MaRePo Project

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Kelp

Appendix 1. Kelp species recorded on the English coast.

Species	Taxanomic Order	Annual or perennial	Depth Range	Distribution (Worldwide)	Distribution (England)	Native or invasive	Exposure	Tidal strength	Substratum	Age at maturity	Life span	References
Tangle or cuvie *Laminaria hyperborea*	Laminariales	Perennial	1-36 m	Arctic south to northern Portugal	Most coasts but scarce on south east coast due to lack of suitable substrata.	Native	Exposed, Moderately exposed, Very exposed	Moderately Strong 1 to 3 knots to Weak < 1 knot	Artificial (man-made), Bedrock, Cobbles, Large to very large boulders, Pebbles	two to six years	18 to 20 years	Kain (1979); Tyler-Walters (2007); Burrows *et al*. (2014).
Oarweed *Laminaria digitata*	Laminariales	Perennial	+1-20 m	Arctic waters to the Canary Islands	Most coasts. Scarce along east coast of England, particularly between Ouse and Thames estuaries, due to turbidity and lack of hard substrata.	Native	Moderately exposed or strong currents	Strong	Bedrock or other suitable hard substrata	18-20 months	six to ten years	Hill (2008); Burrows *et al*. (2014).
Sugar kelp *Saccharina latissima*	Laminariales	Perennial	Less than 30 m	Arctic to northern Portugal	All coasts	Native	Sheltered conditions	Unknown	Bedrock and unstable substrata such as rocks and boulders, loose-lying sand (in	15-20 months	two to five years	White and Marshall (2007); Burrows *et al*. (2014).

Species	Taxanomic Order	Annual or perennial	Depth Range	Distribution (Worldwide)	Distribution (England)	Native or invasive	Exposure	Tidal strength	Substratum	Age at maturity	Life span	References
									calm conditions).			
Golden kelp *Laminaria ochroleuca*	Laminariales	Perennial	LWS to shallow subtidal (down to 25 m in some locations)	NE Atlantic, Mediterranean, SE Atlantic	South west only	Native	Unknown	Unknown	Unknown	Unknown	Unknown	Smirthwaite (2007)
Dabberlocks *Alaria esculenta*	Laminariales	Perennial	0-8 m	North Atlantic from Novaya Zemlya to Iceland and south to Brittany in the east and from the shores of Greenland to the Bering Strait in the west. It also occurs in the Bering Sea and Sea of Japan in the North Pacific	south west, west coast and north east coast south to Flamborough Head.	Native	Exposed, Extremely exposed, Very exposed	Strong 3 to 6 knots to Weak < 1 knot	Artificial (man-made), Bedrock, Cobbles, Large to very large boulders, Pebbles, Small boulders	8 - 14 months	5-10 years	Tyler-Walters (2008)
Wakame *Undaria pinnatifida*	Laminariales	Annual	Low intertidal to 18 m	Parts of the northeast and southwest Atlantic, southwest and east Pacific, and the Tasman Sea	Hamble (Solent), Isle of Wight, Torquay, Plymouth and Jersey.	Invasive	Unknown	Unknown	Artificial (man-made)	Unknown	Unknown	Saito, 1975; Oakley (2007); Epstein and Smale (2017b).
Furbelows *Saccorhiza polyschides*	Tilopteridales	Annual	0-35 m	Ghana northwards along the European	all coasts, but absent from Northumberland to the Solent	Native	Extremely sheltered, Moderately exposed,	Very weak (negligible) to Very	Bedrock, Cobbles, Large to very large	8-14 months	<1 year	White (2008)

Species	Taxanomic Order	Annual or perennial	Depth Range	Distribution (Worldwide)	Distribution (England)	Native or invasive	Exposure	Tidal strength	Substratum	Age at maturity	Life span	References
				coastline, to Norway and the Eastern Mediterranean			Sheltered, Ultra sheltered, Very sheltered	string (> 6 knots)	boulders, Pebbles, Small boulders			

Appendix 2. The 25 Kelp forest biotopes identified by de Bettignies (2021a) and their corresponding EUNIS, JNCC and 1997 Biotope codes. White rows represent *L. hyperborea* and *S. Latissima* habitats.

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
Alaria esculenta on exposed sublittoral fringe bedrock	A3.111	IR.HIR.KFaR.Ala	IR.EIR.KFaR.Ala	
Alaria esculenta, *Mytilus edulis* and coralline crusts on very exposed sublittoral fringe bedrock	A3.1111	IR.HIR.KFaR.Ala.Myt	IR.EIR.KFaR.Ala.Myt	
Alaria esculenta and *Laminaria digitata* on exposed sublittoral fringe bedrock	A3.1112	IR.HIR.KFaR.Ala.Ldig	IR.EIR.KFaR.Ala.Ldig	

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
Alaria esculenta forest with dense anemones and crustose sponges on extremely exposed infralittoral bedrock	A3.112	IR.HIR.KFaR.AlaAnCrSp	IR.EIR.KFaR.AlaAnSC	
Laminaria hyperborea forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed infralittoral rock	A3.113	IR.HIR.KFaR.LhypFa	IR.EIR.KFaR.LhypFa	Stamp *et al.*, 2020
Laminaria hyperborea forest with dense foliose red seaweeds on exposed upper infralittoral rock	A3.1151	IR.HIR.KFaR.LhypR.Ft	IR.EIR.KFaR.LhypR.Ft	Stamp, 2015b

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
Mixed *Laminaria hyperborea* and *Laminaria ochroleuca* forest on exposed infralittoral rock	A3.1153	IR.HIR.KFaR.LhypR.Loch	IR.EIR.KFaR.LhypR.Loch	Stamp, 2015e
Saccorhiza polyschides and other opportunistic kelps on disturbed upper infralittoral rock	A3.121	IR.HIR.KSed.Sac	IR.MIR.SedK.Sac	
Saccharina latissima and/or *Saccorhiza polyschides* on exposed infralittoral rock	A3.122	IR.HIR.KSed.LsacSac	IR.EIR.KFaR.LsacSac	Stamp *et al.*, 2022b
Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on	A3.125	IR.HIR.KSed.XKScrR	IR.MIR.SedK.XKScrR	Stamp *et al.*, 2022e

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
scoured or sand-covered infralittoral rock				
Laminaria digitata on moderately exposed sublittoral fringe rock	A3.211	IR.MIR.KR.Ldig	IR.MIR.KR.Ldig	
Laminaria digitata on moderately exposed sublittoral fringe bedrock	A3.2111	IR.MIR.KR.Ldig.Ldig	IR.MIR.KR.Ldig.Ldig	
Laminaria digitata and under-boulder fauna on sublittoral fringe boulders	A3.2112	IR.MIR.KR.Ldig.Bo	IR.MIR.KR.Ldig.Ldig.Bo	
Laminaria hyperborea forest, foliose red seaweeds and a diverse fauna on tide-swept upper infralittoral rock	A3.2121	IR.MIR.KR.LhypT.Ft	IR.MIR.KR.LhypT.Ft	Stamp and Williams, 2021

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
Laminaria hyperborea forest and foliose red seaweeds on tide-swept upper infralittoral mixed substrata	A3.2131	IR.MIR.KR.LhypTX.Ft	IR.MIR.KR.Lhyp.TFt	Stamp, 2015d
Laminaria hyperborea forest and foliose red seaweeds on moderately exposed upper infralittoral rock	A3.2141	IR.MIR.KR.Lhyp.Ft	IR.MIR.KR.Lhyp.Ft	Stamp, 2015c
Grazed Laminaria hyperborea forest with coralline crusts on upper infralittoral rock	A3.2143	IR.MIR.KR.Lhyp.GzFt	IR.MIR.GzK.LhypGz.Ft	Stamp and Hiscock, 2015
Laminaria digitata, ascidians and bryozoans on	A3.221	IR.MIR.KT.LdigT	IR.MIR.KR.Ldig.T	

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
tide-swept sublittoral fringe rock				
Mixed kelp with foliose red seaweeds, sponges and ascidians on sheltered tide-swept infralittoral rock	A3.222	IR.MIR.KT.XKT	-	Stamp *et al.*, 2021
Mixed Laminaria hyperborea and Laminaria ochroleuca forest on moderately exposed or sheltered infralittoral rock	A3.311	IR.LIR.K.LhypLoch	IR.MIR.KR.Lhyp.Loch	Stamp *et al.*, 2022d
Mixed *Laminaria hyperborea* and *Saccharina latissima* forest on sheltered upper	A3.3121	IR.LIR.K.LhypSlat.Ft (2022) IR.LIR.K.LhypLsac.Ft (2015; 2004)	IR.SIR.K.LhypLsac.Ft	Stamp *et al.*, 2022c

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
infralittoral rock				
Grazed, mixed *Laminaria hyperborea* and *Saccharina latissima* on sheltered infralittoral rock	A3.3123	IR.LIR.K.LhypSlat.Gz (2022) IR.LIR.K.LhypLsac.Gz (2015; 2004)	-	Stamp *et al.*, 2015a
Saccharina latissima and *Laminaria digitata* on sheltered sublittoral fringe rock	A3.3131	IR.LIR.K.Slat.Ldig (2022) IR.LIR.K.Lsac.Ldig (2015; 2004)	IR.SIR.K.Lsac.Ldig	Jasper *et al.*, 2022a
Saccharina latissima forest on very sheltered upper infralittoral rock	A3.3132	IR.LIR.K.Slat.Ft (2022) IR.LIR.K.Lsac.Ft (2015; 2004)	IR.SIR.K.Lsac.Ft	Jasper *et al.*, 2022b
Saccharina latissima with *Psammechinus miliaris* and/or *Modiolus modiolus* on	A5.523	SS.SMp.KSwSS.SlatMxVS (2022) SS.SMp.KSwSS.LsacMxVS (2015; 2004)	-	Stamp *et al.*, 2022a

Biotope	EUNIS	JNCC (2004, 2015, 2022)	1997 Biotope	Further reading
variable salinity infralittoral sediment				

Appendix 3. Pressures for which kelp species are moderately or highly sensitive (Adapted from the Marine Life Information Network (MarLIN) sensitivity assessments: Tyler-Walters, 2007; White and Marshall, 2007; Smirthwaite, 2007; Tyler-Walters, 2008; White, 2008; Oakley, 2007; Hill, 2008).

Species	Pressure	Sensitivity
Tangle or cuvie *Laminaria hyperborea*	Substratum loss	Medium
	Displacement	Medium
	Desiccation	Medium
	Increase in emergence regime	Medium
	Increase in water flow rate	Medium
	Increase in temperature	Medium
	Increase in wave exposure	Medium
	Increase in turbidity	Medium
	Abrasion and physical disturbance	Medium
	Increase in salinity	Medium
	Changes in nutrient levels	Medium
	Extraction of this species	Medium
Oarweed *Laminaria digitata*	Substratum loss	High
	Displacement	Medium
	Introduction of non-native species	Medium
Sugar kelp *Saccharina latissima*	Substratum loss	Medium
	Smothering	Medium
	Desiccation	Medium
	Increase in wave exposure	Medium
	Increase in salinity	Medium
Golden kelp *Laminaria ochroleuca*	No sensitivity assessment	
Dabberlocks *Alaria esculenta*	Substratum loss	Medium
	Displacement	Medium
	Increase in temperature	Medium
	Increase in wave exposure	Medium
	Increase in salinity	Medium

Species	Pressure	Sensitivity
	Extraction of other species	Medium
Wakame *Undaria pinnatifida*	No sensitivity assessment	
Furbelows *Saccorhiza polyschides*	Substratum loss	Medium
	Increase in salinity	Medium
	Increase in emergence regime	Medium

Appendix 4. Pressures for which kelp forest habitats (*L. hyperborea* and *S. latissima* kelp forest habitats only) are moderately or highly sensitive (Adapted from the Marine Life Information Network (MarLIN) sensitivity assessments: Jasper *et al.,* 2022a and b; Stamp, 2015 a, b, c, d and e; Stamp *et al.,* 2022 a, b, c, d and e; Stamp and Hiscock, 2015; Stamp *et al.,* 2020; Stamp and Williams, 2021; Stamp *et al.,* 2021).

Pressure	A3.113	A3.11151	A3.11153	A3.1222	A3.1225	A3.2121	A3.2131	A3.2141	A3.2143	A3.222	A3.311	A3.3121	A3.3123	A3.3131	A3.3132	A5.523
Organic enrichment	Low	Low	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Medium	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Low
Temperature decrease	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Medium	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive
Increase in temperature	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Not sensitive	Medium	Medium	Low	Low	Medium
Increase in salinity	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Medium
Decrease in salinity	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Not sensitive	Not sensitive	Medium
Emergence regime changes	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Pressure	A3.113	A3.11151	A3.11153	A3.122	A3.125	A3.2121	A3.2131	A3.2141	A3.2143	A3.222	A3.311	A3.3121	A3.3123	A3.3131	A3.3132	A5.523
Physical loss (to land or freshwater habitat)	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
Physical change (to another seabed type)	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
Physical change (to another sediment type)	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	High
Habitat structure changes - removal of substratum (extraction)	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Medium	Medium	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Medium
Abrasion /disturbance of	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Medium

Pressure	A3.113	A3.11151	A3.11153	A3.1222	A3.1225	A3.2121	A3.2131	A3.2141	A3.2143	A3.222	A3.311	A3.3121	A3.3123	A3.3131	A3.3132	A5.523
the surface of the substratum or seabed																
Penetration or disturbance of the substratum subsurface	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Not relevant	Medium
Changes in suspended solids (water clarity)	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Medium
Smothering and siltation rate changes (heavy)	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Medium	Medium	Low	Medium
Introduction of light or shading	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High	High	Medium

Pressure	A3.113	A3.11151	A3.11153	A3.122	A3.125	A3.2121	A3.2131	A3.2141	A3.2143	A3.222	A3.311	A3.3121	A3.3123	A3.3131	A3.3132	A5.523
Introduction or spread of invasive non-indigenous species	High	High	High	Low	Low	High	High	High	High	High	High	High	High	High	High	High
Removal of target species	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Medium	Medium	Medium	Medium	Medium	Not relevant
Removal of non-target species	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Medium	Medium
Global warming (extreme)	High	Not assessed	Not assessed	High	Not assessed	High	High	Not assessed	Not assessed	High	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	High
Global warming (high)	High	Not assessed	Not assessed	High	Not assessed	High	High	Not assessed	Not assessed	High	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Medium
Global warming (middle)	Medium	Not assessed	Not assessed	Medium	Not assessed	Medium	Medium	Not assessed	Not assessed	Medium	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Medium
Marine heatwaves (high)	High	Not assessed	Not assessed	High	Not assessed	High	High	Not assessed	Not assessed	High	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	High

Pressure	A3.113	A3.11151	A3.11153	A3.1222	A3.1225	A3.2121	A3.2131	A3.2141	A3.2143	A3.2222	A3.311	A3.31121	A3.31123	A3.3131	A3.3132	A5.523
Marine heatwaves (middle)	Medium	Not assessed	Not assessed	High	Not assessed	Medium	Medium	Not assessed	Not assessed	High	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Medium
Sea level rise (extreme)	Medium	Not assessed	Not assessed	Medium	Not assessed	Medium	Medium	Not assessed	Not assessed	Medium	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Medium
Ocean acidification (high)	Not sensitive	Not assessed	Not assessed	Not sensitive	Not assessed	Not sensitive	Not sensitive	Not assessed	Not assessed	Not sensitive	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Medium

Appendix 5. Data sources for records of *L. hyperborea* on the NBN Gateway accessed 14/10/2022 (data with no location or date information were removed).

Data rights holder	Recording schemes
Joint Nature Conservation Committee	Marine Nature Conservation Review (MNCR) and associated benthic marine data held and managed by JNCC
Kent Wildlife Trust	Biological survey of the intertidal chalk reefs between Folkestone Warren and Kingsdown, Kent 2009-2011
	Kent Wildlife Trust Shoresearch Intertidal Survey 2004 onwards
Marine Biological Association	2009 The Marine Biological Association of the UK (MBA) Wembury Bioblitz Survey - Version 3.0
	2017-2018 North Devon Coast Area of Outstanding Natural Beauty (AONB) North Devon Species Census
	DASSH Data Archive Centre expert sightings records
	DASSH Data Archive Centre volunteer survey data
	DASSH Data Archive Centre volunteer sightings records
Marine Biological Association, and Biological Records Centre	Verified marine records from Indicia-based surveys
Merseyside BioBank	Merseyside BioBank (unverified)
National Trust	National Trust Species Records
Natural England	Marine Nature Conservation Review (MNCR) and associated benthic marine data held and managed by English Nature
	Natural England Marine Monitoring surveys
People Power Science	The Rock Pool Project database - intertidal species records from rocky shore habitats - from February 2019
Porcupine Natural History Society	Porcupine Marine Natural History Society Dataset
Seasearch	Seasearch Marine Surveys in England
The Wildlife Trusts	Marine Data from The Wildlife Trusts (TWT) Dive Team; 2014-2018
Yorkshire Naturalists' Union	Yorkshire Naturalists Union Marine and Coastal Section Records
Unknown	Collection Specimens
Environmental Records Information Centre North East	ERIC NE Combined dataset to 2017

Appendix 6. Data sources for records of *S. Latissima* on the NBN Gateway accessed 20/10/2022 (data with no location or date information were removed).

Data rights holder	Recording schemes
Joint Nature Conservation Committee	Marine Nature Conservation Review (MNCR) and associated benthic marine data held and managed by JNCC
Kent Wildlife Trust	Biological survey of the intertidal chalk reefs between Folkestone Warren and Kingsdown, Kent 2009-2011
	Kent Wildlife Trust Shoresearch Intertidal Survey 2004 onwards
Marine Biological Association	2009 The Marine Biological Association of the UK (MBA) Wembury Bioblitz Survey - Version 3.0
	2017-2018 North Devon Coast Area of Outstanding Natural Beauty (AONB) North Devon Species Census
	DASSH Data Archive Centre expert sightings records
	DASSH Data Archive Centre volunteer survey data
	DASSH Data Archive Centre volunteer sightings records
	DASSH Data Archive Centre Academic Surveys
	1984 Farnham and Bishop St Mawes Fal Estuary Cornwall Maerl dive transect survey
	Marine Recorder Snapshot extract of surveys entered by Sussex Wildlife Trust
Marine Biological Association, and Biological Records Centre	Verified marine records from Indicia-based surveys
Merseyside BioBank	Merseyside BioBank (unverified)
National Trust	National Trust Species Records
Natural England	Marine Nature Conservation Review (MNCR) and associated benthic marine data held and managed by English Nature
	Natural England Marine Monitoring surveys
People Power Science	The Rock Pool Project database - intertidal species records from rocky shore habitats - from February 2019

Data rights holder	Recording schemes
Porcupine Natural History Society	Porcupine Marine Natural History Society Dataset
Seasearch	Seasearch Marine Surveys in England
The Wildlife Trusts	Marine Data from The Wildlife Trusts (TWT) Dive Team; 2014-2018
	Yorkshire Wildlife Trust Shoresearch
Yorkshire Naturalists' Union	Yorkshire Naturalists Union Marine and Coastal Section Records
Unknown	Collection Specimens
Environmental Records Information Centre North East	ERIC NE Combined dataset to 2017
Newcastle University and Biological Records Centre	Capturing our Coast (CoCoast) marine citizen science project - data verified via iRecord
North Devon AONB	2017 North Devon Area of Outstanding Natural Beauty (AONB) Combe Martin Devon Bioblitz
Isle of Wight Local Records Centre	Isle of Wight Notable Species

Appendix 7. Number of records and modelled potential restoration area per marine plan area (km^2).

	Laminaria hyperborea				*Saccharina latissima*			
	Current	Historic	Potential Model 1	Potential Model 2	Current	Historic	Potential Model 1	Potential Model 2
North East inshore	591	417	57.53	393.08	170	115	0	0.28
North East offshore	0	0	0	0	0	0	0	0
East inshore	74	21	2.16	5.41	113	31	0	0
East offshore	0	0	0	0	0	0	0	0
South East inshore	5	3	2.56	0	38	26	0	0
South inshore	200	232	0	344.59	314	325	0.09	0.58
South offshore	0	0	0	0	0	1	0	0
South West inshore	3629	1241	22.02	524.51	14176	755	0.04	1.65
South West offshore	0	0	0	0	0	0	0	0

	Laminaria hyperborea				*Saccharina latissima*			
North West	8	6	0	0.12	5	8	0	0

Maerl

Appendix 8 Environmental predictor data sources included in the maerl predictive habitat models.

Environmental Predictor	Source / Description	Licensing
Bathymetry	DEFRA & EA Geomatics: EA recently updated the one and six second Digital Elevation Models from the most recent ascii data provided by the United Kingdom Hydrographic Office (UKHO) which were provided to Natural England.	Derived in part from material obtained from the UK Hydrographic Office with the permission of the Controller of Her Majesty's Stationary Office and UK Hydrographic Office, under License for Natural England.
Slope	Calculated by Natural England using bathymetry, in R	As for bathymetry
Aspect	Calculated by Natural England using bathymetry, in R	As for bathymetry
Suspended inorganic particulate matter (winter and summer)	Freely available online predictors from the CEFAS online portal, created for the North-west European continental shelf quantitative sediment analysis (Mitchell, Aldridge and Diesing 2019). Derived from data downloaded from Copernicus online portal (http://marine.copernicus.eu/).	Open Government License
Current speed	Modelled by CEFAS: Data to calculate these were taken from a number of sources, the bathymetric data were downloaded from EMODnet bathymetry (http://www.emodnetbathymetry.eu/).	Contains public sector information licensed under the Open Government license v3.0.

Environmental Predictor	Source / Description	Licensing
Orbital waves at the seafloor	Modelled by CEFAS: Data to calculate these were taken from a number of sources, the bathymetric data were downloaded from EMODnet bathymetry (http://www.emodnetbathymetry.eu/).	Contains public sector information licensed under the Open Government license v3.0.
Kinetic wave energy at the seabed (KEC) in the Atlantic Sea (Celtic and North Sea)	Freely available from EMODnet. Expressed as Kinetic Energy (KE) (where KE = 1/2 UWP^2, where UWP is the peak value of water particle velocity on the seabed during the passage of the wave). https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/2a2659c4-ce1b-4feb-81cf-a2bcbc362a3f https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/2a2659c4-ce1b-4feb-81cf-a2bcbc362a3f	Created for the EMODnet Seabed Habitats initiative, financed by the European Union under Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund. (www.emodnet-seabedhabitats.eu)
Average Photosynthetic Active Radiation (PAR) at the seabed, Europe wide	Freely available from EMODnet: Expressed as moles of light per square meter per day (mol.phot.$m^{-2}.d^{-1}$). NOTE, this used data only from 2005 - 2009, but was updated in 2019. https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/90669dac-a9cf-4e25-94ae-96e8c5e70005	EMODnet Seabed Habitats initiative – as above
Fraction of light reaching the seabed Europe wide	Freely available from EMODnet: Expressed as mol.phot.$m^{-2}.d^{-1}$. http://gis.ices.dk/geonetwork/srv/eng/catalog.search#/metadata/90669dac-a9cf-4e25-94ae-96e8c5e70005	EMODnet Seabed Habitats initiative – as above

Native oyster

Appendix 9 Fauna and flora supported by oyster reefs

Species	Taxanomic Order	Reproductive frequency	Depth Range	Distribution (Worldwide)	Distribution (England)	Native or invasive	Exposure	Tidal strength	Substratum	Age at maturity	Life span	References
Native Oyster	*Ostreida*	Annual protractive	0-80m	Norwegian Sea south through the North Sea down to the Iberian Peninsula and the Atlantic coast of Morocco. Found in the Mediterranean Sea and extends into the Black Sea.	Widely distributed. Main stocks are in the south-east and Thames estuary, the Solent, the River Fal, and Lough Foyle. Less common on the east and north-east coasts.	Native	Exposed, Extremely sheltered, Moderately exposed, Sheltered, Very sheltered	Very Weak (negligible), Weak < 1 knot	Bedrock, Cobbles, Gravel / shingle, Large to very large boulders, Mud, Muddy gravel, Muddy sand, Pebbles, Small boulders	3 years	5-10 years	Perry et al. (2017).
Native oyster beds			0-20m	Pan-European, including			Extremely sheltered	Very Weak (negligibl	Mixed coarse substrates,			Perry *et al.* (2020);

Species	Taxanomic Order	Reproductive frequency	Depth Range	Distribution (Worldwide)	Distribution (England)	Native or invasive	Exposure	Tidal strength	Substratum	Age at maturity	Life span	References
			Typically less than 10m but have been found at depths up to 80m	the northeast Atlantic from the south of Norway through to the Mediterranean Sea, as far as the Black Sea.			, Sheltered, Very sheltered	e), Weak < 1 knot	shell material in particular but also Cobbles, Gravel / shingle, Large to very large boulders, Mixed, Pebbles, Sandy gravel, Sandy mud, Small boulders			Preston *et al.* (2020)

(Khaled, Guillou et al. 2021)

Appendix 10 Sensitivity assessment of *Ostrea edulis and O. edulis* beds carried out by Perry *et al.* (2017) and Perry *et al.* (2020).

Pressure	*Ostrea edulis* Sensitivity	*Ostrea edulis* beds Sensitivity
Temperature decrease (local)	Medium	Medium
Salinity decrease (local)	Medium	Medium
Physical loss (to land or freshwater habitat)	High	High
Physical change (to another seabed type)	High	High
Habitat structure changes - removal of substratum (extraction)	High	High
Abrasion/disturbance of the surface of the substratum or seabed	High	High
Penetration or disturbance of the substratum subsurface	High	High
Changes in suspended solids (water clarity)	High	Not Sensitive
Smothering and siltation rate changes (light)	High	High
Smothering and siltation rate changes (heavy)	High	High
Genetic modification and translocation of indigenous species	No Evidence	High
Introduction or spread of invasive non-indigenous species	High	High
Introduction of microbial pathogens	High	High
Removal of target species	High	High
Removal of non-target species	High	High

Appendix 11 Data sources for current and historic mapping of Ostrea edulis.

Data sourced from:	Recording scheme
EA WP4 Project	Cornwall County Council (1897). Report of the Technical Instruction Committee for the year 1896. J. Lander, Helston
	Eyton, T.C (1858). A history of the oyster and the oyster fisheries. London.
	Kent and Essex sea fisheries committee. Report on the sea fisheries and fishing industries of the Thames estuary (Waterlow Bros. and Layton Ltd., London) p 251.
	ROYAL COM. TO INQUIRE INTO SEA FISHERIES OF UNITED KINGDOM REPORT, APPENDIX; MINUTES OF EVIDENCE, INDEX 1866
	Philpots, J.R (1891). Oysters and all about them. John Richardson and Co., London.
	1876 (345) Select Committee to inquire into Reasons for Scarcity of Oysters and Effect of Measures adopted after Report of Royal Com. on Sea Fisheries, 1866. Report, Proceedings, Minutes of Evidence, Appendix, Index
	Inspector of Sea Fisheries (England and Wales) Eighth Annual Report, 1893
	Inspector of Sea Fisheries (England and Wales) Sixth Annual Report, 1891.
	Buckland FT and Walpole S 1879. Commissions for Sea Fisheries on the Sea Fisheries of England and Wales. London, HMSO.
	Heape, W (1887). Notes on the fishing industry of Plymouth. JMBA 1 (1), 45-95.
	The history of the generation and ordering of green oysters, commonly called Colchester oysters. The history of the Royal Society of London, ed Sprat T (Samuel Chapman, London), 3rd Edition Ed, pp 307-319.
	The harvest of the sea (John Murray, London) p 519.
	The Oyster and Oyster-Culture' in Report of Commisioner of fish and fisheries (p683-747)
	Select Committee on British Channel Fisheries (1833). Report, minutes of evidence and appendix. House of Commons, London.
	Sea Fisheries (England and Wales) Ninth Annual Report of the Inspectors for 1894
	Inspector of Sea Fisheries (England and Wales) Fifth Annual Report, 1890.
	Inspector of Sea Fisheries (England and Wales) Seventh Annual Report, 1892
	Inspector of Sea Fisheries (England and Wales) Tenth Annual Report, 1895
	Dodd G 1856. The Food of London. Longman, Brown, Green and Longmans.

Data sourced from:	Recording scheme
	The North British Review (1867). The North British Review, March and June 1867. Volume XLVI, American Edition. Leonard Scott, New York.
	The deterioration of oyster and trawl fisheries of England: Its cause and remedy (Elliot Stock, Paternoster Row, London) p 128.
	Fal Oysters, Orton 1924
	Faversham Oyster Fishery through 11 centuries, by Patricia Hyde and Duncan Harrington
	Lancashire and Western Sea Fisheries District Nautical Chart
	Historical nautical charts
	Collard, A.O (1902). The oyster and dredgers of Whitstable. Joseph Collard, London.
	The Herne Bay, Hampton and Reculber Oyster Fishery Company (1866). Evidence taken on oath in the Committee of the House of Lords April 19 and 20, 1866. Royal Exchange, London.
	Notes on oyster culture. Journal of the Marine Biological Association of the United Kingdom, 1 (3).pp. 257-267.
	Humber River Nautical Chart - McIntosh 1891 ME SFC Report
	A journal kept in the Isle of Man: giving an account of the wind ... Volume 1 by Richard Townley, 1791
	On the geographical distribution and uses of the common oyster (Ostrea edulis). The Edinburgh New Philosophical Journal 47:239-247.
	Island of Jersery naturical chart 1904
	Sprat T (1667) The history of the Royal Society of London, for the improving of natural knowledge. Royal Society, London.
	email and map from Lundy Field Society - courtesy of Keith Hiscock
	Moore T (1829) The History of Devonshire from the Earliest Period to the Present. Devonshire. Vols I-II.
	Sea Fisheries (England and Wales) Fourth Annual Report of the Inspector for 1889.
	Buckland FT (1875). Fisheries (Norfolk): report on the fisheries of Norfolk, especially crabs, lobsters, herrings, and the Broads. [London]: [Her Majesty's Stationery Office].
	OYSTER FISHERIES ON THE NORTH KENT COAST. By ROBERT H. GOODSALL
	A feasibility study of native oyster (Ostrea edulis) stock regeneration in the United Kingdom. in Native Oyster Stock Regeneration - A Review of Biological, Technical and Economic Feasibility (CEFAS).
	Moore T (1829) The History of Devonshire from the Earliest Period to the Present. Devonshire. Vols I-II.
	Inquiries concerning the propogation of American smelt and shad, and notes on the fisheries of the Wash in England. Bulletin of the United States Fish Commission 1:428-429.
	THE BILLS PROMOTED BY THE WHITSTABLE AND THE HERNE BAY &c., FISHERY COMPANIES,
Natural England's	2002 English Nature (EN) Fal and Helford European Marine Site (EMS) Sublittoral Monitoring

Data sourced from:	Recording scheme
Marine Evidence Database	2006 Natural England Survey of the Subtidal Sediments of the Solent Maritime SAC
	1985 OPRU HRE Fal Estuary Survey
	Eurospan Condition Monitoring of the Intertidal Mudflats and Sandflats Feature at Fal and Helford Marine Sites 2011
	1985 – 1996 MNCR Area Summaries – Inlets in the western English Channel
MMO1135	Marine Conservation Society
	Conchological Society of Great Britain and Ireland
	Joint Nature Conservation Committee
	Marine Biological Association
	Cumbria Biodiversity Data Centre
	Natural England
	Porcupine Marine Natural History Society

Appendix 12 Number of records for *Ostrea edulis* per marine plan area

	Current	Historic
North East inshore	0	3
North East offshore	0	6
East inshore	0	12
East offshore	0	9
South East inshore	0	104
South inshore	116	422
South offshore	0	9
South West inshore	4	55
South West offshore	0	0
North West	0	30

Sea pens and burrowing megafauna

Appendix 13 Data sources for current and historic mapping of sea pens and burrowing megafauna

Source	Reference
MarineRecorder	Data derived from UK Marine Recorder (Public) snapshot (v20220124), available from https://jncc.gov.uk/our-work/marine-recorder/ - downloaded on 02/11/2022. Data licenses, access and use limitations as described per survey as contained within the database.
Cefas Surveys	Farne Deeps MCZ CEND2116
FSS	Data were extracted from the Cefas' Fish Survey (FSS) database.
Marine Institute	Data provided by the Marine Institute; Doyle, J., Aristegui, M., Sullivan, M., O'Connor, S., Kinneen, M., Sugrue, S., Derbyshire C., Ryan, G., Bentley, K., Graham, J., Oliver, P., & O'Brien, B. (2022). The Labadie, Jones and Cockburn Banks Nephrops Grounds (FU2021) 2022 UWTV Survey Report and catch scenarios for 2023. Marine Institute UWTV Survey report. http://hdl.handle.net/10793/1798;
	Doyle, J., Aristegui, M., O'Connor, S., Sullivan, M., Kinneen, M., Sugrue, S., & Derbyshire, C. (2022). The "Smalls" Nephrops Grounds (FU22) 2022 UWTV Survey Report and catch scenarios for 2023. Marine Institute UWTV Survey report. http://hdl.handle.net/10793/1797
OBIS	OBIS (2022) Ocean Biodiversity Information System. Intergovernmental Oceanographic Commission of UNESCO. www.obis.org.
OneBenthic	OneBenthic (2023). Data downloaded using the 'OneBenthic Data Extraction Tool: Grab/Core' available via https://rconnect.cefas.co.uk/onebenthic_portal/. Tool accessed: 04/11/2022.

Appendix 14 Full list of species included in “burrowing megafauna”

Name	Taxonomy
Cepola rubescens	Pisces
Gobius niger	Pisces
Maxmuelleria	Polychaeta
Upogebiidae	Decapoda
Calocaris macandreae	Decapoda
Chaetopteridae (tube or worm)	Polychaeta
Callianassa subterranea	Decapoda
Pestarella tyrrhena	Decapoda
Nephrops norvegicus	Decapoda
Goneplax rhomboides	Decapoda
Jaxea nocturna	Decapoda
Lumpenus lampretaeformis	Pisces
Myxine glutinosa	Pisces
Lesueurigobius friesii	Pisces
Alpheus glaber	Decapoda

Khaled, F., et al. (2021). "Impact of the blockage ratio on the transport of sediment in the presence of a hydrokinetic turbine: Numerical modeling of the interaction sediment and turbine." International Journal of Sediment Research **36**(6): 696-710 %@ 1001-6279.