes (see also 'refugia')	inshore & offshore	A.m. - fully marine (inshore = coastal); A.t. - often found in estuaries [2] Offshore (poss. inshore): A.m. - Preferred depth range 30-50m, but some important grounds also in deeper areas (e.g. 70m Turbot Bank off north-east Scotland); preference for shallower slopes within the limitations of preferred sediment (e.g. top of sand banks) [4] Most aggregations are found in areas of sand ripples where the net residual flow is likely to be >0.5 m s−1 [4 and references therein] Juvenile and adult lesser sandeels are largely resident and rarely disperse over distances greater than 30 km [10], and occupy turbulent, fairly shallow waters bottom temperature of 8.5-9.0°C and a surface salinity of 34.9-35.0 ppt [9,11]. Sandeel has not been reported to occur in seagrass meadows [18,19] because the species actually inhabits sandy bottoms.	Found in offshore waters of the North Sea [11] with patchy habitat distribution (Macer, 1966; Scott, 1968) [16]. Sandeel abundance in northwestern North Sea has undergone a sustained decline since 2001 despite the absence of a fishery [11,13]. Present in SE Scotland at Wee Bankie, Marr Bank, and Berwick's Bank and Shetland [17].

References:
1. Coull et al. 1998
2. Ellis et al. 2012
3. Seitz et al. 2014
4. Wright et al. 2000
5. Holland et al. 2005
6. Brown and May Marine Ltd 2013
7. Langton et al. 2021
8. Cefas 2004
9. Van der Kooij et al. 2008
10. Frederiksen et al. 2005
11. Green 2017
12. Freeman et al. 2004
13. Lynam et al. 2013
14. Johnsen et al. 2017
15. Komiyama 2021
16. Jensen et al. 2003
17. Greenstreet et al. 2006
18. Pergent et al. 2012
19. Hartvig et al. 2022

Notes
- Recent model/map based on grab data by MSS [4]
- Survey data limitations: sandeels are generally too small to be fully selected in GOV trawl panels and so this gear cannot be used to reliably estimate abundance (Wright et al. 2019 in [4]); neither otter trawl nor beam trawl are very effective at examining sandeel abundance (part. smaller life stages), and groundfish and ichthyoplankton surveys may not effectively sample sandbank areas [2]

Table A1.3. (N/A is indicated where the habitat function is not relevant to the species).

Spratt (*Sprattus sprattus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	N/A	N/A	N/A
Nursery	Yes	Mostly inshore	Inshore (coastal): Intertidal soft bottom, Saltmarsh, Shallow (<30m) open water [3] Inshore: after metamorphosis, juveniles migrate to inshore nurseries [4,5]	Juvenile aggregations inshore Juvenile size: <9-9.5cm 0-group (variable cut-off lengths depending on survey method & quarter) [2]
Spawning	No specific requirements known, but hydrography plays role in eggs/larval distribution and survival	inshore/ offshore	Pelagic spawning (water column, pelagic eggs), occurring offshore [4] Spawn at depths 10-20m, near to the coast or up to 100 km out to sea [5] Hydrographic factors determine the concentration of sprat eggs and larvae at tidal fronts in the North Sea (part. on mixed side of the tidal front); higher larval growth rate positively correlated with chlorophyll water content [6]	Spawning period: Mar-Aug (May-Jun peak) [1] Length at maturity 10.1cm (range 8-12 cm) [5]; minimum 8.8-9cm [7]
Feeding	No specific requirement known other than open water (pelagic)	Inshore & offshore	Inshore (coastal): Shallow (<30m) open water [3]	Winter feeding grounds. Feeding of both juveniles and adults was observed in sea lochs and surrounding coastal waters in Western Scotland. High feeding activity of 0-group individuals in October. Adults show a similar trend, move offshore to spawn over winter and then begin feeding again from January onwards [7].
Migratory routes	N/A	N/A	N/A	N/A
Occurrence (aggregations, generic)	N/A No specific habitat requirements known	inshore/ offshore	usually inshore schooling (esp. as juveniles) [5] Pre-spawning aggregations in winter - coastal and estuarine shoals [4])	N/A

References:
1. Coull et al. 1998
2. Aires et al. 2014
3. Seitz et al. 2014
4. MALSF 2011
5. Fishbase
6. Munk 1993
7. De Silva 1973
8. Moore and Moore 1976
9. Potter and Claridge 1985

Spratt (*Sprattus sprattus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Notes: - Known nursery grounds in Severn Estuary: where juveniles of ~5cm feed almost exclusively on *G. salinus* between April-June [8]. 0-group recruits in the Severn estuary were caught in high abundances in August and September, with secondary peak in January-March that contained larger individuals [9]. - Spawning occurring in central areas of Bristol channel during winter before moving back inshore to feed post spawning [9].				

Table A1.4. Herring (N/A is indicated where the habitat function is not relevant to the species).

Herring (*Clupea harengus*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	N/A	N/A	N/A
Nursery	N/A no specific requirement other than open water (pelagic)	Inshore & offshore	Inshore (coastal): Shallow (<30m) open water [5] Juveniles (up to 2 years) shoal close inshore [7]; Juveniles occupy inshore coves and estuaries with low salinities in the spring and summer of their first year of growth, whereas older juveniles avoid brackish estuarine conditions [10 and references therein] Wide temperature and salinity tolerance of juveniles; preferred temperature 8-12°C (physiological stress at <4°C and >16°C), salinity 28-32 (but can tolerate salinity as low as 5 for short time), but salinity not as important (laboratory studies) [10 and references therein]	Juvenile size: <17.5cm 0-groups [2]; <15.5-16.5cm 0-group (variable cut-off lengths depending on survey method & quarter) [3]
Spawning	Yes	Inshore & offshore	Demersal spawning (ribbon of sticky eggs laid on seabed as a dense mat) Inshore (coastal): Seagrass, mussel beds, macroalgae, rocky shore [5] Inshore (Spring spawning stocks), on shallow coastal areas (15-40 m depth) [6],7] Offshore (Autumn/Winter spawning stocks): edges of ocean banks, offshore banks down to 200 m [6,7] Inshore/Offshore: gravel or rock bottoms [7]; high-energy environments (bottom velocity >1m/sec; tidal & wave energy inshore; tidal currents offshore, e.g. 1.5-4.5 knots), thermally well mixed areas; eggs deposited on marine vegetation [incl. maerl, kelp, macroalgae] or on gravel (coarse gravel and small stones, 2-10mm diameter, free from silting), eggs are tolerant to temperatures in the range of 5–14 °C and salinities in the range of 3–34.4‰ [8,9 and references therein]. >50% gravel & <5% mud/silt = prime spawning habitat (>10% gravel & <5% mud sub-prime, >25% gravel & <5% mud	Geographically distinct breeding stocks or races identified, each of which has distinct times and places of spawning around the UK [1,6] Herring typically congregate near their spawning grounds for several weeks to months prior to spawning [8] Length at maturity 16.7cm [7]; Eggs 0.9-1.5mm diameter [2] Early-stage larvae <11mm [4]

			suitable, <10% gravel & >5% mud unsuitable); preferable (prime, sub-prime & suitable) substrata = gravelly sands, sandy gravels, gravels (Folk classification) [9]. The substrate does not appear to be critical provided that it is relatively clean of fine sediment that could prevent gaseous exchange by the eggs with their environment. Temperature and salinity conditions also do not appear to be critical to the successful spawning of herring although they determine the rate and success of embryonic development and hatching [8 and references therein] Fidelity to particular areas / traditional spawning grounds [7]	
Feeding	No specific requirement other than open water (Pelagic stage, opportunistic planktivorous feeder)	Inshore & offshore	Pelagic planktivorous feeder - water column (generic) All life stages of herring are opportunistic feeders, and will take advantage of whatever prey of the appropriate size is available [10] Inshore (coastal): Shallow (<30m) open water [5]	Feeding occurs throughout UK waters in April-October before herring move offshore to spawn. Feeding then occurs again Jan-Feb onwards [11].
Migratory routes	N/A no migratory routes	N/A	N/A	N/A
Occurrence (aggregations, generic)	N/A		Shoaling/schooling species, water column (generic)	

References:
1. Coull et al. 1998
2. Ellis et al. 2012
3. Aires et al. 2014
4. MMO1044
5. Seitz et al. 2014
6. Dickey-Collas et al. 2010
7. Fishbase
8. Haegele & Schweigert 1985
9. Reach et al. 2013
10. Stevenson & Scott 2005
11. De Silva 1973

Notes:

Table A1.5. Mackerel (N/A is indicated where the habitat function is not relevant to the species).

Mackerel *(Scomber scombrus)* [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A			
Nursery	Yes (no specific habitat requirements known, but studies have shown juvenile distribution related with environmental conditions)	Inshore & offshore	Inshore (coastal): Shallow (<30m) open water [4] High levels of turbulence during autumn and winter may become limiting to the survival of juveniles; low turbulent mixing explains about 50% of recruitment variability of the species [5] First-year survival of mackerel related to abundance of prey (Calanus) [9] Depth range 0-210m, but distribution in water column varies seasonally (autumn: offshore, most abundant at 20-40m; winter: 50-70m; spring: dispersed through water column but concentrated at 30-90m; Summer: move higher 20-50m); Salinity >25 [10] *Offshore (but from Mediterranean & modelling): Bathymetry (<130m with upwelling, or deeper to 220m with downwelling) along with SST (22-26°C) and circulation patterns (sea level anomaly and zonal component of the absolute geostrophic velocity, <-0.1m/s or >0.2 m/s) were the variables found to determine species nurseries [8]*	Bottom-trawl surveys in winter (Q4/Q1) are an appropriate platform for sampling juvenile mackerel [7] Juvenile size: <23.5cm 0-groups [2]; <23-26cm 0-group (variable cut-off lengths depending on survey method & quarter) [3]
Spawning	Yes	offshore	Pelagic spawner / pelagic eggs and larvae. Areas with low turbulent mixing (turbulence explains about 50% of recruitment variability of the species) [5] Spawning begins when temperatures are ≥ 7°C (peak 9-14°C), peak spawning at salinity >30 [10]	Egg distribution from ichthyoplankton/egg surveys. Spatial (East/West) variability of spawning period: Mar-Aug (May-Jul peak) in North Sea (distinct stock); Mar-Jul (May-Jun peak) on West coast/Atlantic [1] Eggs 1.0-1.38mm diameter; Larval size up to 21mm? (at 21 mm - adult-like appearance) [2] Length at maturity 28.7cm [6]
Feeding	No specific habitat requirement known for feeding (water	offshore	Pelagic feeder (feeds on zooplankton and small fish) [6] Opportunistic feeder, can ingest prey either by individual selection of organisms or by passive filter feeding [10] Mackerel migrate North to feeding grounds for the summer, after spawning	

Mackerel *(Scomber scombrus)* [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
	column / pelagic / opportunistic)			
Migratory routes	Migratory fish, with clear migratory routes (spatial), but no specific habitat requirement known for this function identified	Inshore & offshore	Inshore (coastal): Shallow (<30m) open water [4] Offshore: migration along the continental shelf edge from mid-November to early March, coinciding with the location of the relatively warm shelf edge current and, as a consequence of this affinity, mackerel are guided towards the main spawning area in the south [11]	West coast: after spawning (Feb July) in SW Ireland and Celtic Sea, mackerel migrate North to feeding grounds for the summer; then it migrates again at the end of summer to overwinter (Shetlands, northeast North Sea); end of the year, migrates back South for spawning. North Sea: North Sea mackerel overwinters in the deeper parts of the Skagerrak and north-eastern North Sea from where it ascends to the surface layer and central North Sea in spring for spawning; after spawning mackerel redistributes in the North Sea or migrates into nearby waters (e.g. Skagerrak, Kattegat)
Occurrence (aggregations, generic)	No specific requirement known for aggregations, other than water column inshore/offshore	Inshore & offshore	Pelagic species, Forms large schools near the surface; overwinter in deeper waters but move closer to shore in spring when water temperatures range between 11° and 14°C [6]	

References:
1. Coull et al. 1998
2. Ellis et al. 2012
3. Aires et al. 2014
4. Seitz et al. 2014
5. Borja et al. 2002*
6. Fishbase
7. Jansen et al 2015
8. Giannoulaki et al. 2017
9. Jansen 2016
10. Studholme et al. 1999
11. Jansen et al 2012

*(similar result from Villamor et al 2011, but focused on Bay of Biscay only)

Mackerel *(Scomber scombrus*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Notes: - Migratory route information are hydrodynamic/spatial factors rather than specific habitat requirement. - The mackerel in the eastern Atlantic has traditionally been divided into three spawning components named according to their spawning areas: Southern (Gibraltar to southern Biscay), Western (Biscay to northwest of Scotland), and North Sea. The North Sea component is considered to be a distinct stock.				

Table A1.6. Cod (N/A is indicated where the habitat function is not relevant to the species).

Cod (*Gadus morhua)* [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A (shelter/refugia function mainly for juveniles, covered under 'nursery')	N/A	Juveniles avoid predation by seeking refuge in structured habitats [12] - see 'nursery'	N/A
Nursery	Yes	Inshore (0-group)	Demersal juveniles. Inshore (coastal): Seagrass, Kelp, Macroalgae, Rocky shore, Subtidal soft bottom (gravel bottom with cobble and attached fauna, incl. biogenic structures in gravel habitats; 'Cobble' preferred over finer grains); Dependence of juveniles on such complex habitats due to protection from predators they provide (reduced juvenile mortality risk) [4,10, 12] Inshore: Juvenile densities off Western Scotland (shallow inshore waters, <7m depth) were highest from September to November, during the day and associated with maerl (that lacked macroalgal cover) than with heavily vegetated rocky and gravel substrata [14] Inshore: cod juveniles (0-group) selecting shallow nearshore habitat (≤10m), with preference for seagrass (Z. marina) [7]; Juveniles prefer shallow areas <10-30m [10] Ontogenetic migration of older, larger individuals to deeper waters to join adult stocks (0-group almost exclusively inshore, 1 group further onto the shelf area, larger juveniles largely distributed on the shelf) [7, 8]; 0-group Atlantic cod also found in a few studies on offshore banks at depths of approximately 80 m, but density was low and occurrences rare [7] Young (0-group) gadoid fish been observed sheltering beneath jellyfish umbrellas (refugia from predation, increased survival) [13]	Juvenile size: <23cm 0-groups [2]; <20-33cm 0-group (variable cut-off lengths depending on survey method & quarter) [3]; post-larval stage starts at approx. 4.5mm (ref. in [2]) Juvenile cod: <25cm 0- & 1-group; ≤10cm 0-group, (post-settled (non pelagic) at >6cm) [7]

Cod (*Gadus morhua*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Spawning	Yes	offshore	Spawns in pelagic habitat (open water/water column) offshore, eggs and larvae drift with currents for up to 3 months before settling to the seabed [4,10], but cod aggregate over specific grounds to spawn (territorial males, seasonal site fidelity) [9] Spawning in cool water (5-7°C) and salinity >32 in Southern North Sea; coarse sand & mixed sediment as preferred spawning substratum than mud, sandy mud, muddy sand and sand, avoiding areas of very high tidal flow (preference for <1.1m/s tidal flow (springtide)) [6,9] Spawning offshore at depth 50-200m, and 0-12°C (0-6°C preferred) [10]	Best indicator is distribution of 'running' adults (i.e. with ripe gonads). Eggs have also been used, but they can be rapidly dispersed away from spawning grounds [9] Spawning period: Jan-Apr (Feb-Mar peak) [1] Length at maturity 68.3cm (range 31-74) [10] Cod in spawning stage (CSS): in North Sea, Viking cod (NE NS) spawns at larger length [at least 20% of CSS at size >70cm] than in NW NS and S NS [at least 20% of CSS at size >40cm] [9] Eggs 1.16-1.89mm diameter [2]; Stage 1 cod eggs 1.1-1.75mm diameter [5]
Feeding	No specific habitat requirement known for feeding (changes diet with depth, season, body size)	Inshore & offshore	Demersal feeder (prey on and below the bottom surface); wide food spectrum (prey type and size, from 'low-pelagic' to endobenthic (including many tubicolous) species); ontogenetic shift in food dominance from medium-sized, hyperbenthic prey to large, epibenthic and endobenthic prey; high feeding versatility [11] Inshore (coastal): Kelp [4]	N/A
Migratory routes	N/A	N/A	N/A	N/A
Occurrence (aggregations, generic)	No specific habitat requirement known		When maturing, the optimum temperature for cod decreases, and the larger fish are mainly found in deeper, colder waters [4] Older life stages of cod are less dependent on specific habitat types (lower vulnerability to predation)	Two genetically distinct populations in North Sea (one in deep NE North Sea (around Viking Bank), the other in shallower waters)

References:
1. Coull et al. 1998
2. Ellis et al. 2012
3. Aires et al. 2014
4. Seitz et al. 2014
5. Fox et al. 2008
6. Hoffle et al. 2017
7. Lilley & Unsworth 2014
8. Dalley & Anderson 1997
9. Gonzalez-Irusta & Wright 2016
10. Fishbase
11. Mattson 1990
12. Fahay et al. 1999
13. Lynam & Brierley 2007
14. Kamenos et al 2004

Cod (*Gadus morhua)* [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Notes: None				

Table A1.7. Haddock (N/A is indicated where the habitat function is not relevant to the species).

Haddock (*Melanogrammus aeglefinus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A no refuge habitat required	N/A	N/A	N/A
Nursery	* (see notes)	offshore only	Pelagic juveniles From modelling in North Sea (NS-IBTS data), age 0 (Q3/4) appear to prefer (aggregations) deeper waters (around 80m in Q3, 100-120m in Q4), with temperature <11°C in Q3/summer, springtide values between 0.3 and 0.6 m/s. No major shift in habitat use [between juveniles of 0 to 3 years of age] following settlement or seasonally persistent aggregation [5] No clear preference for sediment type (contrasting results from different studies) [5 and references therein] Young (0-group) gadoid fish been observed sheltering beneath jellyfish umbrellas (refugia from predation, increased survival) [4]	Juvenile size: <18-21cm 0-group (variable cut-off lengths depending on survey method & quarter) [2] Juveniles settle from June to August, at a total length of 2.9 to 8cm [5]
Spawning	Yes Haddock are known to aggregate over specific grounds to spawn (territorial male behaviour, courtship with visual and acoustic displays) [6]	offshore only	Haddock reported spawning over various substrates including rocks, gravel, smooth sand and mud, but coarse sand as preferred (higher densities) sediment type during the spawning season (quarter 1), possibly associated with fine sediment resuspension interfering with acoustic and visual display during male courtship [5,6] Optimum/preferred spawning habitat from modelling of Haddock Spawning Stage in North Sea and West of Scotland [6]: bottom temperature 7 ◦C; high salinity (>34.6) preferred in the northern North Sea and shelf edge waters (40-80km from coast, to 150m depth) to the west of Scotland, indicating preference for Atlantic rather than coastal waters; springtide 0.25-0.5 m/s in North Sea [6] Spawning occurs in typically marine waters between 50 and 150 m depth [7]	Best indicator is distribution of 'running' adults (i.e. with ripe gonads, Haddock in Spawning Stage (HSS)). Eggs have also been used, but they can be rapidly dispersed away from spawning grounds. Spawning period: Feb-May (late Feb- mid Apr peak) [1,5 and references therein] Length at maturity 34.9cm [7]; Age at maturity: 3y over the 20th century, but those found in the waters off Scotland are now mostly mature by age 2 [5 and references therein]

Haddock (*Melanogrammus aeglefinus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	N/A no specific habitat requirement known for feeding	offshore only	Haddock feed benthically over a wide range of sediments including clay, sand and gravel [5 and references therein] Haddock does not feed during spawning period [8]	N/A
Migratory routes	N/A	N/A	N/A	N/A
Occurrence (aggregations, generic)	N/A	offshore only	Not associated to any coastal habitat [3] Adults are found more commonly from 80 to 200 m, over rock, sand, gravel or shells, usually at temperatures between 4° and 10°C [7] In the North Sea, haddock occur mainly in the north and central areas, but can be found as far south as the Humber Estuary [5]; Haddock from North Sea (NS) and Scottish West coast (SWC) form Northern shelf stock (ICES 2015 in [6])	N/A

References:

1. Coull et al. 1998
2. Aires et al. 2014
3. Seitz et al. 2014
4. Lynam & Brierley 2007
5. Asjes et al. 2016
6. Gonzalez-Irusta & Wright 2016b
7. Fishbase
8. Homans & Vladykov 1954

Notes:

* Lack of a distinct nursery habitat: Haddock appears to disperse soon after settling and do not aggregate again until spawning. Juvenile haddock aggregations do not appear to occupy distinct areas of habitat repeatedly selected over time and that there is not a disjunction between juvenile and adult areas, therefore aggregations of juvenile haddock cannot be regarded as nursery areas [5]

- Northern shelf stock = haddock from North Sea (NS) + Scottish west coast (SWC) [6]

Table A1.8. Whiting (N/A is indicated where the habitat function is not relevant to the species).

Whiting (*Merlangius merlangus*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A (but see refugia for juveniles under 'nursery')	N/A	Refugium effect suggested in relation to offshore artificial substrata (wind farms) [7], but not always confirmed [8]	N/A
Nursery	Yes	Mostly inshore	Inshore (coastal): Seagrass, Subtidal soft bottom, Macroalgae [4], often estuary/inshore areas/ sea lochs (e.g. [13]) Inshore: settled (demersal) juveniles migrate to shallow inshore waters [10] Young (0-group) gadoid fish been observed sheltering beneath jellyfish umbrellas (refugia from predation, increased survival) [6] Juveniles found in high abundance in estuaries throughout the UK - most abundant in low salinity conditions however are not limited to estuaries [15]. inhabit estuaries over winter where they actively feed and grow [15]. Juvenile whiting were observed in higher abundances over deeper sand and mud in Western Scotland - South Arran MPA. Whiting are positively correlated to the habitat diversity of epibenthic and demersal fauna [16].	Juvenile size: <20cm 0-groups [2]; <17-22cm 0-group (variable cut-off lengths depending on survey method & quarter) [3]; post-larval stage starts at approx. 4.3mm (ref. in [2])
Spawning	Yes	offshore	Pelagic spawner (open water / water column) Optimum spawning temperature in North Sea: Near bottom temperature (NBT) [in Q1] around 7.5°C, 5-8°C range [5,11] High plasticity in spawning ground selection with extensive areas of the North Sea appearing suitable; springtide (0.1 to 0.8 m/s) as a key physical determinant of whiting spawning distribution, which may be linked to the need for larvae to be advected offshore [11] High spatial fidelity to spawning site due to either geographical attachment or year-to-year persistence of the spatial distribution of the population. As long as changes in present environmental conditions remain within the fundamental niche of whiting, it should be expected that the	Best indicator is distribution of 'running' adults (i.e. with ripe gonads). Eggs have also been used, but they can be rapidly dispersed away from spawning grounds [11] Spawning period: Feb-Jun [1], repeat spawning [11] Length at maturity 27.8cm (range 28-30) [12]; Age at maturity 2y in North Sea [11] Whiting in Spawning Stage (WSS) used in [11]; at least 20% of WSS (mature stage) at size >23(male)-25 (female) cm (Lm 25.5-27.5cm - at least 50% WSS, incl. all 3-group, most of 2-group, some 1-group) (West Scotland)[13] (see also [14]) Eggs 0.97-1.32mm diameter [2]

Whiting (*Merlangius merlangus*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			geographical configuration of spawning areas will vary little [14]	
Feeding	N/A no specific habitat requirements known for feeding	N/A	Feeds on both pelagic and demersal prey (amphipods, mysids, sprat & sandeel, Norway pout & herring). Ontogenetic shift from epibenthos to fish [9]	N/A
Migratory routes	N/A	N/A	N/A	N/A
Occurrence (aggregations, generic)	N/A	N/A	N/A	N/A

References:
1. Coull et al. 1998
2. Ellis et al. 2012
3. Aires et al. 2014
4. Seitz et al. 2014
5. Fox et al. 2017
6. Lynam & Brierley 2007
7. Derweduwen et al. 2012
8. Stenberg et al. 2015
9. Pedersen 1999
10. Tobin et al. 2010
11. Gonzalez-Irusta & Wright 2017
12. Fishbase
13. Cooper 1983
14. Loots et al. 2010
15. Henderson 1989
16. Elliott et al. 2017

Notes: -

Table A1.9. Saithe (N/A is indicated where the habitat function is not relevant to the species).

Saithe (*Pollachius virens*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A (shelter/refugia function mainly for juveniles (e.g. maerl), covered under 'nursery')	N/A	Saithe and pollack congregating around projecting seabed structures such as reefs and wrecks; potential refuge function suggested for offshore wind farms by [5]	N/A
Nursery	Yes	Mostly inshore	Inshore: Juvenile pollock (Pollachius virens) school in open water at low tide and disperse in beds of macroalgae on rocky intertidal areas (foraging grounds and refuge) at high tide [7] Inshore (coastal): Subtidal soft bottom, Kelp, Macroalgae, Rocky shore/intertidal [3, 6] Inshore: Juvenile densities off Western Scotland (shallow inshore waters, <7m depth) were highest from September to November, during the day and associated with maerl (that lacked macroalgal cover) than with heavily vegetated rocky and gravel substrata [4] Juvenile prefer salinity around 31.5 [10 and references therein]	Juvenile size: <22-25cm 0-group (variable cut-off lengths depending on survey method & quarter) [2] Saithe juveniles stay in inshore nurseries until they are 2-3 years of age, and therefore nursery areas can be modelled using age 1 fish [2] Rapid growth: ca. 20 cm at 1 year, 35 cm at 2 years, 50 cm at 3 years, 60-65 cm at 4years etc. [12]
Spawning	No specific habitat requirements known (information on habitat association limited to US EFH only)	offshore ?	Pelagic spawning, eggs and larvae Spawning occurs over hard, stony or rocky bottom; it begins when the water column cools to near 8°C, and peaks at 4.5-6°C [10 and references therein, but note this is in Western Atlantic, e.g. Massachusetts Bay, US]	Spawning period: Jan-Apr (Jan-Feb peak) [1] Length at maturity 39.1cm [9]

Saithe (*Pollachius virens*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	No specific habitat requirements known for feeding (as adult; juvenile feeding included in 'nursery' function)	Inshore & offshore	See juvenile feeding in macroalgae beds on rocky intertidal areas as part of the nursery function of these habitats [6] No apparent dependence on kelp for feeding (mostly feeding on pelagic copepods rather than kelp-associated fauna in [8] Smaller fish in inshore waters feed on small crustaceans (copepods, amphipods, euphausiids) and small fish, while larger fish prey predominantly upon fishes and molluscs (e.g. squids) [9,10]	N/A
Migratory routes	N/A No specific habitat requirements known for this function	N/A	Inshore-offshore seasonal movements associated with use of coastal nursery habitats in spring-autumn and return to deeper waters in winter [9], and larger scale migrations in NE Atlantic [11], but no specific habitat requirements identified for migration routes.	N/A
Occurrence (aggregations, generic)	N/A no specific habitat requirements known	Offshore	Schooling species found throughout the water column No particular preference (of adults) for bottom types, salinity 31-34, temperature 0-14°C, wide range of depths (100-125m preferred) [10]	N/A

References:

1. Coull et al. 1998
2. Aires et al. 2014
3. Seitz et al. 2014
4. Kamenos et al 2004
5. Wilson & Elliott 2009
6. Rangeley & Kramer 1995
7. Rangeley & Kramer 1998
8. Norderhaug et al. 2005
9. Fishbase
10. Cargnelli et al. 1999*
11. Homrum et al. 2013
12. Cohen et al. 1990

*Note this is in Western Atlantic, e.g. Massachusetts Bay, US

Notes: -

Table A1.10. Norway pout (N/A is indicated where the habitat function is not relevant to the species).

Norway pout (*Trisopterus esmarkii*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A (but see refugia for juveniles under 'nursery')	N/A	N/A	N/A
Nursery	No specific habitat requirements known for this function	Inshore (possibly offshore)	This species is not considered to have specific nursery grounds [6] SST during spring determined the overall level of recruitment of age-1 individuals [7] Inshore: juveniles migrate inshore (<100m depth) after the larval stage from spawning in the open sea on west coast of Scotland (Firth of Lorne, various sea lochs) [8] Low and variable salinity in Loch Etive as limiting factor to the occurrence of Norway pout [8] Young (0-group) gadoid fish been observed sheltering beneath jellyfish umbrellas (refugia from predation, increased survival) [4]	Juvenile size: <12-14cm 0-group (variable cut-off lengths depending on survey method & quarter) [2] 0-group found in inshore areas (W Scotland) in Jul-Dec [8]
Spawning	No evidence of specific habitat requirements for this function, nor clear evidence of large spawning aggregations	Offshore	Pelagic spawning (open water/substratum egg scatterer) Major spawning grounds are Northwestern Scotland, Norway, Faeroe Islands and Iceland [5] Depth >100m (North Sea) [6 and references therein] Norway pout undergo heavy spawning mortality (mainly from the first to the second quarter of the year), a major direct and indirect cause of stock mortality [9]	No clear evidence of large spawning aggregations. Distribution of stage I eggs from ichthyoplankton surveys in Feb/Mar are more reliable indicator of spawning grounds in North Sea, but there are difficulties in distinguishing stage I gadoid eggs visually (genomic analysis is needed); Age 2+ distribution (from bottom trawl surveys in Q1) may also provide information on the probable spawning location (good matching with distribution of stage I eggs) [6] Spatial (shelf/deep) variability of spawning period: Jan-Apr (Feb-Mar peak) on coastal shelf; Mar-May in deeper areas [1] Length at maturity range 11-15cm (mostly 2+ years) [5] Stage I eggs 1.03-1.28mm diameter (Feb-Mar) [6]

Norway pout (*Trisopterus esmarkii*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	No specific habitat requirements known for this function	Inshore & offshore	Inshore (coastal): Subtidal soft (muddy) bottom [3,5] Offshore: feed on planktonic crustaceans (copepods, euphausiids, shrimps, amphipods) but also on small fish and various eggs and larvae [5,8,10]. Lower adult feeding intensity during January, March-April (spawning period) and August [10]	N/A
Migratory routes	No specific habitat requirements known for this function		Migrates for spawning between the Shetland Islands and Norway and out of the Skagerrak [5]	N/A
Occurrence (aggregations, generic)	No specific habitat requirements known		depth 50-300 m [6]	N/A

References:
1. Coull et al. 1998
2. Aires et al. 2014
3. Seitz et al. 2014
4. Lynam & Brierley 2007
5. Fishbase
6. Nash et al. 2012
7. Alexander et al. 2009
8. Gordon 1977
9. Nielsen et al. 2012
10. Raitt & Adams 1965

Notes: -

Table A1.11. Blue whiting (N/A is indicated where the habitat function is not relevant to the species).

Blue whiting (*Micromesistius poutassou*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	N/A	N/A	N/A
Nursery	No known specific habitat requirements	offshore only	N/A	Juvenile size: <19cm 0-group [1,2] post-larval stage starts at approx. 6.7mm (ref. in [1])
Spawning	No evidence of specific habitat requirements for this function, but influence of hydrographic factors	offshore only	Pelagic eggs Spawning grounds [location] along the continental-shelf edge west of the British Isles [5] Spawning distribution is variable, regulated by hydrography. The strength of the North Atlantic subpolar gyre has an influence on the spawning distribution and temporal fluctuation of recruitment. With strong gyre (wider influence of cold, fresh water masses) spawning constrained along European continental slope in a southerly position, with weak gyre (more saline and warm conditions) spawning distribution moved northwards along the slope [5,6]	Spawning period: Apr-Jun (Apr-May peak) [1] Eggs 1.04-1.28mm diameter [1] Size at maturity 15cm [4]
Feeding	No known specific habitat requirements	offshore only	Pelagic feeding, mostly on small crustaceans but large individuals also prey on small fish and cephalopods [4] Blue whiting exploits the pelagic and benthopelagic resources at depths shallower than 750 m depth (Rockall Trough) [7]	N/A
Migratory routes	No known specific habitat requirements	offshore only	Performs extensive diel vertical migrations, hence variable degree of occupancy of seafloor habitat; spends a large portion of the daytime near the bottom [1]	N/A
Occurrence (aggregations, generic)	N/A	offshore only	Fully marine species, typically offshore (>50m depth) [1] Pelagic fish. Not associated to any coastal habitat [3] Found over the continental slope and shelf to more than 1000 m, but more common at 300-400 m [4]	N/A

References:
1. Ellis et al. 2012
2. Aires et al. 2014
3. Seitz et al. 2014
4. Fishbase
5. Payne et al. 2012
6. Hatun et al. 2009
7. Mauchline & Gordon 1984

Blue whiting (*Micromesistius poutassou*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Notes: -				

Table A1.12. Hake (N/A is indicated where the habitat function is not relevant to the species).

Hake (Common -) (*Merluccius merluccius*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	N/A	N/A	N/A
Nursery	Yes? *	offshore only	Juvenile and small European hake usually live on the continental shelf, on muddy bottoms, between depths of 70 and 200 m, with the highest densities at a depth of 100 m [6]	Juvenile size: <20cm 0-group and a few older fish at the start of the year [1,6]; <19cm 0-group [2] post-larval stage starts at approx. 5mm (ref. in [1])
Spawning	Yes? **	offshore only	Pelagic eggs; limited information on the species reproductive biology [6] Adult hake live and spawn at the shelf edge/break [6]. Spawning grounds in deeper waters of continental shelf and along continental slope [1]. 200-1000m depth [3] Pelagic eggs with major densities in the upper 200 m of the water column over the shelf break, but depth distribution in the water column may vary depending on temperature and upwelling [6 and references therein] Optimum temperature range for spawning 10-12.5°C [6]	Spawning period: Jan-Jun (Feb-Mar peak) [1]; spawning activity all year round [6] Eggs 0.94-1.03mm diameter [1] Size at maturity: 42.7cm (20-70cm range) [5]; 35cm for males, 45-50cm for females [6]
Feeding	No specific habitat requirements known for this function	offshore only	Top predator of the demersal community. Adults feed mainly on fish (small hakes, clupeids, blue whiting and other gadoids) and squids. The young feed on crustaceans (especially euphausiids and amphipods) [5,6]	N/A
Migratory routes	N/A	offshore only	European hake lives close to the bottom during the daytime but at night they move up and down the water column [6]	N/A

Hake (Common -) (*Merluccius merluccius*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Occurrence (aggregations, generic)	N/A	offshore only	Fully marine species, typically offshore (>50m depth) [1]. Demersal and benthopelagic specie found mainly between 70 and 370 m depth [5,6] Not associated to any coastal habitat [4] Large adult individuals are found on the shelf slope, where the bottom is rough and associated with canyons and cliffs [6]	N/A

References:
1. Ellis et al. 2012
2. Aires et al. 2014
3. Alvarez et al. 2004 in [1]
4. Seitz et al. 2014
5. Fishbase
6. Murura 2010

Notes:
British Isles = northern stock; Bay of Biscay = Southern stock
* /** No specific habitat requirements known for this function, but correlation with depth/location on continental shelf apparent for distinguishing adult/juvenile habitats

Table A1.13. Plaice (N/A is indicated where the habitat function is not relevant to the species).

Plaice (*Pleuronectes platessa*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	No specific habitat for refuge	inshore & offshore	Sandy/mixed sediments, shallow, confined areas, low energy Shelter/refugia function for juveniles covered under 'nursery' Refuge function can be associated to all plaice habitat due to its burying behaviour, although burying in sand appears to provide only a partial refuge from predation [10])	N/A
Nursery	Yes	inshore	Inshore (coastal): Intertidal soft bottom, subtidal soft bottom, saltmarsh [4]; Plaice are dependent on shallow sediment substratum as nursery grounds (e.g.<5m [4]; <2m [5]; shallow sandy beaches [6,8]; fine to medium sandy beaches (Firth of Forth, [11]) and shallow bays, low energy environments). Strong preference of 0-group for fine sediment such as mud and fine sand [13] Field studies within shallow sandy beaches and laboratory studies also show preference for or lower vulnerability to predation in structured habitats v. bare sand (biogenic reefs (*Lanice conchilega*) [9]; contrasting results re. filamentous macroalgae [10, 12]	Settlement period Apr-May [10]; juveniles remain in the intertidal zone until autumn [17] Juvenile size: <11.5cm 0-groups [1]; <14-17cm 0-group (variable cut-off lengths depending on survey method & quarter) [2]; <21cm likely including also 1+ group [3]; demersal post-larval stage begins at length approx. 13mm [1]; Recently metamorphosed juveniles 11-15cm; post settlement juveniles 16-26cm [12]; <7.5cm cut-off between 0 and 1-group, based on otoliths, inshore beaches in Irish Sea [5]
Spawning	No specific habitat requirement known for this function, but location related with hydrography and topography determining connectivity to coastal nurseries	Offshore & inshore	Pelagic spawning Adult spawn in the water column, depth constraint (minimum) 20m and temperature constraint around 6 °C [8]. Spawning mainly 50-200 km offshore, salinity >32 [7]. Spawning grounds in the UK are generally located between 20 and 40 m [16] No specific habitat requirement for spawning, except for location (such that eggs and larvae are transported by prevailing currents (via STST) to coastal nurseries) [4]. Spawning location in areas with high connectivity to nursery areas [hydrodynamic transport] [14] Place requires salinity >13-14 for neutral buoyancy of eggs hence successful reproduction (Baltic) [15]	Spawning period: Dec-Mar (Jan-Feb peak) [1]; Dec-Apr (Feb-Mar peak), Irish Sea [6] Eggs 1.66-2.17mm diameter [1]; Early-stage eggs (EG1) <2.29mm [3] Length at maturity 30.8cm (range 24-42cm) [8]

Plaice (*Pleuronectes platessa*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	No specific habitat requirements known for this function (other than sedimentary habitat where the species occurs)	Inshore & offshore	Demersal feeder, feed mainly on thin-shelled molluscs and polychaetes [8] Inshore (coastal): Subtidal soft bottom [4] No association with a specific habitat for feeding (feeds on a variety of sedimentary substrata, adjusting their diet depending on food availability) [13]	N/A
Migratory routes	N/A	Inshore-offshore	Spawning migrations can be long (from tagging studies) [8]	N/A
Occurrence (aggregations, generic)	N/A	Inshore & offshore	Sediment structure has major influence on the distribution patterns of flatfish. Inshore (coastal): occurrence in sandy and muddy substrata, <100m depth [4], usually 10-50m [8]	N/A

References:

1 Ellis et al. 2012
2 Aires et al. 2014
3 MMO1044
4 Seitz et al. 2014
5 Fox et al. 2006
6 Fox et al. 2009
7 Rijnsdorp 1989
8 Fishbase
9 Rabaut et al. 2010
10 Wennhage 2002
11 Poxton & Nasir 1985
12 Wennhage & Pihl 1994
13 Lauria et al. 2011
14 Hufnagl et al. 2013
15 Vuorinen et al. 2015
16 MALSF 2011
17 Kuipers 1977

Notes: None

Table A1.14. Common sole (N/A is indicated where the habitat function is not relevant to the species).

Common sole (*Solea solea*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	No specific habitat for refuge, but rather refuge function can be associated to all sole habitat due to its burying behaviour	inshore & offshore	Burrowing in sandy and muddy sediments [8]; Generic habitat preference for sandy and finer grained sediment [6] Shelter/refugia fuction of estuaries for juveniles covered under 'nursery'	N/A
Nursery	Yes	Inshore	Inshore (coastal): Intertidal soft bottom [5] Generic habitat preference for sandy and finer grained sediment [6 and references therein] Juvenile sole (0-group, 1-group and 2-group) found almost exclusively in the shallow (<20m deep) parts of the north-east Irish Sea and down to 40m depth in Bristol Channel [10]	Juvenile size: <13cm 0-groups, likely including also 1+ group [2,3]; <12-13cm 0-group (variable cut-off lengths depending on survey method & quarter) [4 Sole spends 2-3 years in inshore nursery grounds before migrating offshore [7 and references therein]
Spawning	No specific habitat requirement known for this function, but location related with hydrography and topography determining connectivity to coastal nurseries and timing related with temperature	mainly inshore (+ offshore, depending on topography - see Bristol channel for example)	Pelagic spawning (mid-water or surface; Horwood 1993 in [6]) Inshore (coastal): Shallow (<30m) open water [5]; Shallow waters (<10m CD; English Channel & Southern North Sea; <40m eastern Irish Sea; 40-75m in Bristol Channel) [6,9,10]; Spawning takes place in shallow coastal waters at temperatures of 6 - 12°C [8] Sole spawns when temperature rise above a minimum, variable with site (e.g. >10°C East Coast of England, >7°C EC & SNS) [6]; No specific sediment requirement for spawning, but generic habitat preference for sandy and finer grained sediment [6]. The more important requirements of a successful spawning ground is the presence of suitable hydrographic conditions to transport eggs and larvae to nursery areas [10]	Stage 1A egg distribution from ichthyoplankton surveys used as indicator of spawning grounds [9] Spawning period: Feb-Jun (Apr peak) [1,10]. Spawning starts sooner at lower latitudes [11] Eggs 1.0-1.6mm diameter [1] Size at maturity of 30.3cm (reproduction starts after 3-5 years of age) [8]

Common sole (*Solea solea*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	No specific habitat requirements known for this function (other than sedimentary habitat where the species occurs)	Inshore	Inshore (coastal): Intertidal soft bottom [5] Sole feed during the night on infaunal invertebrates associated with finer-grained sediments [6]. No association with a specific habitat for feeding (feeds on a variety of sedimentary substrata, adjusting their diet depending on food availability) [13]	N/A
Migratory routes	No specific habitat requirement known for this function, depends on hydrodynamics and relative location of nursery and spawning grounds	Inshore & offshore	Inshore (coastal): Shallow (<30m) open water [5] Offshore pre-spawning migration (dispersal and dispersion) of young adults (3+ group) towards the spawning grounds; selective tidal stream transport used for migration into coastal/estuarine nurseries and for pre-spawning migration [12]	N/A
Occurrence (aggregations, generic)	N/A	Inshore & offshore	Sediment structure has major influence on the distribution patterns of flatfish. Generic habitat preference (both juveniles and adults) for sandy and finer grained sediment; <30% gravel [6 and references therein]. This generic preference may also reflect on refugia, spawning, nursery and feeding grounds, although it may not be a specific requirement for those functions. Adults occur at a temperature range of 8.0-24.0°C [8]	N/A

References:

1. Coull et al. 1998
2. Ellis et al. 2012
3. MMO1044
4. Aires et al. 2014
5. Seitz et al. 2014
6. Eastwood et al. 2001
7. EA 2013
8. Fishbase
9. Fox et al. 2000
10. Symonds & Rogers 1995
11. Vinagre et al. 2008
12. Koutsikopulos et al. 1995
13. Amezcua et al. 2003

Notes: -

Table A1.15. Lemon sole (N/A is indicated where the habitat function is not relevant to the species).

Lemon sole (*Microstomus kitt*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	N/A	N/A	N/A
Nursery	No specific habitat requirement	Offshore	Suggestion that settlement and early nursery areas are located on rougher terrain in deeper, offshore areas, overlapping with spawning areas (due to observed limited dispersal of larvae from spawning grounds) [6] Suggestion that Lemon sole <15cm (TL) likely inhabit rocky areas from 50–100 m deep (western English Channel), but no direct evidence (based on absence of juveniles from more sampled sedimentary areas where other juvenile flatfish occur) [7]	Juvenile size: <21cm 0-groups, likely including also 1+ group [2]
Spawning	No specific habitat requirement	Offshore	Pelagic spawning, with planktonic larvae (late summer - early autumn North Sea, and overwintering due to extended spawning period) [6] *[Note: several studies (e.g. [6,7]) based on ichthyoplankton (egg) surveys have identified offshore locations of M. kitt spawning grounds in certain areas and years, but no information on the environmental determinants (habitat requirements) for it]*	Eggs distribution during spawning period as indicator of spawning grounds (drift away from them afterwards) [6] Spawning period: Apr-Sep [1]; May-Oct (peak May-Aug) (North Sea) [6] Size at maturity 31.5cm (range 20-30cm) [4]; 19cm/3y males, 26cm/4-5y females in Scottish waters [7]. Larvae 3.5-5.5mm at hatching [6]
Feeding	No specific requirements known (other than sedimentary where species occurs)	Offshore	Feeds on a variety of small invertebrates (polychaetes dominant) [4] Very specific dietary requirements, but no association with a specific habitat for feeding (feeds on a variety of sedimentary substrata) [5]	Apparently, they do not feed in wintertime [4]
Migratory routes	N/A	Offshore	No indication of extensive or regular migration of lemon sole (tagging study in English Channel; + literature for NE North Sea) [7 and references therein]	N/A
Occurrence (aggregations, generic)	N/A	Offshore	Sediment structure has major influence on the distribution patterns of flatfish. Lives most often on stony bottoms; depth range 10 - 200 m, usually 10 - 150 m [4] Not associated to any coastal habitat [3]	N/A
<u>References:</u>				
1. Coull et al. 1998	3. Seitz et al. 2014	5. Amezcua et al. 2003	7. Jennings et al. 1993*	

Lemon sole (*Microstomus kitt*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
2. MMO1044		4. Fishbase	6. Geffen et al. 2021	* Western English Channel
Notes: None				

Table A1.16. Lemon sole (N/A is indicated where the habitat function is not relevant to the species).

Anglerfish (*Lophius piscatorius*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	N/A	*[it lies half-buried in the sediment, but as predation ('sit-and-wait') strategy rather than for refuge effect]*	N/A
Nursery	No specific habitat requirements known for this function except for size/maturity distribution correlation with depth	inshore & offshore	Small (young) individuals predominate in shallow inshore and shelf waters. The juveniles presumably drift from deeper spawning areas towards shallower water before settlement [6] Pelagic anglerfish larvae (4 mm long) drift with surface currents for weeks to several months before juveniles (50-120 mm total length) settle on the inshore seabed [11]. In northern British waters, pelagic phase was described to last up to 120 days before settlement [10].	Juvenile size: <28cm 0-groups and some 1-group [1]; <16cm 0-group [2]; 17.9cm mean length 0-group [6]; 5-12 cm [likely 0-group, see [10]] [11]
Spawning	No direct evidence of spawning grounds (deeper areas) hence no specific habitat requirements known for this function	offshore	Pelagic spawning (buoyant egg ribbons, pelagic larvae) Increasing percentages of mature fish within the population with increasing depth. There is the assumption that the anglerfish spawn in deep or very deep water (>200 m, likely concentration of mature females; around the 1000 m contour line along European coasts; shelf edge) [6,7,10] Potential spawning grounds assumed at 100-1100 and temperatures >5°C [10]	Spawning period: Nov-Jun [1]; Apr-Jun (British Isles, north west and south) [5]; late winter-early spring (Faroese waters) [7] Length at maturity: range 35-60cm [5]; 58cm males, 98cm females (Shetland) [6]; 57cm (5y) males, 83cm (8y) females (Faroese waters) [7]; 50.3cm (6y) males, 93.9cm (14y) females (Iberian coast) [9]
Feeding	No specific habitat requirements known for this function	offshore only	Mainly piscivorous, wide range of prey types, but main prey are Norway pout and lesser sandeel; opportunistic feeder [4,5, and references therein] On sandeel grounds during summer (Shetland) [8]	N/A
Migratory routes	No specific habitat requirements known for this function	offshore only	General movement into deeper waters with increasing size and age/maturity [6] Weak swimmer, possible use of selective tidal stream transport through areas of strong tidal currents [8]	N/A

Anglerfish (*Lophius piscatorius*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Occurrence (aggregations, generic)	N/A	offshore only	Not associated to any coastal habitat [3] Occurs on sandy and muddy bottoms from the coast (below 20m) down to depths of 1,000m; may also be found on rocky bottoms [4,5 and references therein] Demersal; not a shoaling species.	N/A

References:

1. Ellis et al. 2012
2. Aires et al. 2014
3. Seitz et al. 2014
4. Laurenson & Priede 2005 (Shetland)
5. Fishbase
6. Laurenson et al. 2001 (Shetland)
7. Ofstad & Laurenson 2007 (Faeroes)
8. Laurenson et al. 2005 (Shetland)
9. Duarte et al. 2001 (Atlantic Iberian coast)
10. Hislop et al. 2001
11. Hislop et al. 2000

Notes:

- Spawning: there are several studies on species biology (part. Reproductive-), not much on ecology (habitat association/requirements)

Table A1.17. Skates (N/A is indicated where the habitat function is not relevant to the species).

Skates- Former Common skate complex (*Dipturus batis* complex), now two separate species: flapper skate (*D. intermedius*) & blue skate (*D. flossada/D. batis*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	N/A	N/A	N/A
*Nursery**	Possibly, but lack of general data for the species (site-specific studies may not be representative across the entire species' range); possible overlap with spawning/egg-nursery ground	inshore and offshore	CS: Nursery grounds should overlap with spawning/egg-laying grounds if juveniles do not leave the habitat [1,7,10], but no evidence available about this. Juveniles not typically occurring at <30m [1] FS: Western Scottish coast (<50m depth) as potential nursery areas [9] FS: Inverse size-depth relationship - Smaller (mostly immature) skate distribute across wider depth range than larger (mature) females: 20 - 150m for skates 130-190cm TL; 20-240m for skates 110cm TL (tagging study, MPA west coast of Scotland, inshore) [10]	CS: Juveniles in groundfish surveys allow for preliminary identification of nurseries (but low coverage of shallower waters) [1] CS: Juvenile size: <43cm 0-groups & 1-group, hatch at length 21cm [1] Dipturus spp.: juveniles ≤40cm TL [12]
*Spawning***	Possibly, but limited evidence available (from non-systematic surveys (citizen science) and site-specific (inshore only), may not be representative of the full species' range) Mating habitat not known	mostly inshore? (offshore ?)	FS, BS: Oviparous with internal (oviduct) fertilisation; demersal egg capsules deposited on sandy or muddy flats [3] FS: Shetland's role in supporting significant numbers of FS eggs [5] FS: Anecdotal evidence from scallop and recreational scuba divers suggests that flapper skate use egg-laying grounds; Habitat of potential egg-laying sites at >20m depth, with boulders or exposed bedrock, moderate current flow (0.3-2.8 knots) with low sedimentation (based on citizen science observation (stranded egg case data, opportunistic dives observations, towed camera surveys), Orkney) [7] FS: Inverse size-depth relationship - extended preference for shallow depths (20-100m) observed in some large females (compared to smaller skates) may be caused by mature females utilising habitats suitable for egg deposition [10]	CS: Egg cases indicator of spawning areas (egg-laying grounds), but few data [1] CS, FS, BS: Mating thought to occur in spring (Mar-Apr); egg capsules laid in spring-summer [3,4] BS: Length at maturity 160cm female (males reach maturity at ca. 115cm, females at 123cm TL) [3]; FS: Length at maturity 197.5cm female, 185.5cm males [10 and reference therein]; males reach maturity at ca. 185cm, females at 197cm TL [3] CS: Do not mature until around 15 year old [2]
Feeding	No specific habitat requirements known + lack of data	inshore and offshore	FS, BS: Wide range of prey (demersal fish and crustaceans), ontogenetic change from benthic specialist to fish feeder [3,10]	N/A
Migratory routes	N/A	N/A	CS: Females exhibit extreme site fidelity, apparently remaining within small geographical areas over medium temporal scales (months); high	N/A

Skates- Former Common skate complex (*Dipturus batis* complex), now two separate species: flapper skate (*D. intermedius*) & blue skate (*D. flossada/D. batis*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			rates of vertical movements nocturnally (in water column, >100m daily range daily) [4]	
Occurrence (aggregations, generic)	N/A Anecdotal information or based on presence (no aggregations)	inshore & offshore	CS, FS, BS: Benthic species in coastal waters of the European continental shelf and slopes; wide tolerance for depth and temperature; found in coastal waters from 30 m to deep water 600m, but mainly within 200m range [3,4] Sandy and muddy bottoms [11] FS: Inverse size-depth relationship - larger skate (>210 cm TL) prefer shallower depth (20-100m), while smaller (mostly immature) skate also frequently use deeper depths (to 150m for skates 130-190cm TL; to 240m for skates 110cm TL) (tagging study, MPA west coast of Scotland, inshore) [10] Probability of presence of FS and BS. mainly associated with benthic minimum depth primary productivity mean, + benthic minimum depth temperature mean and surface primary productivity mean for BS, + surface primary productivity mean & benthic maximum depth primary productivity mean for FS [5] *[but nature of the association and meaning of the environmental variables not specified or discussed in the paper]* *CS:* presence associated with cooler SST, no significant substrate preference (modelling of 1902-2013 survey data in southern North Sea) [8] FS: wide temperature tolerance; temperature does not strongly influence skate movement and localised temperature extremes are unlikely to influence skate presence [10]	FS: Lack of data on species' life history across much of its range (from Shetland to southern Ireland), also including ontogenetic shifts in distribution and critical (essential) habitat use (there are a few site-specific studies but these may not be representative across the entire species' range) [6]

References: *(species covered)*

1. Ellis et al. 2012	common skate D.b.complex	(CS)	7. Phillips et al. 2021	flapper skate D.i.	(FS)
2. Scotland's Marine Atlas	common skate D.b.complex	(CS)	8. Sguotti et al. 2016	common skate D.b.complex	(CS)[a]
3. Fishbase	flapper skate D.i.; blue skate D.b.	(FS, BS)	9. NatureScot 2021	flapper skate D.i.	(FS)
4. Wearmouth & Sims 2009	common skate D.b.complex	(CS)	10. Thorburn et al. 2021	flapper skate D.i.	(FS)[b]
5. Bache-Jeffreys et al. 2021	flapper skate D.i.; blue skate D.b.	(FS, BS)	11. Neal & Pizzolla 2006 (MarLIN)	common skate D.b.complex	(CS)
6. Garbett et al. 2021	flapper skate D.i.	(FS)	12. Ellis et al. 2005	Dipturus spp.	

Skates- Former Common skate complex (*Dipturus batis* complex), now two separate species: flapper skate (*D. intermedius*) & blue skate (*D. flossada/D. batis*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*

Notes:
* Intended here as juvenile nursery (in the literature nursery grounds for the species often refer to egg nurseries).
** Spawning grounds identified for this species as egg-laying grounds (also referred to as 'egg nursery' and 'nursery' in the literature), given that egg fertilisation is internal.
- The GOV trawl is more efficient at sampling demersal sharks than batoids (skates and rays), especially small-sized batoids
[a] Southern North Sea
[b] MPA west coast of Scotland

Table A1.18. Thornback ray (N/A is indicated where the habitat function is not relevant to the species).

Thornback ray (*Raja clavata*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A no evidence of relevance of this function for the species	N/A	N/A	N/A
*Nursery**	N/A possible overlap with spawning/egg-nursery ground	Inshore	Inshore areas probably serve as nursery grounds for the immature individuals [4,13] Nursery grounds should overlap with spawning/egg-laying grounds if juveniles do not leave the habitat [1], but no evidence available about this. Coastal areas with rocks and sand seabed are potential nursery areas for R. clavata (but anecdotal, fishers' knowledge) [10] Juvenile presence/absence and CPUE best predicted in near-shore regions of the Irish Sea by increasing Plaice CPUE, temperature warmer than 16°C and salinity (peak preference at 34.3-34.6) [12]	Juvenile catches in groundfish surveys allow for preliminary identification of nurseries [1] Juvenile size: <17.5cm mainly 0-groups [1]; <29cm likely including 1+ groups [2]; ≤20cm TL Raja spp. [9]; ≤25cm [14]. Juveniles hatch at 10-12cm length [1,6] Relatively large size at hatching hence juveniles are immediately susceptible to fisheries exploitation by trawling vessels [6]
*Spawning***	Yes Mating habitat not known	Inshore	Oviparous with internal (oviduct) fertilisation; demersal egg capsules laid and deposited on shallow sand, mud, pebble or gravel bottoms (anchored with an adhesive film) [4]; high diversity of egg-laying habitats, which might differ in terms of bottom topography or sediment composition (little knowledge about substrate/site preference) [9,10] Mature individuals move from offshore grounds to shallow water during the early spring, presumably to mate; very shallow depths (often<10m) occupied during the egg-laying period [6] Mature female presence/absence and CPUE in Irish Sea best predicted by increasing salinity, depth (greatest at ~40 and 100–120m) and temperature warmer than 16°C [12]	Egg cases indicator of spawning areas (egg-laying grounds), but few data [1] Spawning period: Feb-Sep (Apr-Aug peak) [1] (June peak) [4]; Length at maturity 76.6cm (range 47-87.5cm); maturity at age 7-8y [4]; mature ray ≥75cm [14]; first spawning mainly in the 5th year [7] Egg capsules laid in spring (NW Europe) [4], starting in February, peak in June, end in September (British waters) [5]; eggs hatch after 4-5 months [4]

Thornback ray (*Raja clavata*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	No specific habitat requirements known for this function	Inshore & Offshore	Feeds on bottom animals, preferably crustaceans (crabs and shrimps) and fish [4,11]	N/A
Migratory routes	No specific habitat requirements known for this function	Inshore-Offshore	Clear annual migration cycle, with spawning migration of mature individuals from deeper offshore waters (10-30m, autumn/winter) to shallower areas (<10m, spring) presumably to mate [4,6]; e.g. resulting in wider distribution in southern North Sea in autumn/winter, range contraction in spring (fish moves into inner Thames estuary (tagging study)) [6] Movement of rays back into deeper water during the winter may be related to feeding [6]	N/A
Occurrence (aggregations, generic)	No specific requirements known for aggregations (evidence based on presence/absence only)	Inshore (incl. estuaries) & Offshore	Boreal/Lusitanian species, widespread around the British Isles at depths of 7–192m (bottom/beam trawl surveys 1967-2002) [9]; found over almost all substrates from mud to gravel [11] Presence associated preferably with warmer SST, shallower waters (mainly 5-40m depth) and hard, coarse, mixed, and 'unknown' sediments compared to sand and mud (modelling of 1902-2013 survey data in southern North Sea) [3] Inhabits shelf and upper slope waters, most common in coastal waters 10-60m [4] Found on mud, sand and gravel bottoms, rarely on rougher bottoms; tolerates low salinity [4] [also found in estuaries, e.g. Thames]	Demersal species

References:

	(Geographical reference)		
1. Ellis et al. 2012	British waters	8. Maia et al. 2015	Portugal
2. MMO1044	English Channel	9. Ellis et al. 2005	British waters
3. Sguotti et al. 2016	British waters	10. Serra-Pereira et al. 2014	Portugal
4. Fishbase (and references therein)	generic, species range	11. Ebeling 1988	Irish Sea
5. Holden 1975	British waters	12. Dedman et al. 2017	Irish Sea
6. Hunter et al. 2005	southern North Sea & Thames estuary	13. van Steenbergen 1994	North Sea
7. Ryland & Ahayi 1984	Carmarthen bay, South Wales	14. Elliott et al. 2020	Southern North Sea, English Channel, Celtic Sea, Irish Sea

Thornback ray (*Raja clavata*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Notes: * Intended here as juvenile nursery (in the literature nursery grounds for the species often refer to egg nurseries) ** Spawning grounds identified for this species as egg-laying grounds (also referred to as 'egg nursery' and 'nursery' in the literature), given that egg fertilisation is internal - The GOV trawl is more efficient at sampling demersal sharks than batoids (skates and rays), especially small-sized batoids				

Table A1.19. Spotted ray (N/A is indicated where the habitat function is not relevant to the species).

Spotted ray (*Raya montagui*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	No specific requirements known	N/A	Species buries itself to avoid predation and ambush potential prey	N/A
Nursery	N/A possible overlap with spawning/egg-nursery ground	Inshore	Nursery grounds should overlap with spawning/egg-laying grounds if juveniles do not leave the habitat [1], but no evidence available about this. Juveniles usually found in shallow sandy inshore areas, adults utilize more offshore sand or sand-gravel habitats [1,6] Coastal areas with rocks and sand seabed are potential nursery areas for R. montagui Juvenile presence/absence and CPUE in Irish Sea best predicted by Plaice CPUE, salinity ≥34.4 [7]	Juvenile catches in groundfish surveys allow for preliminary identification of nurseries [1] Juvenile size: <18cm mainly 0-groups [1], ≤20cm TL Raja spp. [3]; ≤25cm [8]. Juveniles hatch at length 10-12cm [1,6] As for *R. clavata*, relatively large size at hatching hence juveniles are immediately susceptible to fisheries exploitation by trawling vessels [4]
Spawning	Yes Mating habitat not known	Inshore (+offshore?)	Oviparous with internal (oviduct) fertilisation; demersal egg capsules laid and deposited on substratum (anchored with an adhesive film), but little knowledge about substrate/site preference [3] Mature female presence and CPUE in Irish Sea best predicted by current speed >0.9m/s (peaking at 1.2m/s), depth (peaks at 75 and >100m) and salinity >34 [7]	Egg cases indicator of spawning areas (egg-laying grounds), but few data [1] Spawning period: May-Jul peak (possibly Apr and Aug) [1]; Length at maturity 61.0cm [6]; mature ray ≥65cm [8] Egg capsules laid in summer, hatch after 5-6 months [6]
Feeding	No specific requirements known	Inshore & Offshore	Feeds mainly on crustaceans, and also worms, cephalopods and small fish, with wide dietary range [6,9]	N/A
Migratory routes	N/A no migrations reported for the species	N/A	N/A	N/A
Occurrence (aggregations, generic)	N/A no specific requirements known for generic aggregations (evidence based	Inshore & offshore	Boreal/Lusitanian species, widespread around the British Isles around the British Isles at depths of 8-283m (bottom/beam trawl surveys 1967-2002) [3]; most common between 20-120m [6] Presence associated preferably with warmer SST, 'unknown', coarse and sandy sediment, and rocky substrata compared to mixed sediment and mud, and typically found in shallower waters - as a	Demersal species

Spotted ray (*Raya montagui*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
	on presence /absence only)		results distribution overlaps with Thornback ray (modelling of 1902-2013 survey data in southern North Sea) [2]	

References: *(Geographical reference)*
1. Ellis et al. 2012 British waters
2. Sguotti et al. 2016 British waters
3. Ellis et al. 2005 British waters
4. Hunter et al. 2005 southern North Sea & Thames estuary
5. Serra-Pereira et al. 2014 Portugal
6. Fishbase (and references therein) generic, species range
7. Dedman et al. 2017 Irish Sea
8. Elliott et al. 2020 Southern North Sea, English Channel, Celtic Sea, Irish Sea
9. Ellis et al. 1996 NE Atlantic

Notes:
* Intended here as juvenile nursery (in the literature nursery grounds for the species often refer to egg nurseries)
** Spawning grounds identified for this species as egg-laying grounds (also referred to as 'egg nursery' and 'nursery' in the literature), given that egg fertilisation is internal
- The GOV trawl is more efficient at sampling demersal sharks than batoids (skates and rays), especially small-sized batoids

Table A1.20. Sandy ray (N/A is indicated where the habitat function is not relevant to the species).

Sandy ray (*Leucoraja circularis*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A no evidence of relevance of this function	N/A	N/A	N/A
Nursery	No specific habitat requirement known	N/A (Likely offshore?)	N/A (no information on juvenile/nursery habitats)	Juvenile size: ≤20cm TL Leucoraja spp. [2]
Spawning	No specific habitat requirement known. Mating habitat not known	N/A (Likely offshore?)	Oviparous with internal (oviduct) fertilisation; demersal egg capsules laid and deposited on sandy or muddy flats (anchored with an adhesive film) [1], but little knowledge about substrate/site preference [2] No further information on mating or egg-laying grounds	No definite egg laying period [1] Size at maturity not known [1]
Feeding	No specific habitat requirements	Offshore	Feed on all kinds of bottom animals [1]	N/A
Migratory routes	N/A no migrations reported	N/A	N/A	N/A
Occurrence (aggregations, generic)	No specific requirements known for aggregations (evidence based on presence /absence only)	Offshore	Offshore species found along the continental shelf and on upper slope, mainly around the 100m line [1], but which is not abundant in inshore waters; Individuals caught (occasionally) in the northern North Sea and Celtic Sea at depths of 108–432m (bottom/beam trawl surveys 1967-2002); absent from the inshore waters of England and Wales [2] Often found on sandy muddy bottoms, 70-275m depth [3]	Demersal species
References: 1. FishBase 2. Ellis et al. 2005 3. MarLIN				
Notes: * Intended here as juvenile nursery ** Spawning grounds identified for this species as egg-laying grounds (also referred to as 'egg nursery' and 'nursery' in the literature), given that egg fertilisation is internal - Individuals <73.4cm found in Mediterranean study were all non-mature in Mediterranean (Mulas et al. 2021), but it might not be relevant to UK waters - Mature specimens found in June in Mediterranean (Mulas et al. 2021), but it might not be relevant to UK waters - The GOV trawl is more efficient at sampling demersal sharks than batoids (skates and rays), especially small-sized batoids				

Table A1.21. Spurdog (N/A is indicated where the habitat function is not relevant to the species).

Spurdog / Spiny dogfish (*Squalus acanthias*) [Priority Marine Feature]				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A no evidence of relevance of this function for the species	N/A	N/A	N/A
Nursery	No specific habitat requirements known	Offshore	S. acanthias school by sex and size, rarely seen alone [4,7]. Whether or not there are discrete parturition and nursery areas requires further study; based on historic catches of large numbers of new-born and pregnant S. acanthias in relatively shallow waters (e.g. Bantry Bay and Galway Bay), it has been hypothesised that young moved away from shallow waters after parturition [4] Juveniles are mainly pelagic, and habitat distribution is as in adults [no specific nursery grounds] [7]	Juvenile catches in groundfish surveys allow for preliminary identification of nurseries [1] Juvenile size: <30cm born at length (indicator of primary nursery sites), <48cm secondary nursery sites [1]; ≤40cm TL [4]; Fish <1yr old and <36 cm are considered recruits (US) [7]; neonates ≤26cm [10] In the northeast Atlantic, pups are born in winter, with size at birth about 26-28cm [6]
*Spawning **	No specific habitat requirements known for this function (other than being inshore). Mating habitat not known	Mostly inshore?	Ovoviviparous, internal fertilization; gravid females carry pups for 22-24 months before parturition. Possible parturition sites inshore, based on historic catches of large numbers of new-born and pregnant S. acanthias in relatively shallow waters (e.g. Bantry Bay and Galway Bay) [4] ; in US, birth reported to occur offshore (outer continental shelf, depth 10-400m) [7], but neonate pupping grounds also observed inshore (40m depth, on fine clay and silt sediment) [8] Males and gravid females usually found shallower than non-gravid females; Gravid females have been reported to congregate in enclosed shallow bays to give birth [6]	Spawning period: all year round [1]; Mating probably occurs in late autumn and winter [6,7] Length at maturity 81.4cm (range 69-100cm; 60-70cm males, 75-90cm females) [6] Age at maturity may be ≥10y [7]

Spurdog / Spiny dogfish (*Squalus acanthias*) [Priority Marine Feature]

Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	No specific habitat requirements for this function other than habitat of occurrence (but local topography and hydrology may influence food distribution)	inshore & offshore	Broad dietary range [5]; Feeds on a diversity of prey, ranging from jellyfish, squid, mackerel and herring to a wide array of benthic fishes, shrimps, crabs and even sea cucumbers [6,7] Tidal stages and currents may be important in affecting food distribution (e.g. small pelagic fish in areas of plankton concentration) hence spurdog distribution [7]	N/A
Migratory routes	No specific habitat requirement known	North-South, Inshore-offshore	Spurdog undertake widespread seasonal migrations; latitudinal (north-south) and depth-related (nearshore-offshore) movements apparently correlated with their preferred temperature [6,7]. Tagging experiments showed that populations in the northern North Sea and northwest Scotland made winter migrations to off Norway and summer migrations to Scotland [6]	N/A
Occurrence (aggregations, generic)	No specific requirements known for aggregations (evidence based on presence/ absence only)	inshore (historically) & offshore (currently)	Boreal/Lusitanian species, widespread around the British Isles in waters 15–528 m deep (bottom/beam trawl surveys 1967-2002), but caught infrequently in beam trawl surveys [4]. Worldwide, spiny dogfish favour the temperature range of 7-15°C [7] Tolerates brackish water, often found in enclosed bays and estuaries (incl. sea lochs) [6,9], but not specifically associated to any coastal habitat [2] Strong preference for cooler SST, historically distributed in shallow and deeper waters but increasingly associated with deeper waters over time; strong relationship with colder SST indicates that the marked warming in recent decades relates to the species' decline (modelling of 1902-2013 survey data (pres/abs) in southern North Sea) [3]	Demersal species, forms large foraging schools and schools of large gravid females [6]

References:

1. Ellis et al. 2012	British waters	6. Fishbase (and references therein)	across species range
2. Seitz et al. 2014	--	7. Stehlik 2007	US
3. Sguotti et al. 2016	British waters	8. Sulikowski et al. 2013	US
4. Ellis et al. 2005	British waters	9. Thorburn et al. 2015	UK Loch Etive (tagging)
5. Ellis et al. 1996	NE Atlantic	10. Sagarese et al. 2014	US

Notes:

* Spawning grounds identified for this species as parturition sites (neonate pupping grounds) given its viviparity
- The GOV trawl is more efficient at sampling demersal sharks than batoids (skates and rays), especially small-sized batoids

Table A1.22. Norway lobster (N/A is indicated where the habitat function is not relevant to the species).

Nephrops/Scampi/Langoustine/Norway lobster/Dublin Bay prawn (*Nephrops norvegicus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	- **Adult & juvenile** *N. norvegicus* require muddy sediments in order to **construct their burrows**, and the spatial distribution of these sediments places a major constraint on where the **larvae** are able to settle [1]. - Females form a lower percentage of catches during egg incubation, when they stay in their burrows [authors in 3] indicating refugia is important at this life stage.	Offshore	- Nephrops live in burrows and muddy sediments are essential to this [1]. - Typical env characteristics for adult (and therefore also spawning, refuge, feeding and nursery habitats as all are the same): - muddy substratum [1, 3] - depth range 20-800m [4, 5]	Moulting individuals Mating pairs Females incubating eggs Reproductive season/time of year: Spawning in July in UK waters [4]. Moulting and copulation occur in mature females during May to August. Egg-laying taking place in August and September (Irish Sea), and hatching in April to June of the following year. [11]. The eggs laid around July are carried for about 9 months [4]. Reproductive strategy: Mating occurs when a female moults. The eggs are fertilised and extruded (laid) at the next moult [10]. Females have an annual cycle, although some studies for populations at the northerly part of the species range suggest a biennial cycle, that is one hatch every 2 years [10]. In contrast males do not show a marked reproductive cycle, spermatogenesis occurring throughout the year [11].
Nursery	**Nursery grounds = adult grounds**	Offshore	Juveniles are mobile - though to occur in the same areas as adults are found Adult & juvenile N. norvegicus require muddy sediments in order to construct their burrows, and the spatial distribution of these sediments places a major constraint on where the larvae are able to settle [1].	Juvenile size: carapace length 3-4mm at metamorphosis from larva and settle shortly after (although some may moult 1-2 times more before settling. Grow quickly, attaining around 14mm after 1 year (up to 10 moults). At 11-15mm CL they start appearing in commercial trawls [2]. **All adults and juveniles live in burrows**
Spawning	**Spawning grounds = adult grounds for Nephrops** - Adult Nephrops mate and spawn in their usual burrows in muddy sediments. Females form a lower percentage of catches during egg incubation, when they stay in their burrows [authors in 3] indicating refugia is important at this life stage. '- Eggs are incubated attached to adult females pleopods in burrows in muddy sediments [3] - Pelagic (planktonic) larvae are most	Offshore	- **Pelagic larvae:** the overlap between advective pathway destination and spatial distributions of suitable benthic habitats must be favourable in order for the pelagic larvae to settle and reach maturity [1]. - **Pelagic larvae:** Diel migration with many Zoea in top 40m of water column. Between dusk and dawn this may rise to the top 20m. Larval depth preference usually coincided just below the pycnocline and with light intensity, although occasionally concentrations were found at depth (potentially synchronous hatching) (Hill 1990; Hillis 1975 in [3]) - **Benthic postlarvae:** require the muddy sediments	Adult size at maturity: In the Firth of Clyde (Scotland), estimates of size at onset of sexual maturity varied over small geographic scales (tens of km) and ranged between 21–34 mm carapace length for females and 29–46 mm for males [8]. 50% of females are mature at 23mm CL and almost 100% at 29mm CL [9]. Adult age at maturity: 2-3 years old in the Irish Sea [5]. Egg size individual: 1mm-2mm over the development [authors in 10] Eggs released per animal: 900-6000 [authors in 10]. Allowing for egg losses during incubation, most ovigerous females are expected to produce between 250-2000 pelagic larvae during each breeding season [2]. Eggs sessile/mobile: Sessile (attached to female's pleopods)

Nephrops/Scampi/Langoustine/Norway lobster/Dublin Bay prawn (*Nephrops norvegicus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
	abundant over the adult bed [2] - Benthic post larvae found in muddy sediments as per adults [1, 3].		preferred by adults [3]. - **Benthic postlarvae:** In experiments, mud>muddy sand>sand>gravel substratum preference [3]. - **Benthic postlarvae:** In captivity PL were able to construct small burrows (U-shaped, T-shaped or Y-shaped) although in the wild reside amongst adult burrows (but can build). Chemotactic influence of adult burrows in (authors in [3]).	Larvae and postlarvae - Pelagic larvae: Larvae are most abundant over the adult beds [2]. Larval stage duration: 1-3 months [1], 1-2 months [5]. Larval duration is temperature dependent ~72days at 8°C to ~26 days at 15 6°C [authors in 1] Larvae sessile/mobile: free drifting/swimming until settled but with diel vertical migration in water column [1]. Benthic postlarvae: require burrows as refuge from predatory fish (authors in [3]).
Feeding	**- Adult Nephrops** feed close to their usual burrows in muddy sediments. No known specific EFH for feeding. - **Postlarvae/juveniles**: some evidence they not only burrow for refuge but also to search for food (McIntyre 1973 in [3]). No known specific EFH for feeding.	Offshore	No known specific EFH for feeding.	No known specific EFH for feeding.
Migratory routes	Species does not migrate [6, 7]	N/A	Species does not migrate [6, 7]	Species does not migrate [6, 7]
Occurrence (aggregations, generic)		Offshore	**Adult habitat preferences (general):** - Habitat location: benthic - Tidal strength: Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.) [7] - Substratum: Mud, muddy sand, sandy mud [7] - Wave exposure: Extremely sheltered, Sheltered, Ultra sheltered, Very sheltered [7] - Salinity: full (30-40 psu) [7] - Depth range: 20-800m - Bed temperature: 7°C-13°C (Irish sea), 10°C-15°C (Adriatic). Below 5°C activity may cease [7] - Light intensity: burrowing activity of Nephrops is restricted to an optimum range of light intensity from about 10,000 to 10 m-c (meter/candles) (equivalent to approximately, 10% to 0.001% of natural daylight). Therefore, in shallow waters *Nephrops norvegicus* is active by night and in	**General species info:** Adult size: total body length between 8-24cm usually 10-20cm, typical 18-20cm [4]. Adult max age: 5-10 years, 15 years in exceptional cases [5]. Adult sessile/mobile: Mobile Sampling methods (state life stage): Adult - potting or bottom trawling. Juvenile & larval stages are difficult to catch [5] Other: simulations suggest that the distinct N. norvegicus sites largely rely upon local recruitment of larvae (in the Irish Sea) [1]

Nephrops/Scampi/Langoustine/Norway lobster/Dublin Bay prawn (*Nephrops norvegicus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			deeper water by day, at intermediate depths activity will most likely occur at dusk and dawn (Simpson, 1965 in [7]). At depths greater than 80 m tides exerted a stronger influence on activity than light intensity (Hillis 1971 in [7]).	

References:
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11. Farmer, ASD., 1974.

Notes: None

Table A1.23. European lobster (N/A is indicated where the habitat function is not relevant to the species).

Lobster/European lobster (*Homarus gammarus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	**Juveniles:** shelter preference for rocks & pebbles [1] BUT - location is likely in the same area as adults are found.	Offshore & inshore	Juveniles are Mobile (benthic) Juveniles (stage 7, ~ 8mm CL) prefer stones of >7mm ≤20mm to cohesive muds when conditions are light, when dark they do not show any substratum preference. Related to light stress causing need for shelter [10].	Lobsters (adult) were more active during night-time than during daytime, and there was a tendency for lobsters to reside in more shallow water during night-time versus daytime [9]
Nursery	No known specific nursery areas in the literature HOWEVER, juvenile lobsters (Stage 7, ~8mm CL) known to create burrows in muddy substratum. Also, show a preference for either unsieved cohesive mud, or, stones of >7mm ≤20mm out of a range of sediments offered in lab studies [10]	Offshore & inshore	Juveniles: In an Isle of Man MPA, juvenile lobster abundance was positively associated with habitats dominated by <u>kelp forests or macroalgae</u> [4]. Juveniles: <u>shelter</u> preference for rocks & pebbles [1] Trials in captivity at a lobster hatchery (Padstow UK) showed juvenile lobsters have clear preferences for shelter. Rocks and pebbles were also preferred (to artificial shelters) [1] Early benthic phase (EBP) lobster are rarely but can sometimes be found in intertidal rocky crevice habitats (Johnshaven Scotland). The crevices were several meters deep [18]. This is more of an indication of shelter need than anything else. It is suggested juvenile lobster (<10cm) may inhabit different topography to adults [15]. Juvenile lobsters (Stage 7, ~8mm CL) known to create <u>burrows in muddy substratum</u>. Also, show a preference for either unsieved cohesive mud, or, stones of >7mm ≤20mm out of a range of sediments offered in lab studies [10]	No known/agreed upon specific EFH for nursery in the literature. Juveniles: general behaviour (in laboratory studies) of emerging, collection food, then quickly returning to their shelter [10]. Sampling: Juveniles: prawn/Nephrops creels are a method for sampling juvenile H. gammarus but few are caught in comparison to adult potting methods [10, 19] Little is known about juvenile lobster under 10cm total length as they are rarely found in the wild [Bennet and Howard 1978 in 15].
Spawning	n/a	Offshore	Lobster planktonic larvae display diel vertical migration to and from the neuston (surface film area of water). Densities were low during the day and night but increased at dawn and dusk. The dawn peak, which lasted from sunrise to 4-5 hours later, yielded the majority of larvae [17].	Adult size at maturity: Lobsters from the Firth of Forth (Scotland) had smaller size at the onset of sexual maturity (male = 80 mm carapace length (CL) and female = 79 mm CL) than those from the Hebrides (male = 98 and female = 110 mm CL) [11]. In France (Le Croisic area), 100% female lobster were at functional maturity at Cl 115mm, with 50% mature at around 103-106 mm [12] Adult age at maturity: 6-10 years [5] Reproductive season/time of year: Spawning season July [2] Egg size individual: approx. 1.5mm [5]

Lobster/European lobster (*Homarus gammarus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
				Eggs released per animal: carried per female 13000-15000 [13] Egg duration until hatching: 10-11 months [2]. 3.5-9.5 months in the Irish Sea [14]. Hatching occurs at night [15]. Eggs sessile mobile: sessile, carried on female's pleopods Larvae sessile/mobile: Mobile (free drifting/swimming until settled) but with diel migration in the water column [17] Larval stage duration: Larval duration is 11-35 days where lobsters moult 3 times to reach the fourth stage then settle [Taylor 1975 in 15]. 11-30 days [5]. 20 days at 15°C [16].
Feeding	n/a			No known specific EFH for feeding.
Migratory routes	**N/A.** Homarus gammarus shows no migrations in mark-recapture [7] and ultrasonic tracking [8] studies. "Movements >5 km from all 3 release areas, which comprised **5% of recaptures** after >6 mo., were generally undertaken by larger lobsters and were almost exclusively to the west or southwest, against the general direction of tide- and wind-generated residual water movement in the English Channel" [7].	N/A	N/A Species does not migrate [7, 8]	N/A Species does not migrate [7 ,8]
Occurrence (aggregations, generic)	N/A Lobsters are solitary animals [3].	Offshore	**Adult habitat preferences (general):** - Adult habitat: benthic Depth: Continental shelf between 0 and 150 m depth; usually not deeper than 50 m [2] or 60m [3, 9] - Substratum: hard substrates: rock or hard mud. Nocturnal and territorial, living in holes or crevices [2]. found on rocky substrata, living in holes and excavated tunnels [3]. High capture densities were recoded within rock reef habitat, low capture	**General species info:** Adult size: Maximum total body length about 60 cm (weight 5 or 6 kg), large size specimens usually 23 to 50 cm [2]. Adult sessile/mobile: Mobile (benthic) Sampling methods (state life stage): Adult - potting

Lobster/European lobster (*Homarus gammarus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			densities were recorded in mixed/sand habitat [6]. - Salinity: Full (30-40 psu) [5] - Tidal stream/current/flow: insufficient information [5] - Temperature: In Norwegian waters, activity of adults is correlated with water temperature with declining activity from Sept (water temp 18°C) to a minimum activity in Feb-March (water temp 2°C) and activity resuming from April [9]. Extreme temp limits may be <0°C to ~28°C (authors in 14). But preference range is much narrower [14]. Temp preference ~12°C [19] - Lobsters are more active at night in Norwegian waters [9]. - Lobsters tend to reside in shallower waters in the day and deeper waters at night (Norwegian study) [9].	Other: In Scotland, lobsters have a minimum landing size of 87mm carapace length. There is also a max landing size for females of 156mm CL.

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11. Lizarraga-Cubedo HA., et al., 2009
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15. Richards P., Wickens JF., 1979
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Notes: None

Table A1.24. Brown crab (N/A is indicated where the habitat function is not relevant to the species).

Brown crab/Edible crab (*Cancer pagurus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	Relevant for ovigerous females (spawning habitat)	Offshore	**Ovigerous females**: do not feed, remaining in pits dug in the sediment or under rocks and are unlikely to be caught in a baited pot. As a result, fishing pressure does not affect larval supply (Howard 1982 in [7]). **Ovigerous females**: Observations under laboratory conditions and by divers suggest that the low rate of capture of ovigerous females is likely to be the result of these crabs remaining partially buried in sand or gravel while carrying eggs, and not feeding [Nichols et al 1982 in [2]] Individuals utilised complex artificial reefs in winter as opposed to less heterogeneous environments [11].	
Nursery	Yes	Coastal Inshore Intertidal Shallow subtidal	**Juvenile crabs** preferentially select structurally complex biotopes like maerl beds, seagrass and rock formations, kelp forests or macroalgae in coastal areas to shelter from predation [4, 12]. Boulders were found to be an important habitat structure for juveniles as they enable the sheltering from predation and environmental pressures [13]. As individuals attain greater size, predation risk decreases and habitat associations diffuse [4]. Juveniles have a strong preference for inshore grounds - peak catch rates of individuals <100mm within 20km from the coast in the North Sea [12]. Gower Peninsula and Swansea Bay population comprised of almost exclusively juveniles - males 1–2-year class and females 3-4 years. Juveniles located in rocky substrates at depths of 10-30m [14]. Carapace width relates to depth - shallow waters <25m mean CW is 14cm, 25-55m mean CW is 17cm and >55m CW mean is 18cm [2]. Young can tolerate reduced salinities (<full salinity 30) for extended period [7, 8]. Juveniles can often be found in rock crevices and buried in the sediments under rocks on intertidal rocky shores [K. Smyth pers. obs.]	Juvenile size: Juveniles settled in the intertidal zone remain there until they reach a carapace width (CW) of 6-7 cm which takes about 3 years [1, 2]. Young 5-10 cm CW [7, 8]. Juveniles settle in intertidal zone in late summer/early autumn and remain there for ~3 years before moving to subtidal areas (Regnault, 1994 within [8]. Juvenile stage duration: Very little is known about post-larvae recruitment processes [9]. Age at maturity is minimum 10 years [2].
Feeding	n/a no specific habitat requirements for feeding, other than the habitat where the species occurs	inshore/offshore	**Berried females do not feed - they remain in dug pits in the sediment or under rocks [8].**	

Brown crab/Edible crab (*Cancer pagurus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Spawning	Yes	Offshore	***C. pagurus* females** require a soft substratum of sand or gravel to scoop a hollow in which to lower the abdomen and ensure attachment of the eggs to the pleopods during spawning. She then spends much of the next nine months before hatching buried in the sand and likely not feeding much if at all (Edwards, 1967, and diver observations in [2]) In the North Sea, **berried females** migrate offshore to release larvae and then move back inshore to feed (Nichols et al 1982 in [7]) Comparison of results from larval surveys undertaken in July 1976 , 1993 & 1999 showed that the epicentre of crab spawning (off the English east coast), as perceived by the density of stage I larvae, has remained consistent over the 23 year period, being centred to the south-west of The Dogger Bank approximately 70km offshore [9] In the English Channel, berried females migrate westwards (South Devon) towards suitable soft sediments to spawn in Autumn [2, 6]. This allows residual currents moving east to transport larvae upon spawning [2]. Spawning and larval development in the edible crab are both dependent upon temperature and neither are triggered below 7 or 8°C [9].	Berried females. Larvae distribution Adult size at maturity: CW at maturity 11cm males, 11.5cm females [8]. Age at maturity is minimum 10 years [2]. Reproductive season/time of year: Copulation in spring and summer and occurs shortly after the female has moulted [7, 8]. Egg-bearing females were observed in English Channel catches from January to October but 71% were observed during April, May and June [2]. Fecundity is 0.25 to 3 million eggs per female depending on size of female, but mortality of larvae is high [8]. Eggs are sessile, carried on female's abdomen. Egg duration until hatching: Eggs carried (berried females) for 6-9 months following mating then release larvae in late spring/early summer [7, 8]. Larval stage duration: 1-6 months [7]. The larvae are planktonic for 60-90 days before settling on hard substrates in the intertidal zone [authors in 2]. Larval season/time of year: late spring/early summer [7, 8]. Larvae sessile/mobile: mobile - planktonic until settled
Migratory routes	n/a Evidence of inshore-offshore migrations, but no specific habitat requirements for the migration route itself, other than for habitats at the two ends (spawning offshore, non-spawning adult & juveniles inshore)	inshore-offshore	**Ovigerous females**: In the North Sea, berried females migrate offshore to release larvae and then move back inshore to feed (Nichols et al 1982 in [7]). "**Migrations occur against primary currents within the surrounding region**. The uses of primary currents are **hypothesised to be used within larvae transport** (Sinclair, 1988), with larvae carried back on regional primary currents, providing the opportunity for both localised and long-distance recruitment. Similar migratory behaviours and larval transport has been observed within other areas of the UK (Eaton et al, 2003), with female migrations documented along the Northumbria coast moving from a south to a northern orientation post moult (Edwards, 1979). Similar migrations were observed and documented within populations off the coast of Norway and Sweden (Ungfors et al, 2007)" [all authors can be found in reference 3].	Migrations: In a study in the Orkneys, a number of long-distance migrations were recorded for brown crab, with a number of individuals moving in a westward direction, with two cases of individuals travelling a minimum distance 236 and 258km respectively, with other individuals equally travelling 87– 178km prior to recapture [3]. Suggestion that females exhibit both localised movement patters and long-distance migrations, whereas males are predominantly inshore with little movement [3]. Mark recapture studies have shown tagged females being caught between 0.9-258km from the point of release, and males from 0.1-67km [3].

Brown crab/Edible crab (*Cancer pagurus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Occurrence (aggregations, generic)	N/A Brown crab are solitary animals [7]. Adult crabs do not exhibit any habitat preferences - as individuals attain greater size, predation risk decreases and habitat associations diffuse [4].		Mainly located on sublittoral bedrock on mixed course grounds and offshore in muddy sands - offshore to ~100m [8]. **Adult habitat preferences (general):** - Depth: depths of 6 to 100 m; usually between 6 - 40 m [1]. - Substratum: High capture densities were recorded between habitat boundaries of sand/missed sediment and rocky reef habitat [5]. Wide range on bottoms from sand & gravel to rocky [1]. Catch rates gradually increased from soft to hard substrate trawls, peaking in gravel sediment types [12]. - Salinity: Full (30-40 psu) [8]. Adult Cancer pagurus cannot tolerate salinities of 17 psu or lower; found in salinity preferences between 18-40psu [7, 8]. - Tidal stream/current/flow: Moderately Strong (1-3 knots), Weak (<1 knots) [7]. - Bed temperature: - Wave exposure: Prefer tidal strengths of <1-3 knots in areas of exposed-moderately exposed wave action [8]. - Light intensity: Mainly nocturnal [7].	**General species info**: Adult size: Maximum carapace length 20 cm; width 30 cm. Usually carapace width does not exceed 24 cm [1]. Typically 15cm. Max 25cm carapace width [8]. Size can be related to depth. In less than 25 m of water, males and females have a mean CW of 14 cm. Between 25 and 55 m, males are on average 17 cm CW and females 15.8 cm, over 55 m these sizes increase to 18 cm CW for males and 17 cm CW for females [2]. Adult sessile/mobile: mobile (benthic) Sampling methods (state life stage): Adult: potting

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Notes:
Some evidence that while moulting is necessary to mate, that crabs become berried each year, although moulting has not occurred recently. It seems likely that the presence of sperm in the female spermathecae, from a single impregnation at the previous moult, inhibits moulting and results in successive annual spawning events. This conclusion is supported by the considerable proportion of crabs with well-developed ovaries which had dirty exoskeletons encrusted with epizoites and which had obviously not moulted recently [2]

Table A1.25. Velvet crab (N/A is indicated where the habitat function is not relevant to the species).

Velvet crab/Velvet swimming crab (*Necora puber*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A No evidence in the literature of a specific refuge habitat	n/a	n/a	n/a
Nursery	N/A No evidence in the literature of a specific nursery habitat although larvae have been shown to selectively settle on complex habitats such as pebbles and algae (lab experiments) [4]	inshore	Laboratory experiments indicated that flow conditions set initial patterns of distribution of settlers on substrata of complex structure for N. puber. However, active habitat selection occurred (towards algae and pebbles) and the settlers were actively modifying the distribution patterns set by the hydrodynamics. Ontogenetic shift in habitat use occurred early in the juvenile phase and first juvenile instars were less habitat specific than megalopae [4].	
Spawning	N/A No evidence in the literature of a specific spawning habitat	inshore	In the water column, most of the megalopae larvae of N. puber were collected at the surface and their abundance appears to be regulated by the tidal cycle, as megalopae were more abundant during flood than ebb tides. This behaviour could produce a net shoreward transport of megalopae [4].	Adult size at maturity: estimated at approximately 45 mm LCW for males and 40 mm LCW for females of N. puber (Norman 1989 in [6]) Egg size Individual: 490-500 µm [2]. 380 to 504 µm [summary of various studies quoted by [6]] Larvae sessile/mobile: mobile (drifting) - despite decapod postlarvae generally being strong swimmers, tidal stream velocities commonly exceed their swimming capabilities [2]. during the postlarval stage, flow plays a major role in dispersal [2] Larval stage duration: 1-2 months [2]. Larval season/time of year: zoeal release was estimated to occur from April to June [6]
Feeding	N/A No evidence in the literature of a specific feeding habitat.	inshore	N. puber is an omnivorous species and brown algae appears to be an important constituent of N. puber diets throughout the year, irrespective of zonation and crabs' sex [5]	n/a
Migratory routes	N/A No evidence in the literature of migration in *Necora puber*	n/a	n/a	n/a

Velvet crab/Velvet swimming crab (*Necora puber*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Occurrence (aggregations, generic)	N/A Species is solitary [2]	inshore	**Adult habitat preferences (general):** - Depth: up to 70m [2] lower intertidal down to depths of approximately 20 m, although individuals have been recorded from depths of 70 m [4, 6]. Although found in the intertidal zone, N. puber is restricted exclusively to the lower tidal mark, where it is abundant [4]. - Substratum: heavily habitat dependant, with capture densities restricted to rocky reef habitat only [1] ALSO Bedrock; Large to very large boulders; Pebbles; Gravel / shingle; Rockpools; Under boulders [2]. Found on stony and rock substrata intertidally and in shallow water, most abundant on moderately sheltered shores [3]. - Salinity: Full (30-40 psu); or Variable (18-40 psu) [2] - Tidal stream/current/flow: not known [2] - Seasonality: capture density highly seasonal, with high densities coinciding with the contraction of the winter fishery [1].	**General species info:** Adult size: up to 10cm carapace width [7] Adult max age: 6-10 years [2] Reproductive season/time of year: May [2]. Relatively high numbers of ovigerous females were found from January to June in Plymouth Sound UK [6]. Adult sessile/mobile: mobile - can crawl and swim Sampling methods (state life stage): Potting is the most common (commercial) method for adults and often larger N. puber can deter smaller ones from entering the pots creating some bias in size of individuals caught [various authors in 6]. Other: Adult dispersal potential is thought to be up to 100m [2] (seems a bit low!)
References: 1. Coleman MT., Rodrigues E., 2017. Succorfish Report 2. Barnes M., Undated 2 3. Wilson E., 2008b 4. May L., 2015. 5. Norman CP., Jones MB., 1992 6. Norman CP., Jones MB., 1993 7. Wildlife Trusts., Undated 1				
Notes: None				

Table A1.26. Queen scallop (N/A is indicated where the habitat function is not relevant to the species).

Queen scallop (*Aequipecten opercularis*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	n/a	n/a	n/a	n/a
Nursery	Yes	Offshore	Larvae drift in the water column for 3-4 weeks before settling as spat and attaching to the substratum [6]. Movement of juvenile *A. opercularis* from a settlement substratum to nursery sites may be facilitated by their high surface area-to-volume ratio and thin, light shells making transport by currents easy. Spat can also use byssal drifting to move [2]. Young *A. opercularis* remain attached by the byssus. They detach from their byssal thread, usually upon attaining 1.5-2.0 cm but retain the ability to secrete a byssus until at least 6.5 cm long [3]. In Scotland, pristine live maerl grounds fulfil nursery area requirements for commercial populations of *A. opercularis* as well as other invertebrates. The complex architecture of maerl beds attracts high densities of these juvenile invertebrates, which use pristine live maerl grounds as nursery areas in preference to adjacent substrata [2]. Juvenile *A. opercularis* attach primarily to various algae, including Laminaria saccharina and *Desmarestia aculeata*, but also to bryozoans, hydroids, gravel, clean shell and general benthic epifauna however little is known about how they subsequently recruit onto adult habitats (authors in [2]).	Juvenile size: no information Juvenile season/time of year: Recruitment season: High densities of juveniles are found in October to December [2]. Juveniles sessile/mobile: X
Spawning	N/A: There is no movement to a particular spawning habitat evident in the literature.	Offshore	*A. opercularis* are broadcast spawners, a decrease in density is likely to rapidly reduce fertilisation efficiency [7]. Spawning occurs over/on scallop beds.	Adult age at maturity: 1 year [1]. Reproductive season/time of year: June to October [1]. Spawning season: In UK waters scallops spawn in August/September (Minchin 1992 in [2]) Egg size individual:68 µm [1]. Eggs sessile mobile: drift in water after spawning Larval stage duration: 11-30 days [1] Larval season/time of year: Larval settlement period - June to July and September to October [1]. Larvae sessile/mobile: Embryos develop into free-swimming trocophore larvae, succeeded by the bivalve veliger, resembling a miniature clam [4].
Feeding	N/A:	Offshore	Scallops filter feed on their scallop beds. There is no movement to a particular feeding habitat evident in the literature.	
Migratory routes	n/a No specific	Offshore	Spat have been observed to use post metamorphic byssal drifting and are active swimmers, with adult populations shown to migrate large distances (authors in [2]).	

Queen scallop (*Aequipecten opercularis*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
	habitats known			
Occurrence (aggregations, generic)		Offshore	**Adult habitat preferences (general):** - Depth: lower eulittoral zone down to 100m [1], up to 400m [4]. - Substratum: gravel / shingle, Coarse clean sand, Fine clean sand, Muddy sand, Gravelly sand [1]. sand or gravel, often in high densities. It also occurs amongst beds of horse mussels *Modiolus modiolus* [3, 6]. - Salinity: Full (30-40 psu) [1]. - Temperature: Temperate, preferred 12°C, 7 - 15.9, mean 10.1 [4] - Geomorphology: Physiographic preferences: Open coast; Offshore seabed; Strait / sound; Sealoch; Ria / Voe; Estuary; Enclosed coast / Embayment [1].	**General species info:** Adult size: 9cm [3] to 11cm [4] in diameter. Adult max age: 6-10 years [1]. Adult sessile/mobile: mobile (benthic), can free-swim [1]. Scallops are considered generally as sedentary animals but are capable of moving small distances through water propulsion, created by the rapid opening and closing of the valve [5].

References:
1. Barnes M., Undated 1. *Aequipecten opercularis*.
2. Kamenos NA., et al., 2004
3. Carter MC., 2008a
4. May L., 2015
5. Scot.gov., Undated
6. Orkney Fisheries., Undated.
7. Vause BJ., et al., 2007.

Notes: -

Table A1.27. King scallop (N/A is indicated where the habitat function is not relevant to the species).

King Scallop (*Pecten maximus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	Offshore	Adult P. maximus live partially buried in the substratum [1] but this is not considered as refugia by any literature.	Adult *P. maximus* are free-swimming. They spend most of the time resting in self-dug depressions. Most active during the day [5]. Prefers areas of clean firm sand, fine or sandy gravel and may occasionally be found on muddy sand [3]. This is not considered as refugia in any literature
Nursery	Yes?	Offshore	Juvenile P. maximus attach primarily to various algae, including Laminaria saccharina and Desmarestia aculeata, but also to bryozoans, hydroids, gravel, clean shell and general benthic epifauna however little is known about how they subsequently recruit onto adult habitats (authors in [2]). Temperature has a strong influence on recruitment, particularly by affecting adult sexual maturation (various authors in [6]). Spat (post-settlement larvae) salinity preference: [[Laing 2002 in [3]] found that the growth rate of spat grown at 13-21 °C was significantly lower at 26 psu than at 28-30 psu [3].	Like larvae, post-larval stages (spat) can also byssus drift or create a special drifting thread which aid in distribution [1].
Spawning	N/A: There is no movement to a particular spawning habitat evident in the literature.	Offshore	Spawning occurs over/on scallop beds. There is no movement to a particular spawning habitat evident in the literature.	Adult age at maturity: Reach first maturity at 2 years and full maturity at 3-5 years [3]. Reproductive maturity 2-3 years [1]. Pecten maximus are hermaphrodite and, therefore, there is no separate male and female size range or size at maturity [1]. Reproductive season/time of year: Generally April or May to September (can be bi-modal e.g. in early season then again in late season [3]. In general, mature scallops spawn over the summer months from April or May to September. However, many factors including food availability, genetics, age, temperature etc, mean different locations/populations have different times of spawning [summary of various authors in [1]]. Eggs released per animal: >1,000,000 eggs released (15 - 21 million oocytes per emission for a three-year-old) [3]. Eggs sessile mobile: eggs drift in water column after release Larval stage duration: 11-30 days [3]. Dispersal potential in Pecten maximus is high given that the length of the pelagic larval stage exceeds one month [1] Larvae sessile/mobile: Mobile (drifting). Larval dispersal potential: Greater than 10 km [3].

King Scallop (*Pecten maximus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Feeding	N/A: There is no movement to a particular feeding habitat evident	Offshore	Scallops filter feed on their scallop beds.	
Migratory routes	N/A: Scallops are mobile but within a localised area and no migrations are indicated by available literature	N/A	N/A	N/A
Occurrence (aggregations, generic)		Offshore	**Adult habitat preferences (general):** - Depth: 10-110m [1]. from the extreme low tide down to 250 m [5]. Lower Infralittoral, Upper Circalittoral, Lower Circalittoral [1]. - Substratum: Coarse clean sand, Muddy sand, Sandy mud, Gravel/shingle, Fine clean sand [1]. Prefers areas of clean firm sand, fine or sandy gravel and may occasionally be found on muddy sand [3]. - Salinity: Full (30-40 psu) [1] - Tidal stream/current/flow: Moderately Strong (1-3 knots), Weak (<1 knot) [1] - Wave exposure: Exposed, Sheltered, Very Sheltered, Extremely Sheltered [1]	General species info: Adult size: Maximum 17 cm in diameter; common 10 to 15 cm [3]. Adult sessile/mobile: Benthic. Limited mobility: Scallops are considered generally as sedentary animals but are capable of moving small distances through water propulsion, created by the rapid opening and closing of the valve [4]. Swimming is generally limited to escape reactions [1].

References:
1. Marshall C., Wilson E., Undated
2. Kamenos NA., et al., 2004
3. Marshall C., Wilson E., 2008
4. May L., 2015
5. FAO, Undated 4
6. Le Pennec M., et al., 2003.
7. Orkney Fisheries., Undated.

Notes: -

Table A1.28. Common cockle (N/A is indicated where the habitat function is not relevant to the species).

Common cockle (*Cerastoderma edule*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A	Intertidal	N/A - sessile species, lives, feeds, spawns, nursery, all in the same habitat	N/A - sessile species, lives, feeds, spawns, nursery, all in the same habitat
Nursery	N/A - sessile species, lives, feeds, spawns, nursery, all in the same habitat	Intertidal	Settlement and recruitment are sporadic and varies with geographic location, year, season, reproductive condition of the adults and climatic variation [1]. Juveniles may be transported by currents until 2mm in size and high densities of juveniles may be swept away by winter storms resulting in subsequent patterns of adult distribution (Olaffsson et al., 1994 in [1]). Newly settled spat and juveniles are capable of bysso-pelagic dispersal. Therefore, water flow rates probably affect their distribution and dispersal [1].	Newly settled spat and juveniles <4.8 mm [1] Juvenile size: Juvenile cockle (pediveliger) at ca. 270 µm. The juveniles reach ca. 600-700 µm after about 3 weeks, and by 3 months are ca. 0.75-1.5 mm long [1]. Juvenile season/time of year: Larval settlement period May-September but varies [2].
Spawning	N/A - sessile species, lives, feeds, spawns, nursery, all in the same habitat	Intertidal	eggs released into water column. Both eggs and sperm rapidly lose viability becoming unable to fertilise after 4-8h [6]. Larvae are free drifting until settled. Dispersal modelling has predicted that there is a rapid dilution of sperm and is significant egg fertilisation will only occur close to male cockles [6].	Adult size at maturity: Male size at maturity: 15-20mm [1]. 14-18mm [4]. Shell length at first maturity was estimated as 18.6 mm [5]. Adult age at maturity: Adults first mature and spawn in their second summer, at about 18 months and 15-20 mm in length, however, large cockles (>15 mm) may mature in their first year suggesting that size and maturity are linked [1]. Reproductive season/time of year: Spawning generally occurs between March - August in the UK followed by peak spatfall between May and September, however the exact dates vary between sites in the UK and Europe [1, 2]. Spawning (in Strangford Lough Northern Ireland) occurs over a 1–2-month period during the summer, followed by a brief period of heavy recruitment [4]. A rise in water temperature (possibly to above 13°C) is a possible trigger for spawning [2] Egg size individual: 75 µm [2]. Larvae size: Typical bivalve veliger at ca. 80 µm. It metamorphoses into a juvenile cockle (pediveliger) at ca. 270 µm after about 3 -5 weeks [1].
Feeding	N/A - sessile species, lives, feeds, spawns, nursery, all in the same habitat	Intertidal	Several authors (in [1]) have suggested that lack of tidal flow may exclude C. edule from an area (it is a filter feeder) due to reduced food availability.	

Common cockle (*Cerastoderma edule*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Migratory routes	N/A	N/A	N/A	N/A
Occurrence (aggregations, generic)		Intertidal	**Adult habitat preferences (general):** - Depth: high water to sublittoral fringe but most abundant at mid-tidal level [1, 2, 3]. More exposure results in slower growth rates [1]. - Substratum: Coarse clean sand, Fine clean sand, Muddy gravel, Muddy sand, Sandy mud [1] - Salinity: Usually live at salinities between 15 - 35 psu but can tolerate salinities as low as 10 psu [1] - Tidal strength/current/flow: Preferred tidal strength: Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Very Weak (negligible), Weak < 1 knot (<0.5 m/sec.) [1]. But unable to colonise still water conditions [2]. Coffen-Smout & Rees 1999 [in 1] reported that cockles could be distributed by flood and ebb tides, but especially flood tides (by rolling around the surface) up to 0.45 m on neap tides or between 94 m and 164 m on spring tides. - Bed temperature: Preferred temperature: 7.6 - 13.7, mean 10.4°C [3] - Wave exposure: sheltered [2] - Disturbance: cockle beds are easily washed away by storms [1] - Light intensity: not known however species is intertidal so is light exposed regularly. - Climate change: (Wilson 1993 in [1]) concluded that *C. edule* was probably tolerant of a long-term temperature rise of 2°C associated with climate change. **Adult cockle habitat:** Found in shallow coastal and estuary areas, in the subtidal zone, seagrass meadows *Zostera noltii* and *Cymodocea nodosa* in sand flats, also found on intertidal muddy sand flats [3]. Active suspension feeders, living in the top few centimetres of sediment. They are easily dislodged by storms and cockle beds can be washed away during winter gales [2]. Inhabits the surface of sediments to a max depth of 5 cm [1]. Found on clean sand, muddy sand, mud or muddy gravel. Often abundant in estuaries and sheltered bays, and population densities of 10,000 per m^2 have been recorded. Increased water flow rate is likely to increase the grain size of the sediment. *C. edule* prefers muddy-sand to sandy-mud substrates. Decreasing water flow rate may increase siltation and favour muddy substrates that are unsuitable [1].	General species info: Adult size: Max length: 5.6 cm, common length: 3.5 cm [3]. Adult max age: In Strangford Lough (Northern Ireland) cockles rarely live more than 3 years, however, can live in other areas for up to 14 years (Cole 1956 in [4]) Adult sessile/mobile: Benthic. Largely sessile - cockle beds - HOWEVER, cockles can burrow into and emerge from sediments, and can move across the substratum to increase distance between neighbours (Richardson et al 1993b in [1]) Sampling methods (state life stage): Adult *C. edule* are commercially harvested by tractor dredge or hydraulic dredge. Sometimes they are hand-raked. Other: highest juvenile growth rates at low density (160-200 adults /m^2) whereas adult growth rates were only depressed at the highest density examined (2000 adults/m^2) [1].

Common cockle (*Cerastoderma edule*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
References: 1. Tyler-Walters H., 2007a 2. Tyler L., Undated 2. 3. Sealifebase., Undated 4 4. May L., 2015 5. Maia F., et al., 2021 6. André C., Lindegarth M., 1995				
Notes: - Growth rates decrease with increasing tidal height, probably due to decreased immersion times and hence reduced food availability at higher shore heights. The highest growth rates in *Cerastoderma edule* were reported in continuously immersed populations [1]. - Gamete viability is short and fertilization is reduced to 50% in 2 hours and that no fertilization was observed after 4 -8 hrs [1]. - *Cerastoderma* grows rapidly in its first year after settlement. It first reproduces during its second year and the resumption of rapid growth is generally delayed until spawning has been completed. In subsequent years, growth becomes progressively slower (in Strangford Lough N. Ireland) [4]. - In *Cerastoderma*, mortality is heavy in all age classes and relatively few cockles survive beyond their third year. Early reproduction following a period of very rapid growth is therefore probably the optimal strategy for this species (study from Strangford Lough N. Ireland) [4]. - Growth in *Cerastoderma* is maximal in the first spring-summer following spatfall and it is only during their second summer that the majority of cockles first become sexually mature and spawn [various authors in [4])].				

Table A1.29. Dog cockle (N/A is indicated where the habitat function is not relevant to the species).

Dog cockle (*Glycymeris glycymeris*)				
Habitat function:	*Relevance to the species*	*Inshore/offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A (endofauna - refuge function not relevant)	N/A	N/A	N/A
Nursery	n/a no information	n/a no information	n/a no information	n/a no information
Spawning	n/a no information	n/a no information	n/a no information	n/a no information
Feeding	n/a no information	n/a no information	n/a no information	n/a no information
Migratory routes	N/A	N/A	N/A	N/A
Occurrence (aggregations, generic)		inshore / offshore	- Shallow burrower in fine shell gravels or sandy/muddy gravels [1] - The dog cockle lives just below the surface of gravelly and sandy seabed [3] - *G. glycymeris* is part of the endofauna, living below the surface of the sediment [4] **Adult habitat preferences (general):** - Depth: 5-100m [1, 2] - Substratum: fine shell gravels or sandy/muddy gravels or sandy bottoms [1, 3] - Salinity: ~34 psu [4] - Tidal stream/current/flow: "strong" bottom currents [4] (no value given) - Location: Found around the Shetland Islands, the Orkneys, the south and west coasts of Britain, Northern Ireland and Blacksod Bay, Ireland. Appears to be uncommon in the North Sea [1].	**General species info:** Adult size: up to 6.5cm [1]. 3-10cm [2]. Adult max age: average lifespan ~25 years [4] but up to 100 years [2, 3]. Sampling methods (state life stage): Bottom trawling has been used to sample adult *G. glycymeris* for scientific study [4]. Other: Not closely related to the common cockle (*Cerastoderma edule*) despite their similar common names.

References:
1. Carter MC., 2008b
2. Tyler L., Undated
3. Wildlife Trusts., Undated 2
4. May L., 2015

Notes: In general, the literature is lacking information on *Glycymeris glycymeris*

Table A1.30. Surf clam (N/A is indicated where the habitat function is not relevant to the species).

Surf clam (*Spisula solida*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	Noted as being a burrowing species [1, 3, 4], however, no evidence from the literature of a specific refuge habitat for *Spisula solida*.	Offshore	n/a	n/a
Nursery	n/a no information	Offshore	n/a	n/a
Spawning	n/a no information	Offshore	n/a	Adult size at maturity: around 2.5cm [4]. Adult age at maturity: *S. solida* reaches sexual maturity during its first year, which is a function of age, not of size [4]. Reproductive season/time of year: Feb-June [4] (In Portuguese waters, seawater temperature is a primary environmental factor determining reproductive development and spawning of *S. solida*; reproductive activity occurred during low temperatures. The spawning period began in late winter as a consequent response to the increase in seawater temperature and extended through spring. By June, most of the population was spent [5])
Feeding	n/a no information	Offshore	n/a	n/a
Migratory routes	N/A Recorded as a non-migratory species [1]	n/a	n/a	n/a
Occurrence (aggregations, generic)		Offshore	*S. solida* is a "substrate specialist" with clear preferences for sediment with grain sizes between around 2 to 4 phi (medium-fine to very fine sand) [3] *S. solida* showed a preference for grain sizes that ranged between 2-3 mm (Kristensen 1996 in [1]). *S. solida* mainly prefers coarse-grained sediments: the higher the median grain size, the higher the relative occurrence (up to 20%). The species furthermore also tends to prefer the presence of a low mud content (0-20%). The species does not occur in sediments with a mud content exceeding 20% [7]. **Adult habitat preferences (general):**	**General species info:** Adult size: up to 5cm length [4] Adult max age: 6-10 years [1]. Adult sessile/mobile: Benthic. Sessile, however – *S. solida* can be moved along by water movement (bed load transport) along the sea bottom to another position on the seabed [4]. Sampling methods (state life stage): Commercial dredges (box or hydraulic) have been used for sampling *S. solida* in commercial Irish fisheries for this species [6]

Surf clam (*Spisula solida*)

Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			- Depth: most likely at 5-15m (max 50m). Lower Eulittoral; Sublittoral Fringe; Upper Infralittoral; Lower Infralittoral [1] - Substratum: Mixed Pebbles; Gravel / shingle; Fine clean sand [1] *S. solida* is a "substrate specialist" with clear preferences for sediment with grain sizes between around 2 to 4 phi (medium-fine to very fine sand) [3]. Burrowing bivalve occasionally found at low water but more usually in the sublittoral. It prefers sandy beds with continually moving water and avoids mud and stagnant water [4]. - Salinity: full salinity [1] - Tidal stream/current/flow: Strong (3-6 knots); Moderately Strong (1-3 knots); Weak (<1 knots) [1] - Bed temperature: around 10°C [2] - Wave exposure: Very Exposed; Exposed; Moderately Exposed; Sheltered [1] - Light intensity: NOT KNOWN [1] - Other: Burrow dwelling [1]	

References:
1. Tyler L., Undated 1
2. Sealifebase., Undated 3
3. Alexander RR., et al., 1993
4. May L., 2015*
5. Joaquim S., et al., 2008
6. Fahy E., et al., 2003
7. WoRMS., Undated 1

Notes: In general, the literature is lacking information on *Spisula solida*
* Please note: the biology of *Spisula solida* is poorly known and MARLIN has used information on closely related species where appropriate

Table A1.31. Razor clam (N/A is indicated where the habitat function is not relevant to the species).

Razor clam/Razor shell (*Ensis ensis,* but review also covers closely related *E. siliqua* and *E. arcuatus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	N/A No evidence of a specific refuge habitat	n/a	n/a	n/a
Nursery	N/A No evidence of a specific nursery habitat	n/a	*Ensis ensis* larvae: after about a month they settle out of the zooplankton and burrow into the substrate [3]	Info on larval and juvenile stages is poor [1, 2].
Spawning	N/A No evidence of a specific spawning habitat	n/a	*Ensis ensis* larvae are pelagic and form part of the zooplankton [3].	Adult size at maturity: >10cm in males [1]. Adult age at maturity: 3 years [1, 3]. Reproductive season/time of year: Breeding occurs during the summer but larval settlement is not successful every year, and recruitment of juveniles is irregular [1]. In *Ensis ensis* reproduction takes place in the spring [3]. Larval stage duration: 1-2 months [1]. Info on larval and juvenile stages is poor [1, 2].
Feeding	N/A No evidence of a specific feeding habitat.	n/a	n/a	n/a
Migratory routes	N/A No evidence of migration in *Ensis ensis*	n/a	n/a	n/a
Occurrence (aggregations, generic)	There are three species of razor shell in Britain and Ireland: *Ensis ensis, Ensis siliqua* and *Ensis arcuatus*. Difficult to distinguish between species in juvenile individuals [1]	inshore	Benthic burrowing species (adults/juveniles) **Adult habitat preferences (general):** - Depth: Up to 60m. Common at 10m (*Ensis ensis*) [1]. E. siliqua has a restricted depth range of c. 20 m., but the other species (*E. arctuatus* and *E. ensis*) may be found in small numbers in deeper water [4] - Substratum: Fine, sometimes muddy, sand from extreme low water to the shallow sublittoral [1] - *Ensis arcuatus* inhabits a coarser grade of substratum than *E. siliqua* and *E. ensis* [4] - *E. siliqua* and *E. ensis* are restricted to sands of a fairly fine grade in which the percentages both of silt and of coarse particles are fairly low. *E. ensis* shows a greater tolerance of silt and of coarse particles than E. siliqua. E. siliqua occurs in sands of fairly fine grade, in which particles between 0.21 and 0-0.313 mm are the most common. *E. ensis* occurs in soils of a grade similar to that in which E. siliqua is found. *E. arcuatus* inhabits sands of a coarser grade, but has a wide tolerance of different grades, so that its distribution overlaps that of the other two species [4]. - Anaerobic/hypoxic sands (sand black below the surface) were avoided	**General species info:** Adult size: *Ensis ensis*: 130mm max *Ensis siliqua*: 200mm max *Ensis arcuatus*: 150mm max [1]. Adult max age: 10 years [3]. Sampling methods (state life stage): Adults and juveniles - Hand collect (scuba) or hydraulic dredge [1]. *Ensis* spp have been collected for scientific purposes by scoop-sampler or anchor-dredge (for offshore sampling) or by digging/hand collection (intertidal) [4].

Razor clam/Razor shell (*Ensis ensis,* but review also covers closely related *E. siliqua* and *E. arcuatus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			by all three species. Where seaweed or other organic matter gets buried in and incorporated in the sand, resulting in a black layer containing ferrous sulphide, *Ensis* spp are also absent. [4]. (ALSO SEE "Habitat adults" below) - Salinity: Full salinity [1, 4] - Tidal stream/current/flow: Tidal strength: Moderately Strong (1-3 knots). Weak (<1 knot). In moderate wave exposure *Ensis ensis* may be replaced by the larger *Ensis siliqua* [2] - Wave exposure: mild to moderate [4]. On wave-exposed beaches, *Ensis siliqua* may be the only lamellibranch present, but in more sheltered areas the smaller *Ensis ensis* may be found [4]. -Other: Very sensitive to minor perturbations (for instance increased/decreased temperature and higher to lower salinity - salt is used as a method of dislodging them from their burrows) [1]. Habitat adults: - Razor shells live in deep, vertical, permanent burrows in fine, sometimes muddy, sand from extreme low water to the shallow sublittoral. *Ensis arcuatus* lives in coarser sediment than *either Ensis ensis* or *Ensis siliqua* [1] - *E. siliqua* can withstand a moderate degree of wave-exposure, but is absent from fully exposed beaches. *E. arcuatus* and *E. ensis* are restricted to more sheltered beaches. Tolerance of wave-action seems to depend on the stability of the beach sediments [4] - *Ensis* is found burrowing in sand at low-water mark of spring tides, and also occurs in shallow water offshore. On the beach, it burrows nearly vertically in the sand by means of a powerful foot, but it does not seem to possess a permanent burrow [4].	

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4. May L., 2015

Notes: None

Table A1.32. Common whelk (N/A is indicated where the habitat function is not relevant to the species).

Common whelk (*Buccinum undatum*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	n/a	n/a	n/a	n/a
Nursery	n/a	n/a	Juveniles are mobile [2].	The whelk larval stage takes place entirely within the egg mass capsule, with fully formed juvenile whelks emerging from the capsule during Feb and March [2].
Spawning	Yes Egg deposition appears to be associated to specific substratum	inshore/offshore	Egg mass laid on seabed, attached to rocks, stones, shells [3]. Whelks lack a planktonic larval phase [4] Females gather in groups to deposit eggs in a communal mass of egg capsules where veligers develop and metamorphose inside and later hatch out as young individual [6]. Spongy mass of up to 2000-3000 egg capsules [7, 1] which is contributed to by several females and cemented onto a solid structure [5] such as rocks, stones or shells [3].	Adult size/age at maturity: In Whitstable and the River Crouch (UK) Whelks do not commence spawning until they are almost 2 inches in length which equates to 2-3 years old [2]. The size at maturity for whelks sampled in Welsh waters between 2013 and 2014 varied over small spatial scales. Sites 8-10 miles apart had populations of whelks with very different length frequencies and size at maturity [5]. Reproductive season/time of year: Egg laying around the British Isles varies but typically between Oct-March [9]. Copulation usually takes place between three weeks and two months before the females spawn and release the eggs (Kideys et al 1993 in [4]). Fertilisation takes place in late autumn and whelk typically commence spawning soon after in November when the temperature has dropped below about 9°C [1]. Eggs released per animal: 1000-2000 [7, 8], but females often lay communally into the egg mass [6]. Of the 1000 eggs in a capsule, only about 10 undergo full development, the rest providing nutrition. Female whelk may store sperm for up to eight weeks until the eggs are ready to fertilise (Fretter & Grahamn in [5]). Snails hatch from these capsules fully developed [8]. The whelk larval stage takes place entirely within the egg mass capsule (November to March), with fully formed juvenile whelks emerging from the capsule during Feb and March [2]. With typical spawning in November - indicating a larval duration of 4-6 months.
Feeding	n/a	n/a	Does not appear to be a specific feeding habitat BUT East coast fishermen (UK) report the occurrence of large numbers of whelk along mussel and cockle "trails" which are concentrations of young mussel and cockles on which the whelks are presumed to feed. On the south coast the same happens on scallop beds [2]. The greatest proportion of whelks found with food in their stomachs were from sandy bottoms [1] (Note: Canadian study)	Feeding: In the laboratory, feeding is greatest in the spring and lower in winter, ceasing in extremely low temperatures [specific temp not stated] and during the warmest summer months [also not stated] [2].

Common whelk (*Buccinum undatum*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			Keen chemosensory abilities enable them to detect carrion from within a 111 - 585 m2 area (Himmelman 1988 in [5]).	
Migratory routes	N/A (Whelks that were marked and recaptured, showed no major migrations [2])	N/A	N/A Species does not migrate [2]	N/A Species does not migrate [2]
Occurrence (aggregations, generic)		inshore/offshore	Whelks living on soft sea bottoms spend time completely buried with just the siphon protruding [1]. **Adult habitat preferences (general):** - Depth: Occasionally intertidal but mainly subtidal down to 1200 m [3]. Occasionally found intertidally but this is often fatal. Considered a subtidal only species [2]. - Substratum: Variety of bed types, though normally found on bottoms of mud mixed with sand and shells [2]. Muddy sand, gravel and also rock [3]. - Salinity: Full, but occasionally present in brackish waters [3]. Estuarine whelks tend to be smaller than those from the open sea [2]. - Tidal stream/current/flow: Whelks normal move against the flow of water [2]. - Temperature: Considered to be a boreal species [5] with UK waters being the southern limit of the range [2]. 7 - 11.8, mean 9.8°C [6].	**General species info:** Adult size: 10cm long & 6cm wide [3]. In Scotland, whelks measuring up to 6 inches have been found, although size varies considerably with location [2]. Adult max age: >10 years [2]. Adult sessile/mobile: sessile - egg mass is cemented onto a solid structure [5] but may be dislodged by disturbance events. Sampling methods (state life stage): Baited pots is the common commercial fishing method in the UK. BUT for scientific studies whelks are attracted to a baited pot and will travel some distance to feed. Whelk are often caught in large numbers in baited pots, even when sampling the area by other methods may have only shown few whelks [2]. Dredging for whelk takes place commercially in Holland [5]. Other: EU-wide Minimum Landing Size of 4.5cm.

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Notes: -

Table A1.33. Dog whelk (N/A is indicated where the habitat function is not relevant to the species).

Dog whelk (*Nucella lapillus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	No specific refuge habitat requirements, other than the usual rocky shores that *N. lapillus* lives on. Adults thought to move less than 30m in their lifetime [1].	Intertidal	Various authors summarised in [3] suggest that in icy conditions dog whelks take refuge together in crevices and overhangs, or by moving below the low water mark. Known to seek shelter in rock crevices or under algal growth during adverse weather [4]. Lives on rocky shores where it can be found in rock crevices, overhangs etc, however is also found on exposed flat rock surfaces [1, 3, 4].	n/a
Nursery	No specific nursery habitat requirements, other than the usual rocky shores that N. lapillus lives on. Adults thought to move less than 30m in their lifetime [1].	Intertidal	The larval stages take place inside the egg capsule and fully formed juveniles emerge after around 4 months [3]. Juveniles develop below the mean water stand and as they mature, move upward along the littoral zone [4]. Juveniles are mobile but relatively sedentary as per adults	Juvenile size: ~10mm within a year of life [1]. Juvenile stage duration: ~2 years [1]. Juvenile season/time of year: Breeding occurs throughout the year but is maximal in spring and autumn [1] hence juvenile season follows this same pattern.
Spawning	No specific spawning habitat requirements evident, other than the usual rocky shores that N. lapillus lives on. Adults thought to move less than 30m in their lifetime [1].	Intertidal	Dog whelks form spawning aggregations, often 30 or more individuals in pool or cleft in a rock surface [3]. Sessile eggs attached to rocks. Nucella lapillus lacks a dispersive pelagic larval phase [1].	Adult size at maturity: ~20mm [3]. Adult age at maturity: 2-3 years [3]. Reproductive season/time of year: In spring, at temperatures above 9°C capsule production is initiated [3]. Breeding occurs throughout the year but is maximal in spring and autumn [1]. Females can store sperm for up to 3 months [3]. Egg size individual: Individual egg capsules 9-10mm tall by 3-4mm across [3]. Eggs released per animal: 20-100 capsules per female per season, with each capsule containing 600 eggs 94% of which are "feed" eggs for the remaining 6% that develop and hatch [3]. Egg duration until hatching: around 4 months in temperate latitudes (the entire larval stage takes place in the egg capsule and when "hatching" happens, fully formed juveniles emerge [1, 3]. Larval stage duration: 4 months [1]. Larval season/time of year: Breeding occurs throughout the year but is maximal in spring and autumn [1] hence larval season follows this same pattern.
Feeding	No specific feeding habitat requirements, other than the usual rocky shores that N.	Intertidal	n/a	n/a

Dog whelk (*Nucella lapillus*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
	lapillus lives on. Adults thought to move less than 30m in their lifetime [1].			
Migratory routes	Non migratory [2].	N/A	N/A	N/A
Occurrence (aggregations, generic)	On the Yorkshire coast dog whelks form 3 aggregations: - summer aggregations of mixed age groups on exposed surface rock, which are though to offer group protection from water pressure and predators. - winter aggregations of mixed age groups, though to protect against dislodgement, - pre-breeding aggregations of mostly adult whelks in early spring and occasionally summer. Animals in these groups do not feed [3]. Dog whelks form spawning aggregations, often 30 or more individuals in pool or cleft in a rock surface [3].	Intertidal	Mobile but sedentary, do not move more than 329mm per day [1]. **Adult habitat preferences (general):** - Depth: 0-40m [2, 4]. Intertidal [1]. - Substratum: Rocky shores [3]. Rocky shores (natural or artificial [1]. This species avoids areas of low salinity and with dense algal growth, as well as sandy or muddy areas [4]. - Salinity: Full, dog whelks are unable to feed or breed under brackish conditions [3]. they can survive to 10 ppt but cannot breed [3]. Newly hatched are less tolerant of ow salinities than adults No values given [3]. 18-40 psu [1]. - Tidal stream/current/flow: Moderately Strong 1 to 3 knots (0.5-1.5 m/sec.), Strong 3 to 6 knots (1.5-3 m/sec.), Very Strong > 6 knots (>3 m/sec.), Weak < 1 knot (<0.5 m/sec.) [1]. - Temperature: Ice is a limiting factor in distribution of dog whelks [3]. So, 0°C. Feeding stops below 3°C and below 5°C movement slows. Above 22°C feeding, movement etc also slow and stop [various authors in 3]. *Nucella lapillus* is widely distributed approximately between the 19 °C summer isotherm in the south and the -1 °C winter isotherm in the north (Moore, 1936) in [1], except in areas of reduced salinity such as the Baltic Sea [3]. - Wave exposure: Wave exposed to sheltered rocky shores from the mid shore downward [1]. - Turbidity: *Nucella lapillus* is found in turbid estuaries such as The Severn Estuary therefore turbidity is not through to be an issue, although silt deposits may affect distribution in such areas [1].	General species info: Adult size: 42mm [4]. Usually up to 3 cm in height by 2 cm broad but may reach up to 6 cm in height [3]. Adult max age: 6 years [4], 5-10 years [1]. 6-10 years [2] Sampling methods (state life stage): all stages best hand collected from intertidal rocky shores

Dog whelk (***Nucella lapillus***)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
References: 1. Tyler-Walters H., 2007b 2. Tyler L., Undated 4 3. Crothers JH., 1985 4. Sealifebase., Undated 7				
Notes: None				

Table A1.34. Long finned squid (N/A is indicated where the habitat function is not relevant to the species).

Long finned squid (***Loligo forbesii (*****also *****L. forbesi***** in the literature*)**)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
Refugia	No evidence in literature of that this species uses refugia.	Both inshore and offshore		
Nursery	No evidence in literature of specific nursery areas for this species. However, it is mentioned that they spawn inshore [10].	inshore	No evidence in literature of specific nursery areas for this species. However, it is mentioned that they spawn inshore [10].	Juvenile season/time of year: Recruitment throughout the summer months, but the population recruitment index showed the peak to be in October in most years, with an additional smaller peak in April [1]. Most recruitment occurs in September and October in Irish and Scottish waters [1]. In Scottish waters there are two pulses of recruitment, in April and in July–September [5].
Spawning	n/a no specific habitat requirements known	inshore (offshore?)	Coleoid cephalopods have traditionally been considered to exhibit semelparous life with a short life-span and rapid early growth being followed by maturation, spawning and death. Death follows spawning in squid. However, multiple and intermittent spawning my occur before death [1]. Although spawning grounds have not yet been documented it has been indicated from the analysis of spatial patterns in fishery data that L. forbesi move from the West Coast of Scotland into the North Sea to spawn [11] & (Pierce et al., 2001 in [3]). In Scottish waters, the winter breeding cohort appears to spawn in inshore waters and some evidence suggests that the spawning grounds of the summer breeders are also inshore [9].	Adult size at maturity: Males approximately 40% of population mature at small size (180-200 mm mantle length), and the remainder mature at >250 mm mantle length. Females 150mm ML [4]. Mean size at maturity was 205mm dorsal mantle length (DML) for males and 192mm DML for females [8]. Adult age at maturity: 30-325 days in males [4]. In Irish waters, mean estimated age of mature males and females was 317 and 312 days respectively, with the minimum age at maturity found to be 236 and 241 days [6]. In Irish and Scottish waters the critical period for reproduction (spawning) occurs between November and February [1]. In Scotland small numbers of mature animals present for much of the year, but peak in spawning animals (in commercially exploited population) occurs between Dec & Jan [1]. There is an extended breeding season, from January to May with a peak in February–March, and

Long finned squid (*Loligo forbesii (*also *L. forbesi* in the literature*)*)				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
				two pulses of recruitment, in April and in July–September [5]. In Scottish waters spawning occurred during December to March and the peak spawning period occurred in February [8]. Egg duration until hatching: In the laboratory, hatching occurred between 50 and 70 days at temperatures of 8-10'C, however in low temperatures hatching my take up to 6 months [1]. Larval season/time of year: Squid hatched in the spring grew faster than those hatched in the autumn and winter [7].
Feeding	n/a no specific habitat requirements known	inshore / offshore	No evidence in literature of specific feeding area requirements for this species. However, it is mentioned that they feed offshore [10].	n/a
Migratory routes	n/a no specific habitat requirements known	inshore-offshore	No evidence of migrations in Scottish waters between East and West coasts, although inshore-offshore movements occur during the life-cycle of the cohort that recruits in autumn (winter breeders) [9]. No specific migration is noted in the literature for this species. However, it is thought to show ontogenic downslope migration from inshore feeding grounds to offshore feeding grounds [10]. There is limited evidence in one study [10] that this species may migrate into the Irish Sea in the late summer, possibly to stay in warmer waters. Note: this based mostly on speculation.	n/a
Occurrence (aggregations, generic)		Both inshore and offshore	Mobile species, use full water column. Found over sandy and muddy bottoms. During the day they aggregate near the bottom and at night they disperse in the water column [2]. **Adult habitat preferences (general):** - Depth: 10-400m [2]. 63-431m [5]. - Substratum: Found over sandy and muddy bottoms [2]. - Salinity: full - Temperature: preferred 24°C [5]. Seems too high considering distribution extends to north of Scotland. Squid were usually markedly more abundant in warmer than in colder areas [11]. Augustyn 1990 (in [11]) suggests that the majority of loliginids prefer a temperature range	In Scottish waters, there is limited evidence for the existence of a separate offshore population, breeding earlier than the main coastal population and with wide interannual fluctuations in abundance. However, improved information on distribution is required to test this hypothesis [5]. General species info: Adult size: 90cm [2] Adult max age: 1 year and dies after spawning [5]. *L. forbesi* is usually the only squid species caught in Scottish waters (Pierce et al 1998 in [9])

Long finned squid (*Loligo forbesii* (also *L. forbesi* in the literature))				
Habitat function:	*Relevance to the species*	*Inshore/ offshore*	*Environmental/habitat requirements*	*Species indicators*
			of 12 - 20°C. - Other: *L. forbesi* in Scottish waters can be found in higher abundance and bigger sizes at middle longitudes, intermediate depths and, depending on seasons, on water with approximately 11°C [9].	

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Notes: None

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