Dudgeon and Sheringham Shoal Offshore Wind Farm Extensions

Preliminary Environmental Information Report

Volume 3

Appendix 10.4 - MarESA Biotope Sensitivities

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Glossary of Acronyms

AoO	Advice on Operations
DEP	Dudgeon Extension Project
MarLIN	Marine Life Information Network
MARESA	Marine Evidence Based Sensitivity Assessment
MCZ	Marine Conservation Zone
SEP	Sheringham Shoal Extension Project

Glossary of Terms

The Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.
Resistance	The likelihood of damage (termed intolerance or resistance) due to a pressure
Resilience	The rate of (or time taken for) recovery (termed recoverability, or resilience) once the pressure has abated or been removed.
The Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.

10.4 MarESA Biotope Sensitivity

10.4.1 Introduction

1. The impact assessment presented in **Chapter 10 Benthic Ecology** identifies receptors for which there is a pathway for effect, and the sensitivity of those receptors to each effect. The definitions of sensitivity used in **Chapter 10 Benthic Ecology** are based on Marine Life Information Network (MarLIN's) Marine Evidence based Sensitivity Assessment (MarESA) (Tyler-Walters et al., 2018) which determines sensitivity based on resistance (tolerance) and resilience (recoverability) which are defined as:
   - Resistance: the likelihood of damage (termed intolerance or resistance) due to a pressure;
   - Resilience: the rate of (or time taken for) recovery (termed recoverability, or resilience) once the pressure has abated or been removed.
2. Descriptions of Resistance and Resilience as used in **Chapter 10 Benthic Ecology** are presented in **Table10-1** below.

Table10-1: Resistance and Resilience Scale Definitions

Level	Description
Resistance (Tolerance)	
None	Key functional, structural, characterizing species severely decline and/or physicochemical parameters are also affected e.g. removal of habitats causing a change in habitats type. A severe decline/reduction relates to the loss of 75% of the extent, density or abundance of the selected species or habitat component e.g. loss of 75% substratum (where this can be sensibly applied).
Low	Significant mortality of key and characterizing species with some effects on the physicochemical character of habitat. A significant decline/reduction relates to the loss of 25-75% of the extent, density, or abundance of the selected species or habitat component e.g. loss of 25-75% of the substratum.
Medium	Some mortality of species (can be significant where these are not keystone structural/functional and characterizing species) without change to habitats relates to the loss <25% of the species or habitat component.
High	No significant effects on the physicochemical character of habitat and no effect on population viability of key/characterizing species but may affect feeding, respiration and reproduction rates.

Level	Description
Resilience (Recovery)	
Very Low	Negligible or prolonged recovery possible; at least 25 years to recover structure and function.
Low	Full recovery within 10-25 years.
Medium	Full recovery within 2-10 years.
High	Full recovery within 2 years.

3. The MarESA assessment of sensitivity is guided by the presence of key structural or functional species/assemblages and/or those that characterize the biotope groups. Physical and chemical characteristics are also considered where they structure the community. MarESA uses a matrix approach to determine sensitivity based on both recovery and resilience. The sensitivity matrix used in the impact assessment in **Chapter 10 Benthic Ecology**, based on MarESA, is presented in **Table 10-2**.

Table 10-2: Sensitivity Matrix

		Resistance			
		None	**Low**	**Medium**	**High**
Resilience	**Very Low**	High	High	Medium	Low
	Low	High	High	Medium	Low
	Medium	Medium	Medium	Medium	Low
	High	Medium	Low	Low	Negligible

4. MarESA has been used in order to determine sensitivity of specific biotopes and dominant macrofauna recorded during the Dudgeon Extension Project (DEP) and Sheringham Shoal Extension Project (SEP) site specific benthic characterisation surveys. The sensitivity of biotopes taken from MarESA is provided in **Section 10.4.2** below which has been used in the impact assessment in **Chapter 10 Benthic Ecology**.

5. MarESA sensitivities are not available at the habitat level (EUNIS[1] level 3). However, the confidence in the data at the habitat level is higher than at the biotope level (EUNIS level 5). Therefore, where sensitivity at the habitat level is assessed it is based on the worst case sensitivity of biotopes identified within the habitat.

6. It is important to note that where local evidence is available about habitat tolerance and recovery, for example from post construction benthic monitoring surveys at the Dudgeon and/or Sheringham Shoal offshore wind farms, sensitivities are modified accordingly within **Chapter 10 Benthic Ecology**.

[1] The European Nature Information System (EUNIS) habitat classification is a comprehensive pan-European system for habitat identification. More information is available at: https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification

10.4.2 Sensitivity Assessment

7. **Table 10-3** sets out the sensitivity assessment of biotopes recorded during the DEP and SEP benthic characterisation surveys. Biotopes A4.232, A3.116 , A3.1161 And A3.215 were not recorded during the survey however the EUNIS level 2 habitats were recorded therefore the sensitivities of biotopes potentially associated with these habitats was obtained from the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ) Advice on Operations (AoO) from Natural England.

Table 10-3: Sensitivity, resistance and recovery of biotopes recorded during the DEP and SEP benthic characterisation survey (A4.232, A3.116, A3.1161 and A3.215 were not recorded during the survey but have been used as a proxy). Sensitivities are taken from MarESA.

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
Physical change to another seabed type or to another sediment type, depending if it's on rock							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	Low	Very Low	**High**	**Physical change to another seabed type:** Based on the loss of suitable habitat, resistance is assessed as 'None' recovery is assessed as 'Very Low' as the change at the pressure benchmark is permanent. Sensitivity is therefore 'High'. Physical change to another sediment type is not relevant to biotopes occurring on bedrock. (Tillin and Budd, 2002)
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	Low	Very Low	**High**	**Physical change to another seabed type:** Based on the loss of suitable habitat, resistance is assessed as 'None' recovery is assessed as 'Very Low' as the change at the pressure benchmark is permanent. Sensitivity is therefore 'High'. Physical change to another sediment type is not relevant to biotopes occurring on bedrock. (Tillin, 2018)
	A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	Low	Very Low	**High**	**Physical change to another seabed type:** Based on the loss of suitable habitat, resistance is assessed as 'None' recovery is assessed as 'Very Low' as the change at the pressure benchmark is permanent. Sensitivity is therefore 'High'. Physical change to another sediment type is not relevant to biotopes occurring on bedrock. (Tillin, 2016a)
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	None	Very Low	**High**	If rock were replaced with sediment, this would represent a fundamental change to the physical character of the biotope and the species would be unlikely to recover. The biotope would be lost. Sensitivity assessment. Resistance to the pressure is considered 'None', and resilience 'Very low'. Sensitivity has been assessed as 'High'. Physical change to another sediment type is not relevant to biotopes occurring on bedrock (Readman, 2016a)
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	None	Very Low	**High**	**Change to another seabed type:** A change to a sedimentary, rock or artificial substratum would result in the loss of piddocks significantly altering the character of the biotope. The biotope is therefore considered to have 'No' resistance to this pressure, recovery of the biological assemblage (following habitat restoration) is considered to be 'Medium' (2-10 years). The biotope is dependent on the presence of clay or soft chalk, when lost restoration would not be feasible and recovery is therefore categorised as 'Very low'. Sensitivity is therefore assessed as 'High', based on the lack of recovery of the substratum. (Tillin and Hill, 2016)
				None	Very Low	**High**	**Change to another sediment type:** A change to a sedimentary substratum would result in the loss of piddocks significantly altering the character of the biotope. The biotope is therefore considered to have 'No' resistance to this pressure, recovery of the biological assemblage (following habitat restoration) is considered to be 'Medium' (2-10 years) but see caveats in the recovery notes. The biotope is dependent on the presence of soft chalk or clay, when lost restoration would not be feasible and recovery is therefore categorised as 'Very low'. Sensitivity is therefore assessed as 'High', based on the lack of recovery on chalk or clay substratum. (Tillin and Hill, 2016)
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	None	Very Low	**High**	**Change to another seabed type**: Resistance to the pressure is considered None, and resilience Very Low based on the loss of suitable substratum to support the community of the characterizing species of Polydora. Sensitivity has been assessed as High. Although no specific evidence is described confidence in this assessment is 'High', due to the incontrovertible nature of this pressure. Physical change to another sediment type is not relevant to biotopes occurring on bedrock
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?)	Low	Very Low	**High**	**Change to another sediment type:** A change to finer, muddy and mixed sediments is likely to reduce the abundance of the characterizing Tellina spp., venerid bivalves and other bivalves such as Spisula solida, and favour polychaetes. Such changes would lead to biotope reclassification. Biotope resistance is therefore assessed as 'Low' (as some species may remain), biotope resilience is assessed as 'Very low' (the pressure is a permanent change), and biotope sensitivity is assessed as 'High'. (Tillin, 2016b)
				None	Very Low	**High**	**Change to another seabed type:** Based on the loss of the biotope, resistance is assessed as 'None', recovery is assessed as 'Very Low' (as the change at the pressure benchmark is permanent), and sensitivity is assessed as 'High'. (Tillin, 2016b)
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand	None	Very Low	**High**	**Change to another seabed type:** Based on the loss of the biotope, resistance is assessed as 'None', recovery is assessed as 'Very low' (as the change at the pressure benchmark is permanent and sensitivity is assessed as 'High'. (Tillin and Gerrard, 2019)
				None	Very Low	**High**	**Change to another sediment type:** A change to either a finer muddy sediment or a coarser sediment, is likely to lead to changes in the abundance and identity of the characterizing species . Based on the loss of the biotope, resistance is assessed as 'None', recovery is assessed as 'Very low' (as the change at the pressure benchmark is permanent and sensitivity is assessed as 'High'. (Tillin and Gerrard, 2019)
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)	None	Very Low	**High**	**Change to another seabed type:** If sediment were replaced with rock or artificial substrata, this would represent a fundamental change to the biotope with reclassification necessary. Change from a mixed sediment substrata to rock would also result in loss of the infaunal component. Resistance to the pressure is considered 'None', and resilience 'Very Low'. Sensitivity has been assessed as 'High'. (Readman, 2016b)
				Low	Very Low	**High**	**Change to another sediment type:** While the epifauna are unlikely to be affected, change in sediment at the benchmark level, (e.g. to coarser sediments) is likely to impact the infaunal polychaete community. Resistance is assessed as 'Low', as resilience is Very low (the pressure is a permanent change), sensitivity is, therefore, High. (Readman, 2016b)
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	None	Very Low	**High**	**Change to another seabed type:** Based on the loss of the biotope, resistance is assessed as 'None', recovery is assessed as 'Very low' (as the change at the pressure benchmark is permanent), and sensitivity is assessed as 'High'. (Tillin, 2016c)
				Low	Very Low	**High**	**Change to another sediment type:** changes in the sediment type may lead to biotope reclassification. Biotope resistance is, therefore, assessed as 'Low' (as some species may remain), as resilience is Very low (the pressure is a permanent change), and sensitivity is, therefore, High. (Tillin, 2016c)
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment	None	Very Low	**High**	**Change to another seabed type:** Based on reported habitat preferences the species (rather than the biotope) is considered to be 'Not Sensitive' as the resulting habitat is suitable for the development of reefs (however these would be classified as a different biotope type). The resistance of the biotope is, therefore, assessed as None (loss of >75% of extent), resilience is Very low (the pressure is a permanent change) and sensitivity is assessed as High. The more precautionary assessment for the biotope, rather than the species, is presented in the table as it is considered that any

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
							change from a sedimentary habitat to a rock reef habitat would alter the biotope classification and hence the more sensitive assessment is appropriate. (Tillin *et al*., 2020).
				None	Very Low	**High**	**Change to another sediment type:** Based on reported habitat preferences and evidence from Foster-Smith (2001b), where a change in one Folk class results in increased coarseness (e.g. a change to a coarse sediment of gravel, sandy gravel or gravelly sand) then the biotope is considered to be 'Not Sensitive' as the resulting habitat is suitable for this species. However, an increase in fine sediments to the degree that sediments are re-classified as mud or sandy mud would severely reduce habitat suitability. Therefore, resistance has been assessed as 'None', resilience as Very low (the pressure is a permanent change), and sensitivity as High. (Tillin *et al*., 2020).
Habitat structure changes - removal of substratum (extraction)							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	Not relevant	Not relevant	**Not relevant**	The species characterizing this biotope are epifauna or epiflora occurring on rock and would be sensitive to the removal of the habitat. However, extraction of rock substratum is considered unlikely and this pressure is considered to be 'Not relevant' to hard substratum habitats (Tillin and Budd, 2002).
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	None	Medium	**Medium**	The species characterizing this biotope are epifauna or epiflora occurring on rock and would be sensitive to the removal of the habitat. However, extraction of rock substratum is considered unlikely and this pressure is considered to be 'Not relevant' to hard substratum bedrock habitats. Where this biotope occurs on boulders that are removed, resistance is assesed as 'None'. If suitable boulders remain and have been uncovered, then recovery is assessed as 'Medium', and sensitivity is assessed as 'Medium' (Tillin, 2018).
	A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	Not relevant	Not relevant	**Not relevant**	The species characterizing this biotope are epifauna or epiflora occurring on rock and would be sensitive to the removal of the habitat. However, extraction of rock substratum is considered unlikely and this pressure is considered to be 'Not relevant' to hard substratum habitats (Tillin, 2016a).
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock[1]	NR	NR	**NR**	The species characterizing this biotope are epifauna or epiflora occurring on rock and would be sensitive to the removal of the habitat. However, extraction of rock substratum is considered unlikely and this pressure is considered to be 'Not relevant' to hard substratum habitats (Readman, 2016a).
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay[2]	None	Very Low	**High**	The removal of substratum to 30cm depth will remove the clay or chalk substratum, piddocks and the associated biological assemblage, in the impact footprint. Resistance is therefore assessed as 'None', recovery of the biological assemblage (fwhere suitable substratum remains) is considered to be 'Medium' (2-10 years). The biotope is dependent on the presence of clay or chalk substratum, when lost restoration would not be feasible and recovery is therefore categorised as 'Very low'. Sensitivity is therefore assessed as 'High', based on the lack of recovery of clay or chalk habitats (Tillin and Hill, 2016)
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	None	Very Low	**High**	Removal of the substratum to 30 cm would result in the loss of Polydora sp. tubes. Resistance to the pressure is considered None, and resilience Very Low based on the loss of suitable substratum to support the community of the characterizing species of Polydora. Sensitivity has been assessed as High (De-Bastos and Hill, 2016).
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?)	None	Medium	**Medium**	Resistance is assessed as 'None' as extraction of the sediment swill remove the characterizing and associated species present. Resilience is assessed as 'Medium' as some species may require longer than two years to re-establish (see resilience section) and sediments may need to recover (where exposed layers are different). Biotope sensitivity is therefore assessed as 'Medium' (Tillin, 2016b).
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand	None	High	**Medium**	Biotope resistance to extraction of sediment and characterizing species is assessed as 'None. Resilience is assessed as 'High', as sediment recovery will be enhanced by wave action and mobility of sand. The characterizing species are likely to recover through transport of adults in the water column or migration from adjacent patches. Biotope sensitivity is therefore assessed as 'Medium' (Tillin and Gerrard, 2019).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)	None	High	**Medium**	Extraction of 30 cm of sediment will remove the characterizing biological component of the biotope. Resistance is assessed as 'None' and biotope resilience is assessed as 'Medium'. Sensitivity is, therefore, assessed as 'Medium' (Readman, 2016b).
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	None	Medium	**Medium**	Resistance is assessed as 'None' as extraction of the sediment swill remove the characterizing and associated species present. Resilience is assessed as 'Medium' as some species may require longer than two years to re-establish (see resilience section) and sediments may need to recover (where exposed layers are different). Biotope sensitivity is therefore assessed as 'Medium' (Tillin, 2016c).
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment	None	Medium	**Medium**	As *Sabellaria spinulosa* reefs are present on the surface they will be directly removed by extraction of the sediment, resistance to this pressure is therefore assessed as 'None'. Resilience informed by (Pearce et al., 2007) is considered to be 'Medium' to allow for the establishment of reef structure and the potential for variable recruitment and this biotope is therefore considered to have 'Medium' sensitivity to this pressure (Tillin *et al*., 2020).
Abrasion/disturbance of the surface of the substratum or seabed							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	Medium	High	**Low**	The impact of surface abrasion will depend on the footprint, duration and magnitude of the pressure. Based on evidence from intertidal step experiments and the relative robustness of encrusting corallines, Corallina officinalis turf and associated species, resistance, to a single abrasion event is assessed as 'Medium' and recovery as 'High', so that sensitivity is assessed as 'Low'. Resistance and resilience will be lower (and hence sensitivity greater) to abrasion events that exert a greater crushing force and remove the bases than the trampling examples the assessment is based on). Resistance is therefore assessed as 'Low' and recovery as 'Medium' so that the sensitivity of the biotope defined by this species is assessed as 'Medium'. Based on epifaunal position, size and fragility and the available evidence, Echinus esculentus is assessed as having 'Low' resistance to abrasion. Resilience is assessed as 'High' and therefore sensitivity is assessed as 'Low'. (Tillin and Budd, 2002).
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	Medium	High	**Low**	The impact of surface abrasion will depend on the footprint, duration and magnitude of the pressure. Based on evidence from Brosnan & Crumrine (1994) for foliose red and brown species, intertidal step experiments and the relative robustness of encrusting corallines, Corallina officinalis turf and associated species, resistance, to a single abrasion event is assessed as 'Medium' and recovery as 'High', so that sensitivity is assessed as 'Low'. Resistance and resilience will be lower (and hence sensitivity greater), to abrasion events that exert a greater crushing force and remove the bases than the trampling examples the assessment is based on). Resistance is therefore assessed as 'Low' and recovery as 'Medium' so that the sensitivity of the biotope defined by this species is assessed as 'Medium'. Based on epifaunal position, size and fragility and the available evidence,

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
							Echinus esculentus is assessed as having 'Low' resistance to abrasion. Biotope resilience is assessed as 'High' and therefore sensitivity is assessed as 'Low'. (Tillin, 2018).
	A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	Medium	High	**Low**	The impact of surface abrasion will depend on the footprint, duration and magnitude of the pressure. Based on evidence from intertidal step experiments and the relative robustness of encrusting corallines and associated red algal species, resistance, to a single abrasion event is assessed as 'Medium' and recovery as 'High', so that sensitivity is assessed as 'Low'. Resistance and resilience will be lower (and hence sensitivity greater) to abrasion events that exert a greater crushing force and remove the bases than the trampling examples the assessment is based on). Resistance is therefore assessed as 'Low' and recovery as 'Medium' so that the sensitivity of the biotope defined by this species is assessed as 'Medium'. (Tillin, 2016a).
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	Medium	High	**Low**	Whilst disturbance would damage the sessile *F. foliacea*, the flexibility and ability to regenerate damaged fronds (as long as the holdfast is undamaged) would result in a significant proportion of the colonies to survive disturbance. Damage for construction activities such as cable installation might be expected to be more significant than this, however, once settled new colonies of *F. foliacea* take 1-2 years to reach maturity, depending on environmental conditions, so resilience is high (Readman, 2016).
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	Medium	Very Low	**Medium**	Surface abrasion may remove epifauna and result in the loss of some piddocks and damage to habitat so resistance is assessed as 'Medium'. Resilience is assessed as 'Very Low' because unlike the associated biological community the substratum cannot recover. The sensitivity of the overall biotope is considered to be 'Medium'. (Tillin and Hill, 2016)
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	None	High	**Medium**	The characterizing Polydora community in this biotope, is considered likely to be damaged and removed by abrasion. As a soft bodied species, Polydora ciliata is likely to be crushed and killed by an abrasive force or physical blow. Erect epifauna are directly exposed to this pressure which would displace, damage and remove individuals. Resistance to abrasion is considered None. However, Polydora is likely to be able to re-establish the lost community rapidly, so resilience of the biotope is assessed as High with the biotope considered to have Medium sensitivity to abrasion or disturbance of the surface of the seabed. The substratum is unable to recover from damage and therefore the biotope would be considered highly sensitivity to abrasion that damaged or removed the soft rock substratum. (De-Bastos and Hill, 2016).
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?	Medium	High	**Low**	Abrasion is likely to damage epifauna and flora and may damage a proportion of the characterizing species, biotope resistance is therefore assessed as 'Medium'. Resilience is assessed as 'High' as opportunistic species are likely to recruit rapidly and some damaged characterizing species may recover or recolonize. Biotope sensitivity is assessed as 'Low'. (De-Bastos and Hill, 2016).
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand	Low	High	**Low**	Resistance to a single abrasion event is assessed as 'Low' based on the evidence for trampling from Reyes-Martínez et al. (2015). Resilience is assessed as 'High', based on migration from adjacent populations and in-situ reproduction by surviving amphipods. Sensitivity is therefore assessed as 'Low'. This assessment may underestimate sensitivity to high-levels of abrasion (repeated events within a short period). The trampling evidence and the evidence for penetration from mobile gears (see below) differ in the severity (resistance) of impact. This may be due to different levels of intensity (multiple trampling/abrasion events vs single penetration/towed gear impacts) or the nature of the pressure. Abrasion from trampling also involves a level of compaction that could collapse burrows and damage species through compression. Penetration may, however, break sediments open allowing mobile species to escape or species may be pushed forwards from towed gear by a pressure wave where this is deployed subtidally (Gilkinson et al., 1998). Both risk assessments are considered applicable to single events based on the evidence and the sensitivity assessment for both pressures is the same although resistance differs. (De-Bastos and Hill, 2016).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)	Low	High	**Low**	Evidence suggests a decline in all species present following abrasion type events and resistance is, therefore, assessed as 'Low', resilience as 'High' and sensitivity as 'Low'. (Readman, 2016b).
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Medium	High	**Low**	Abrasion is likely to damage epifauna and may damage a proportion of the characterizing species, biotope resistance is therefore assessed as 'Medium'. Resilience is assessed as 'High' as opportunistic species are likely to recruit rapidly and some damaged characterizing species may recover or recolonize. Biotope sensitivity is assessed as 'Low' (Tillin, 2016c).
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment	Low	Medium	**Medium**	Based on the evidence discussed above, abrasion at the surface of Sabellaria spinulosa reefs is considered likely to damage the tubes and result in sub-lethal and lethal damage to the worms. Resistance is therefore assessed as 'Low' (loss of 25-75% of tubes and worms within the impact footprint). Resilience is therefore assessed as 'Medium' (within 2 years) and sensitivity is therefore assessed as 'Medium'. This assessment is relatively precautionary and it should be noted the degree of resilience will be mediated by the character of the impact. The recovery of small areas of surficial damage in thick reefs is likely to occur through tube repair and may be relatively rapid (Tillin, 2016c).
Changes in suspended solids (water clarity)							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	Low	Medium	**Medium**	This biotope is characterized by the presence of brown algae and may revert to a red algae only biotope in areas of high turbidity, such as the similar biotope IR.MIR.KR.XFoR, which is dominated by red seaweeds tolerant of turbidity including Plocamium cartilagineum and Calliblepharis ciliata (which may also be found in this biotope). The fauna in such biotopes is less diverse and at lower abundances (Connor et al., 2004). No information was found for suspended solid thresholds at which the brown seaweeds may be replaced and whether the brown algae could survive, with reduced growth, at the pressure benchmark. Resistance to an increase at the pressure benchmark is assessed as 'Low' and resilience (following a return to previous habitat conditions) is assessed as 'Medium', as red algal turfs may prevent recolonization by brown algae until physical gaps are formed. Sensitivity is therefore assessed as 'Medium'. This biotope is considered to be 'Not sensitive' to a change in suspended solids, where levels of scour are unaffected. (Tillin and Budd, 2002)
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	Low	Medium	**Medium**	This biotope is characterized by the presence of brown algae and may revert to a red algae only biotope in areas of high turbidity, such as the similar biotope IR.MIR.KR.XFoR, which is dominated by red seaweeds tolerant of turbidity including Plocamium cartilagineum and Calliblepharis ciliata (which may also be found in this biotope). The fauna in such biotopes is less diverse and at lower abundances (Connor et al., 2004). No information was found for suspended solid thresholds at which the brown seaweeds may be replaced and whether the brown algae could survive, with reduced growth, at the pressure benchmark. Resistance to an increase at the pressure benchmark is assessed as 'Low' and resilience (following a return to previous habitat conditions) is assessed as 'Medium', as red algal turfs may prevent recolonization by brown algae until physical gaps are formed. Sensitivity is therefore assessed as 'Medium'. This biotope is considered to be 'Not sensitive' to a change in suspended solids, where levels of scour are unaffected. (Tillin, 2018)

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
	A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	High	High	**Not Sensitive**	Overall biotope resistance is assessed as 'Medium' to an increase in suspended solids, as increased scour may reduce the biomass of red algae and may remove some individuals or species that are more sensitive. However, the encrusting corallines and some red algae are considered likely to survive. Resilience is categorised as 'High' as some adults are likely to remain in situ from which recruitment can occur. The biotope is considered to be 'Not sensitive' to decreased suspended solids where scour and abrasion are unaffected. A reduction in turbidity and scour may allow less scour tolerant species and those adapted to higher light levels, such as kelps, to colonize the biotope. Resistance to a decrease in suspended solids, accompanied by a significant reduction in scour is assessed as 'Medium' as space pre-emption by red algae is likely to limit colonization. Resilience (following a return to previous habitat conditions) is assessed as 'High'. Sensitivity is therefore assessed as 'Low'. (Tillin, 2016a)
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	High	High	**Not sensitive**	Sediment scour within CR.HCR.XFa.FluCoAs and associated biotopes is an important factor in the dominance of the scour tolerant Flustra foliacea (Connor et al., 2004). Whilst an increase is unlikely to have an effect, a reduction in suspended sediment could reduce scour and allow other species to colonize the biotope. On return to the original sediment levels, it is probable that Flustra foliacea would again dominate the biotope. Resistance is assessed as 'High', resilience as 'High' and the biotope is 'Not Sensitive' at the benchmark level. (Readman, 2016a)
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	High	High	**Not sensitive**	No direct evidence was found to assess sensitivity to this pressure however, based on the occurrence of Pholas dactylus in turbid areas and evidence for the production of pseudofaeces by piddocks, resistance is assessed as 'High' and resilience as High (no impact to recover from). The biotope is therefore considered to be 'Not sensitive'. (Tillin and Hill, 2016)
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	Low	High	**Low**	An increase in suspended solids at the pressure benchmark level is unlikely to affect the characterizing species of this biotope. However, a decrease in suspended matter in the biotope could result in limitation of material for tube building activity of Polydora and also in the substrate no longer being suitable for colonization by new recruits. Resistance of the biotope is therefore considered to be Low (loss of 25-75%) and resilience is High (following a return to normal conditions) so the biotope is considered to have Low sensitivity to a decrease in suspended solids at the pressure benchmark level. (De-Bastos and Hill, 2016).
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?)[3]	Medium	High	**Low**	No direct evidence was found to assess impacts on the characterizing and associated species. The characterizing, suspension feeding bivalves are not predicted to be sensitive to decreases in turbidity and may be exposed to, and tolerant of, short-term increases in turbidity following sediment mobilization by storms and other events. An increase in suspended solids, at the pressure benchmark may have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing. Biotope resistance is assessed as 'Medium' as there may be some shift in the structure of the biological assemblage and resilience is assessed as 'High' (following restoration of typical conditions). Biotope sensitivity is assessed as 'Low'. (Tillin, 2016b).
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand[4]	Medium	High	**Low**	Increased inorganic suspended solids may increase abrasion but it is likely that the infaunal species would be unaffected. The biotope is considered to be 'Not sensitive' to a decrease in suspended solids that does not affect sediment transport and supply to the biotope. Biotope resistance is assessed as 'Medium' as some effects on feeding and diatom productivity may occur from increases in suspended solids, resilience is assessed as 'High', following a return to usual conditions and sensitivity is assessed as 'Low'. This more precautionary assessment is presented in the table. Indirect effects such as deposition, erosion and associated sediment change that may result from changes in suspended solids in the long-term are assessed separately. (Tillin and Gerrard, 2019).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)[5]	High	High	**Not sensitive**	The biotope occurs in outer estuaries and is therefore probably subject to variable turbidity. Crepidula fornicata is able to survive high turbidity events and is unlikely to be negatively affected by changes in turbidity at the benchmark level (the highest benchmark value is 300 mg/l). The infaunal polychaetes are likely to be resistant to changes in turbidity. Whilst an increase is therefore unlikely to have an impact on the biotope community, a significant, long-term decrease may lead to the development of a community of macroalgae which could potentially compete with some of the epifaunal species in the biotope, and result in loss of the biotope. Assuming a turbidity value of 'Intermediate' (10-100 mg/l), an increase to 'Medium' (100 -300 mg/l) is unlikely to have an effect. However a decrease to 'Clear' (<10 mg/l) could result in colonization from algal species. Whilst mortality from changes in suspended sediment are unlikely, colonization by algae could result in fundamental change in biotope. Given that the pressure benchmark is for one year, return to prevailing conditions would likely result in loss of the algae and full recovery to SS.SMx.SMxVS.CreMed or SS.SMx.SMxVS.CreAsAa. Resistance is, therefore, 'High', resilience is 'High' and the biotope is 'Not sensitive' at the benchmark level. (Readman, 2016b).
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments [6]	Medium	High	**Low**	No direct evidence was found to assess impacts on the characterizing and associated species. The characterizing, suspension feeding bivalves are not predicted to be sensitive to decreases in turbidity and may be exposed to, and tolerant of, short-term increases in turbidity following sediment mobilization by storms and other events. An increase in suspended solids, at the pressure benchmark may have negative impacts on growth and fecundity by reducing filter feeding efficiency and imposing costs on clearing. Biotope resistance is assessed as 'Medium' as there may be some shift in the structure of the biological assemblage although the biotope uis likely to still be characterized as SS.SMx.OMx.PoVen. Biotope resilience is assessed as 'High' (following restoration of typical conditions) and sensitivity is assessed as 'Low' (Tillin, 2016c).
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment[7]	High	High	**Not Sensitive**	The benchmark for this pressure refers to a change in turbidity of one rank (see benchmark) Sabellaria spinulosa do not photosynthesise and do not rely on sight to locate resources and, therefore, no effects are predicted for reef biotopes from an increase or decrease in clarity resulting from a change in one rank on the water framework directive scale. Experiments (Davies et al., 2009) and predictive modelling (Tillin, 2010) indicate that tube building sabellariids can tolerate a broad range of suspended solids. Resistance to an increase or decrease at the pressure benchmark is therefore assessed as 'High' and resilience as 'High' (no impact to recover from) (Tillin *et al*., 2020).
Penetration or disturbance of the substratum or seabed							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	NR	NR	**NR**	The species characterizing this biotope group are epifauna or epiflora occurring on rock which is resistant to subsurface penetration. The assessment for abrasion at the surface only is therefore considered to equally represent sensitivity to this pressure (Tillin and Budd, 2002).
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	NR	NR	**NR**	The species characterizing this biotope group are epifauna or epiflora occurring on rock which is resistant to subsurface penetration. The assessment for abrasion at the surface only is therefore considered to equally represent sensitivity to this pressure (Tillin, 2018).
	A3.2 Atlantic and Mediterranean	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	NR	NR	**NR**	The species characterizing this biotope group are epifauna or epiflora occurring on rock which is resistant to subsurface penetration. The assessment for abrasion at the surface only is therefore considered to equally represent sensitivity to this pressure (Tillin, 2016a).

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
	moderate energy infralittoral rock						
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock[1]	NR	NR	**NR**	The species characterizing this biotope group are epifauna or epiflora occurring on rock which is resistant to subsurface penetration. The assessment for abrasion at the surface only is therefore considered to equally represent sensitivity to this pressure. This pressure is thought 'Not relevant' to hard rock biotopes (Readman, 2016a).
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay[2]	Low	Very Low	**High**	Sub-surface penetration and disturbance will remove and damage the sparse epifauna and result in the loss of piddocks and damage to the habitat. Resistance is therefore assessed as 'Low' for the piddocks and substratum. The piddocks are judged to have 'Medium' resilience (where suitable substratum remains) so that sensitivity of the piddocks is 'Medium'. As the substratum cannot recover, resilience is assessed as 'Very Low' and sensitivity of the overall biotope is considered to be 'High' (Tillin and Hill, 2016).
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	None	High	**Medium**	Activities that disturb the surface of the mat and penetrate below the surface would remove a significant proportion of the Polydora tubes within the direct area of impact. Biotope resistance is therefore assessed as None and recovery is assessed as High based on the assumption that the suitable substratum to support the community of the characterizing species of Polydora would only be damaged, not lost. Sensitivity is therefore assessed as Medium. The substratum is unable to recover from damage and therefore the biotope would be considered highly sensitive to physical disturbance that damaged or removed the soft rock substratum. Although no specific evidence is described confidence in this assessment is 'High', due to the incontrovertible nature of this pressure (De-Bastos and Hill, 2016).
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?)[3]	Medium	High	**Low**	The trawling studies and the comparative study by Capasso et al. (2010) suggest that the biological assemblage present in this biotope is characterized by species that are relatively tolerant of penetration and disturbance of the sediments. Either species are robust or buried within sediments or are adapted to habitats with frequent disturbance (natural or anthropogenic) and recover quickly. The results suggest that a reduction in physical disturbance may lead to the development of a a community with larger, more fragile species including large bivalves. Biotope resistance is assessed as 'Medium' as some species will be displaced and may be predated or injured and killed. Biotope resilience is assessed as 'High' as most species will recover rapidly and the biotope is likely to still be classified as SS.SCS.ICS.MoeVen following disturbance. Biotope sensitivity is therefore assessed as 'Low' (Tillin, 2016b).
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand[4]	Medium	High	**Low**	Based on the evidence above it is considered that Bathyporeia spp. and other characterizing species will have 'Medium' resistance (mortality <25%) to abrasion, their small size, infaunal position and mobility enabling a large proportion of the population to escape injury. Recovery is assessed as 'High' and sensitivity is therefore categorised as 'Low'.The trampling evidence (see above) and the evidence for penetration from mobile gears differ in the severity (resistance) of impact. This may be due to different levels of intensity (multiple trampling/abrasion events vs single penetration/towed gear impacts) or the nature of the pressure. Abrasion from trampling also involves a level of compaction that could collapse burrows and damage species through compression. Penetration may, however, break sediments open allowing mobile species to escape or species may be pushed forwards from towed gear by a pressure wave where this is deployed subtidally (Gilkinson et al., 1998) (Tillin and Gerrard, 2019).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)[5]	Low	High	**Low**	Resistance of the biotope is assessed as 'Low', although the significance of the impact for the bed will depend on the spatial scale of the pressure footprint. Resilience is assessed as 'Low', and sensitivity is assessed as 'High'(Readman, 2016b).
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments [6]	Medium	High	**Low**	The trawling studies and the comparative study by Capasso et al. (2010) suggest that the biological assemblage present in this biotope is characterized by species that are relatively tolerant of penetration and disturbance of the sediments. Either species are robust or buried within sediments or are adapted to habitats with frequent disturbance (natural or anthropogenic) and recover quickly. Biotope resistance is assessed as 'Medium' as some species will be displaced and may be predated or injured and killed. Biotope resilience is assessed as 'High' as most species will recover rapidly and the biotope is likely to still be classified as SS.SMx.OMx.PoVen following disturbance. Biotope sensitivity is therefore assessed as 'Low' (Tillin, 2016c).
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment[7]	None	Medium	**Medium**	Structural damage to the seabed sub-surface is likely to damage and break-up tube aggregations leading to the loss of reef within the footprint of direct impact. Sabellaria spinulosa is assessed as having a resistance of 'None' to this pressure (removal of >75% of the reef in the pressure footprint). Based on evidence (Pearce et al., 2007; Pearce et al., 2011a) resilience was assessed as 'Medium', therefore, the sensitivity of Sabellaria spinulosa biotopes is considered to be 'Medium' (Tillin *et al*., 2020).
Smothering and siltation rate changes (light and heavy)							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	High	High	**Not sensitive**	**Light:** Based on the biotope exposure to wave and water flow which will remobilise sediments and remove these, biotope resistance to this pressure, at the benchmark, is assessed as 'High', resilience is assessed as 'High' (by default) and the biotope is considered to be 'Not sensitive'. This is a likely result of the growth form of the characterizing foliose red algae and their presence in biotopes subject to sedimentation and scour (including the assessed biotope). The assessment considers that sediments are rapidly removed from the biotope and that the scour tolerance of the red algae and other species would prevent significant mortalities although some damage and abrasion may occur. However, if the deposit remained in place; i.e. due to the scale of the pressure or where biotopes were sheltered, or only seasonally subject to water movements or where water flows and wave action were reduced e.g. by the presence of tidal barrages, then resistance would be lower and sensitivity would be greater (Tillin and Budd, 2002).
				Low	High	**Low**	**Heavy:** Resistance is assessed as 'Medium-Low' as the impact on the characterizing and associated red algal species could be significant but may be mitigated by rapid removal. Resilience is assessed as 'High' based on vegetative re-growth from the scour-tolerant surviving bases of the characterizing species. Biotope sensitivity is therefore assessed as 'Low'. Resistance of Echinus esculentus to this pressure was assessed as 'None' by Tillin & Tyler-Walters (2014) due to the depth of overburden and the predicted low level of vertical migration. Resilience was assessed as 'Medium' (2-10 years) and sensitivity is therefore assessed as 'Medium'. Sensitivity may be lower where the footprint of the deposit is small and migration of adults into the habitat from adjacent populations results in rapid recovery. The biotope assessment is based on the red algae, rather than *Echinus esculentus* (Tillin and Budd, 2002).

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	High	High	**Not sensitive**	**Light**: Based on the biotope exposure to wave and water flow which will remobilise sediments and remove these, biotope resistance to this pressure, at the benchmark, is assessed as 'High', resilience is assessed as 'High' (by default) and the biotope is considered to be 'Not sensitive'. This is a likely result of the growth form of the characterizing foliose red algae and their presence in biotopes subject to sedimentation and scour (including the assessed biotope). The assessment considers that sediments are rapidly removed from the biotope and that the scour tolerance of the red algae and other species would prevent significant mortalities although some damage and abrasion may occur. However, if the deposit remained in place; i.e. due to the scale of the pressure or where biotopes were sheltered, or only seasonally subject to water movements or where water flows and wave action were reduced e.g. by the presence of tidal barrages, then resistance would be lower and sensitivity would be greater (Tillin, 2018).
				Low	High	**Low**	**Heavy:** Resistance is assessed as 'Medium-Low' as the impact on the characterizing and associated red algal species could be significant but may be mitigated by rapid removal. Resilience is assessed as 'High' based on vegetative re-growth from the scour-tolerant surviving bases of the characterizing species. Biotope sensitivity is therefore assessed as 'Low'. Resistance of Echinus esculentus to this pressure was assessed as 'None' by Tillin & Tyler-Walters (2014) due to the depth of overburden and the predicted low level of vertical migration. Resilience was assessed as 'Medium' (2-10 years) and sensitivity is therefore assessed as 'Medium'. Sensitivity may be lower where the footprint of the deposit is small and migration of adults into the habitat from adjacent populations results in rapid recovery. The biotope assessment is based on the red algae, rather than Echinus esculentus (Tillin, 2018).
	A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	High	High	**Not sensitive**	**Light:** Based on the biotope exposure to wave and water flow which will remobilise sediments and remove these, the growth form of the characterizing foliose red algae and the presence of these algae and sponges in biotopes subject to sedimentation and scour (including the assessed biotope), biotope resistance to this pressure, at the benchmark, is assessed as 'High', resilience is assessed as 'High' (by default) and the biotope is considered to be 'Not sensitive'. The assessment considers that sediments are rapidly removed from the biotope and that the scour tolerance of the red algae and other species would prevent significant mortalities although some damage and abrasion may occur. However, if the deposit remained in place; i.e. due to the scale of the pressure or where biotopes were sheltered, or only seasonally subject to water movements or where water flows and wave action were reduced e.g. by the presence of tidal barrages, then resistance would be lower and sensitivity would be greater (Tillin, 2016a).
				Low	High	**Low**	**Heavy:** Resistance is assessed as 'Low' as the impact on the characterizing and associated red algal species could be significant but may be mitigated by rapid removal. Resilience is assessed as 'High' based on vegetative re-growth from the scour-tolerant surviving bases of the characterizing species. Biotope sensitivity is therefore assessed as 'Low' (Tillin, 2016a).
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	Medium	High	**Low**	**Low:** A deposit of 5 cm of fine sediment could smother and damage many of the smaller individuals of the faunal community. For example, Flustra foliacea is probably resistant while Clavelina lepadiformis is probably not resistant. However, in the high energy environment that the biotope occurs, deposited sediment would probably be removed quickly. Therefore, resistance is 'Medium', resilience is 'High' and the sensitivity is 'Low' (Readman, 2016a).
				Low	Medium	**Medium**	**Heavy:** A deposit of 30 cm of fine sediment would smother and damage the majority of the faunal community. In the high energy environment that the biotope occurs, deposited sediment would probably be removed fairly quickly. Resistance is therefore assessed as 'Low', resilience as 'Medium' and sensitivity as 'Medium' (Readman, 2016a).
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	Medium	Medium	**Medium**	**Light:** As piddocks are essentially sedentary and as siphons are relatively short, siltation from fine sediments that add to existing silt layers could be lethal. As the evidence suggests that Pholas dactylus is present under deposits up to the benchmark layer, resistance is assessed as 'Medium' where existing deposits are relatively thin. Effects may be mitigated where water currents and wave exposure rapidly removed the overburden and this will depend on local hydrodynamic conditions and the footprint of the deposit. Resilience is assessed as 'Medium' (2-10 years) for piddocks and sensitivity is therefore assessed as 'Medium'(Tillin and Hill, 2016).
				None	Medium	**Medium**	**Heavy:** As piddocks are essentially sedentary and as siphons are relatively short, siltation from fine could be lethal. Siltation at the pressure benchmark is considered to smother most or all of the piddocks and the surface fauna. Resistance to siltation is therefore assessed as 'None' although effects could be mitigated where water currents and wave exposure rapidly removed the overburden and this will depend on shore height and local hydrodynamic conditions. Resilience is assessed as 'Medium' (2-10 years) for piddocks and sensitivity is therefore assessed as 'Medium' (Tillin and Hill, 2016).
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	High	High	**Not sensitive**	**Light:** Based on the evidence presented by Munari & Mistri (2014), Polydora ciliata is considered likely to resist smothering by 5 cm of sediment. Resistance and resilience are therefore assessed as High and the biotope is considered Not Sensitive to a 'light' deposition of up to 5 cm of fine material in a single discrete event (De-Bastos and Hill, 2016).
				Low	High	**Low**	**Heavy:** Polychaete species have been reported to migrate through depositions of sediment greater that the benchmark (30 cm of fine material added to the seabed in a single discrete event) (Maurer et al., 1982). However, it is not clear whether *Polydora ciliata* is likely to be able to migrate through a maximum thickness of fine sediment that would compare to that investigated by Munari & Magni (2014) because muds tend to be more cohesive and compacted than sand. Some mortality of the characterizing species is likely to occur. Resistance is therefore assessed as Low and resilience as High and the biotope is considered to have Low sensitivity to a 'heavy' deposition of up to 30 cm of fine material in a single discrete event. De-Bastos and Hill, 2016).
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?)	Medium	High	**Low**	**Light:** This biotope is exposed to tidal streams which may remove some sediments, but the bivalves and polychaetes are likely to be able to survive short periods under sediments and to reposition. However, as the pressure benchmark refers to fine material, this may be cohesive and species characteristic of sandy habitats may be less adapted to move through this than sands. Biotope resistance is assessed as 'Medium' as some mortality of characterizing and associated species may occur. Biotope resilience is assessed as 'High' and biotope sensitivity is assessed as 'Low' (Tillin, 2016b).
				Medium	Medium	**Medium**	**Heavy:** The character of the overburden is an important factor determining the degree of vertical migration of buried bivalves. Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type. Resistance is assessed as 'Low' as few individuals are likely to reposition. Resilience is assessed as 'Medium' and sensitivity is assessed as 'Medium' (Tillin, 2016b).
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand	High	High	**Not sensitive**	**Light**: As the biotope is associated with wave exposed habitats or those with strong currents, some sediment removal will occur, mitigating the effect of deposition. The mobile polychaete *Nephtys cirrosa* and amphipods are likely to be able to burrow through a 5cm layer of fine sediments. Biotope resistance is therefore assessed as 'High' and resilience as 'High' (by default). The biotope is therefore considered to be 'Not sensitive' to this pressure. Repeated deposits or deposits over a large area or in sheltered systems that were shifted by wave and tidal action may result in sediment change (see physical change pressure). (Tillin and Gerrard, 2019).

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
				Low	High	**Low**	**High:** The thickness of sediment applied during beach nourishment is likely to exceed the 30cm pressure benchmark but the results from studies on the activity are informative, particularly with regard to recovery rate. Sediment removal by wave action could mitigate the level of effect but overall smothering by fine sediments is likely to result in mortality of characterizing amphipods and isopods and possibly *Nephtys cirrosa*. Biotope resistance is therefore assessed as 'Low' and resilience as High (based on Leewis et al., 2012), biotope sensitivity is therefore assessed as 'Low'. (Tillin and Gerrard, 2019).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)	Medium	High	**Low**	**Light:** Removal of 5cm of sediment is likely to be occur and mortality among the characterizing species is unlikely. Therefore, resistance is assessed as 'High', resilience as 'High' and the biotope is 'Not sensitive' at the benchmark level (Readman, 2016b).
				Medium	High	**Low**	**Heavy:** The evidence suggests that the characterizing Crepidula fornicata is quite resilient to sedimentation and burial, however, mortality could not be ruled out. Whilst the polychaetes are unlikely to be affected, the faunal community is likely to be entirely buried.. Where the biotope occurs in lower energy, removal of the sediment may be prolonged. Resistance is, therefore, assessed as 'Low', resilience as 'High' and sensitivity as 'Low' (Readman, 2016b).
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments [6]	Medium	High	**Low**	**Light:** Bivalves and polychaetes are likely to be able to survive short periods under sediments and to reposition. However, as the pressure benchmark refers to fine material, this may be cohesive and species characteristic of sandy habitats may be less adapted to move through this than sands. Biotope resistance is assessed as 'Medium' as some mortality of characterizing and associated species may occur. Biotope resilience is assessed as 'High' and biotope sensitivity is assessed as 'Low' (Tillin, 2016c).
				Medium	Medium	**Medium**	**Heavy:** The character of the overburden is an important factor determining the degree of vertical migration of buried bivalves. Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type. Resistance is assessed as 'Low' as few individuals are likely to reposition. Resilience is assessed as 'Medium' and sensitivity is assessed as 'Medium' (Tillin, 2016c).
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment[7]	High	High	**Not Sensitive**	**Light:** In areas of high water flow dispersion of fine sediments may be rapid and this will mitigate the magnitude of this pressure by reducing the time exposed. Based on the experiments by Last et al. (2011) which are considered relevant to the pressure benchmark, resistance and resilience are assessed as 'High' and this biotope is considered to be 'Not sensitive' (Tillin *et al.*, 2020).
				None	Medium	**Medium**	**Heavy:** No direct evidence was found for the length of time that Sabellaria spinulosa can survive beneath 30 cm of sediment. In areas of high water flow dispersion of fine sediments may be rapid and this will mitigate the magnitude of this pressure by reducing the time exposed. However, this mitigating effect was not taken into account as it depends on site-specific conditions. Resistance was assessed as 'None' due to the depth of overburden. Resilience was assessed as 'Medium' (2-10 years) and sensitivity was therefore categorised as 'Medium' (Tillin *et al.*, 2020).
Underwater noise changes							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	NR	NR	**NR**	Not relevant (Tillin and Budd, 2002).
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	NR	NR	**NR**	Not relevant (Tillin, 2018).
	A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	NR	NR	**NR**	Not relevant (Tillin, 2016a).
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock[1]	High	High	**Not sensitive**	(Readman, 2016a)
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay[2]	NR	NR	**NR**	Not relevant (Tillin and Hill, 2016).
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	NR	NR	**NR**	*Polydora ciliata* may respond to vibrations from predators or bait diggers by retracting their palps into their tubes. However, the species is unlikely to be affected by noise pollution and so the biotope is assessed as Not Sensitive (De-Bastos and Hill, 2016).
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?)	NR	NR	**NR**	Not relevant (Tillin, 2016b).
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand	NR	NR	**NR**	Not relevant (Tillin and Gerrard, 2019).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)	NR	NR	**NR**	Not relevant (Readman, 2016b).
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	NR	NR	**NR**	Not relevant (Tillin, 2016c).
	A5.6	A5.61	A5.611	NR	NR	**NR**	Not relevant (Tillin *et al.*, 2020).

Broad Habitat Level 2	Habitat Complex Level 3	Biotope Complex Level 4	Biotope Level 5 / 6	Resistance (Tolerance)	Resilience (Recovery)	Sensitivity	Justification
	Sublittoral biogenic reefs	Sublittoral polychaete worm reefs on sediment	*Sabellaria spinulosa* on stable circalittoral mixed sediment				
Introduction or spread of INNS							
A3 Infralittoral rock and other hard substrata	A3.1 Atlantic and Mediterranean high energy infralittoral rock	A3.11 Kelp with cushion fauna and/or foliose red seaweeds	A3.116 Foliose red seaweeds on exposed lower infralittoral rock	High	High	**Not sensitive**	As scour within this biotope limits establishment of all but robust species, resistance to INIS is assessed as 'High' and resilience as 'High' (by default) so that the biotope is considered to be 'Not sensitive' to this pressure (Tillin and Budd, 2002).
			A3.1161 Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	Medium	Very Low	**Medium**	Where this biotope is subject to scour, the establishment of all but robust species will be inhibited. However, some examples of this biotope may be subject to only moderate scour (JNCC, 2015). Therefore, resistance to INIS is assessed as 'Medium'. Without human intervention, the INIS may persist in the habitat and recovery is, therefore, prolonged, if it occurs at all. Hence, resilience is assessed as 'Very low' so that the biotope is considered to have 'Medium' sensitivity to this pressure (Tillin, 2018).
	A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	A3.21 Kelp and red seaweeds (moderate energy infralittoral rock)	A3.215 Dense foliose red seaweeds on silty moderately exposed infralittoral rock	High	High	**Not sensitive**	As siltation and turbidity experienced by this biotope limits establishment of all but tolerant species, resistance to INIS is assessed as 'High' and resilience as 'High' (by default) so that the biotope is considered to be 'Not sensitive' (Tillin, 2016a).
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	High	High	**Not sensitive**	Stanley et al. (2014) studied the effects of vessel noise on fouling communities and found that the bryozoans Bugula neritina, Watersipora arcuate and Watersipora subtorquata responded positively. More than twice as many bryozoans settled and established on surfaces with vessel noise (128 dB in the 30–10,000 Hz range) compared to those in silent conditions. Growth was also significantly higher in bryozoans exposed to noise, with 20% higher growth rate in encrusting and 35% higher growth rate in branching species. No evidence could be found for the effects of noise on sponges but they are unlikely to be sensitive. Sensitivity assessment. Resistance to this pressure is assessed as 'High' and resilience as 'High'. This biotope is therefore considered to be 'Not sensitive' at the benchmark level (Readman, 2016a).
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	High	High	**Not sensitive**	Based on the lack of records of invasive non-indigenous species in this biotope, and the unsuitability of the habitat for algae and other attached epifauna this biotope is considered to have 'High' resistance to this pressure and, by default 'High' resilience, this biotope is therefore considered to be 'Not sensitive'. This assessment may need revising in light of future invasions, e.g. the introduction of the whelk *Rapana venosa* (Tillin and Hill, 2016).
			A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	NR	NR	**NR**	There is no evidence on the presence of non-indigenous species or impacts of non-indigenous species relevant to this biotope (De-Bastos and Hill, 2016).
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	A5.133 Moerella spp. with venerid bivalves in infralittoral gravelly sand (?)	None	Very Low	**High**	The sediments characterizing this biotope are likely to be too mobile or otherwise unsuitable for most of the recorded invasive non-indigenous species currently recorded in the UK. The slipper limpet may colonize this habitat resulting in habitat change and potentially classification to the biotope which is found in similar habitats SS.SMx.IMx.CreAsAn. Didemnum sp. and non-native predatory gastropods may also emerge as a threat to this biotope, although more mobile sands may exclude Didemnum. Based on Crepidula fornicata, biotope resistance is assessed as 'None' and resilience as 'Very Low' (as removal of established non-native is unlikely), so biotope sensitivity is assessed as 'High'(Tillin, 2016b).
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand	High	High	**Not sensitive**	The sediments characterizing this biotope are mobile and frequent disturbance limits the establishment of marine and coastal invasive non-indigenous species as the habitat conditions are unsuitable for most species, as exemplified by the low species richness characterizing this biotope. This biotope is therefore considered to have 'High' resistance to this pressure and high resilience (by default), and is assessed as 'Not sensitive' to this pressure (Tillin and Gerrard, 2019).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)	NR	NR	**NR**	These biotopes are dominated by Crepidula fornicata, which is itself an Invasive Non-Indigenous Species. It has spread widely through Europe following introduction from North America at the end of the 19th century (Fretter & Graham, 1981; Eno et al., 1997). The invasive ascidian Styela clava is also present in SS.SMx.IMx.CreAsAn. This pressure is therefore 'Not relevant' (Readman, 2016b).
		A5.44 Circalittoral mixed sediments	-	Not available at this level	Not available at this level	**Not available at this level**	Not available at this level
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	None	Very Low	**High**	The sediments characterizing this biotope are likely to be too mobile or otherwise unsuitable for most of the recorded invasive non-indigenous species currently recorded in the UK. The slipper limpet may colonize this habitat resulting in habitat change and potentially classification to the biotope which is found in similar habitats SS.SMx.IMx.CreAsAn. Non-native predatory gastropods may also emerge as a threat to this biotope. Based on Crepidula fornicata, biotope resistance is assessed as 'None' and resilience as 'Very Low' (as removal of established non-native is unlikely), so biotope sensitivity is assessed as 'High' (Tillin, 2016c).
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment	High	High	**Not sensitive**	No evidence was found that non-indigenous species are currently significantly impacting Sabellaria spinulosa reef biotopes. Based on current evidence, resistance is therefore assessed as 'High' and resilience as 'High' (no impact to recover from), so that all the Sabellaria spinulosa reef biotopes are assessed as 'Not Sensitive'. However, it should be noted that Crepidula fornicata and Magallana gigas may pose a potential threat in terms of competition for food and space and so this assessment may require updating in the future as the distributions and interactions between these species are better understood (Tillin *et al.*, 2020).

10.4.3 References

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