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Biodiversity Metric 2.0: Technical Guidance for Intertidal Habitats

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1. Foreword

This guidance provides the technical resources behind the scores included in the intertidal metric and information to support condition assessments; further detail about the metric can be found in the general guidance documents.

2. Intertidal Habitat definitions:

The UK Habitats Classification (UKHab classification) which is used for most habitats in the metric was not considered suitable for the assessment of intertidal habitats as it includes only a limited number of intertidal and marine habitats.

The European Nature Information System, (EUNIS[1]) is a comprehensive pan-European system developed to facilitate the harmonised description and collection of data across Europe; it covers all habitats types from natural to artificial, and through to the marine environment. The EUNIS habitat classification system is the habitat classification used in reporting across the marine environment, in Europe, and is compatible with marine protected areas' (MPA) monitoring data. Habitats are reported in EUNIS for national and international, biodiversity and natural capital work. For many areas there is preliminary data available through Magic maps[2] or Emodnet[3] EUNIS provides a more comprehensive assessment of inter-tidal habitats that does UKHab and so has been selected to use as the inter-tidal habitat classifications used in Biodiversity Metric 2.0. Habitat types are defined for the purposes of the EUNIS classification as 'plant and animal communities as the characterising elements of the biotic environment, together with abiotic factors operating together at a particular scale.'

European Nature Information System is the habitat classification used for intertidal habitats within the metric. Levels 1 and 2 of the classification simply define the habitat as 'marine' (EUNIS "A") and its location in relation to the tide and depth. At EUNIS level 2, the habitats that will be included in this section of the metric are those located below the mean high water mark with clear marine origin: (A1) Littoral rock and other hard substrate; (A2) Littoral sediment; and (X02/03) Coastal lagoons.

Classifications at Levels 1 and 2 are too broad to result in any meaningful assessment. Whilst EUNIS Level 3 is appropriate for reporting in the majority of circumstances, EUNIS Level 4 and 5 will provide the additional detail needed to separate higher and lower value habitats for certain habitat complexes and allows for the identification of Annex 1[4] and Section 41 Priority Habitats[5] (e.g. *peat and clay exposures* from *high energy littoral rock*). Hence, EUNIS

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[1] http://eunis.eea.europa.eu/habitats-code-browser.jsp?expand=A#level_A
[2] https://magic.defra.gov.uk/home.htm
[3] https://www.emodnet-seabedhabitats.eu/
[4] The Conservation of Habitats and Species Regulations 2017. http://www.legislation.gov.uk/uksi/2017/1012/contents/made
[5] Natural Environment and Rural Communities Act 2006. http://www.legislation.gov.uk/ukpga/2006/16/contents#Scenario5Help

Level 4 should be used to record intertidal habitats so that high value and irreplaceable habitats are identified at an early stage of the process. However, the process needs to be simple, functional but accurate, hence, other parameters within the metric are defined at EUNIS level 2/3.

Artificial habitats have been manually added to the metric where needed. Habitats considered as non-tradeable are identified in the metric as those which occur over bedrock, this distinction includes habitats on peat, clay or chalk.

It is important to note that habitats on bedrock (including peat/clay/chalk) might not be assessed at a European Nature Information System (EUNIS) level that indicates its presence. These habitats fall under EUNIS level 3 A1.1 High energy littoral rock, A1.2 Moderate energy littoral rock, A1.3 Low energy littoral rock, A1.4 Features of littoral rock, A2.6 Littoral sediments dominated by aquatic angiosperms.

3. Area:

Highly dynamic nature of intertidal environments as well as the presence of ephemeral habitats make the definition of habitat more challenging. To address these challenges, approaches such as habitat buffers based on a projected movement over a period of time on mobile habitats like sandbanks[6], or the identification of the core reef[7] for biogenic reefs have been developed. Although these approaches are worth exploring it is important to keep in mind that the metric is to be used as a tool to inform decision making. Hence, area measurements are considered to be a suitable proxy for assessing the extent of a habitat impacted for the purpose of the metric. The unit of area measurement the metric is hectares

4. Distinctiveness:

All habitats are scored for distinctiveness at EUNIS level 3 (see table 1). It is considered that all semi-natural and natural intertidal habitats are of sufficient importance for nature conservation that they require a distinctiveness category of at least '*high'*. Some natural intertidal habitats, like those on bedrock including peat & clay exposures and chalk, are considered irreplaceable due to their unique origin, low or lack of resilience and limited recoverability from impacts. These habitats are formed through complex geological processes, and peat, clay and chalk exposures are uncommon or of significant international importance adding to the biodiversity interest where they occur. As a result these

[6] Guidance developed by JNCC for sandbanks (JNCC, 2008. UK guidance on defining boundaries for marine SACs for Annex I habitat sites fully detached from the coast) and used to define the boundaries of Special Area of Conservation (SAC) such as Hainsborough, Hammond and Winterton : http://jncc.defra.gov.uk/pdf/HHW_SACSAD_v6.0.pdf

[7] *Sabellaria spinulosa* reef presence is highly variable in space and time, which poses a challenge when developing advice on management of the feature. Using the core reef approach, areas which most consistently support reef, evidenced by datasets with the highest confidence, are identified as 'core reef'. Similarly, buffers are defined for some mobile habitats like sandbanks taking in consideration the movement as well as the accuracy of the definition of the limit of the feature: http://publications.naturalengland.org.uk/publication/5970080978960384

vulnerable habitats have a distinctiveness score of '*very high*' for net gain delivery actions but are considered non-tradeable for net gain loss calculations. Artificial habitats have been included in the metric with a score of '*low'* (table 1). As explained in the general guidance, habitats that have been restored by re-establishing natural processes and created with the aim of biodiversity conservation will be considered 'natural' and of high distinctiveness.

5. Habitat Condition:

Condition tables have been developed for a simple assessment of the quality condition of the intertidal habitats. These include a habitat description, a series of criteria for assessing the habitat's condition and the definition of each condition level. These tables can be found in Annex I. An indication of the condition table that will need to be used for each habitat type is in Table 1.

Table 1. Habitats distinctiveness included within the intertidal biodiversity metric 2.0 and its corresponding condition tables

EUNIS code	EUNIS name	Distinctiveness	Broad habitat type for condition
X02/03	Coastal lagoons	High	Coastal lagoons
A1.1	High energy littoral rock	High	Rocky Shore
A1.1	High energy littoral rock - on bedrock including chalk, peat or clay	Very high	Rocky Shore
A1.2	Moderate energy littoral rock	High	Rocky Shore
A1.2	Moderate energy littoral rock - on bedrock including chalk, peat or clay	Very High	Rocky Shore
A1.3	Low energy littoral rock	High	Rocky Shore
A1.3	Low energy littoral rock - on bedrock including chalk, peat or clay	Very High	Rocky Shore
A1.4	Features of littoral rock	High	Rocky Shore
A1.4	Features of littoral rock - on bedrock including chalk, peat or clay	Very High	Rocky Shore
ART_A1.1	Artificial high energy littoral rock	low	Rocky Shore
ART_A1.2	Artificial moderate energy littoral rock	low	Rocky Shore
ART_A1.3	Artificial low energy littoral rock	low	Rocky Shore
ART_A1.4	Artificial features of littoral rock	low	Rocky Shore
A2.1	Littoral coarse sediment	High	Intertidal sediment

EUNIS code	EUNIS name	Distinctiveness	Broad habitat type for condition
A2.2	Littoral sand and muddy sand	High	Intertidal sediment
A2.3	Littoral mud	High	Intertidal sediment
A2.4	Littoral mixed sediments	High	Intertidal sediment
A2.5	Coastal saltmarshes and saline reed beds	High	Coastal saltmarsh
A2.6	Littoral sediments dominated by aquatic angiosperms	High	Intertidal sediment
A2.6	Littoral sediments dominated by aquatic angiosperms - on bedrock including chalk, peat or clay	Very high	Intertidal sediment
A2.7	Littoral biogenic reefs	High	Intertidal sediment
A2.7	Littoral biogenic reefs - on bedrock including chalk, peat or clay	Very high	Intertidal sediment
A2.8	Features of littoral sediment	High	Intertidal sediment
ART_A2.1	Artificial littoral coarse sediment	low	Intertidal sediment
ART_A2.2	Artificial littoral sand and muddy sand	low	Intertidal sediment
ART_A2.3	Artificial littoral mud	low	Intertidal sediment
ART_A2.4	Artificial littoral mixed sediments	low	Intertidal sediment
ART_A2.5	Artificial coastal saltmarshes and saline reed beds	low	Coastal saltmarsh
ART_A2.6	Artificial littoral sediments dominated by aquatic angiosperms	low	Intertidal sediment
ART_A2.7	Artificial littoral biogenic reefs	low	Intertidal sediment
ART_A2.8	Artificial features of littoral sediment	low	Intertidal sediment

6. Connectivity:

The recommended connectivity distance for the Biodiversity Metric calculations will use a precautionary value of 20km in the intertidal zone. This has been arrived at on the basis of earlier research that looked at connectivity in the intertidal zone. In 2010, Natural England commissioned a study (NECR037[8]) to examine two of the criteria to be assessed when creating a Marine Protected Area (MPA) in an ecologically coherent network of MPAs. These were; 1) Adequacy/Viability i.e. is the site large enough to allow for most ecological processes to operate within the area, and 2) Connectivity i.e. are the MPAs suitably spaced

[8] Roberts, C.M., J.P. Hawkins, J. Fletcher, S. Hands, K. Raab, and S. Ward. 2010. Guidance on the size and spacing of Marine Protected Areas in England (NECR037). Natural England. http://publications.naturalengland.org.uk/publication/46009

to allow for propagule dispersal and movement of adults to facilitate recolonization of a site should a species be lost.

This report suggested that MPAs supporting similar habitats should ideally be spaced no more than 40-80km apart to ensure sufficient ecological connectivity. These values were used for the assessment of the MPA Network Gap Analysis[9] by JNCC for the designation process and described in Criteria VII: “Sites affording protection to the same broad habitat type (equivalent to EUNIS Level 2) should not be further than 80km apart to increase the likelihood that sites with similar features are ecologically connected to each other”. These distances combined with a minimum MPA size of 10-20km^2 were considered sufficient to encompass the range of dispersal distances exhibited by the majority of species with a meroplanktonic life-stage. However, the model used (POLPRED model) uses passive drifting and tidal currents (wind-driven currents were not considered) which are unreliably modelled in areas within 5km of the shore. The behavioural aspects of larvae were not included in the model and so do not take into account vertical migration of larvae within the water column, site retention or larval mortality rates.

7. Risk factors

Intertidal (or littoral) zones are transitional coastal regions influenced by tidal cycles and wave energy. The abiotic environment and factors such as sediment transport strongly influence biotic environment. Many of these processes are hard to control and will influence the ability to deliver specific restoration or creation targets. These factors are considered together with the technical difficulty of the habitat restoration or creation.

The metric considers the risk of any proposed net gain delivery through a series of risk factors. This is to ensure a fair evaluation of the delivery proposal’s biodiversity units in relation to the technical difficulty and time needed to reach the proposed target condition and its location.

8. Difficulty of creation/restoration

The intertidal or littoral zones are transitional coastal regions influenced by the cycling of the tides and the breaking of waves. The abiotic environment largely dictates the makeup of the biotic community. There are a series of factors, described below, that influence the likelihood of a successful habitat restoration or creation project. These factors are considered alongside the technical difficulty of restoring or recreating a habitat or habitat complex.

It is important to recognise that it is impossible to predict this precisely, as it all depends on the unique physical and ecological features of every site. On most occasions, restoration is

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[9] Carr, H., A. Cornthwaite, H. Wright, and J. Davies. 2016. Assessing progress towards an ecologically coherent MPA network in Secretary of State Waters in 2016: Methodology. Joint Nature Conservation Committee http://jncc.defra.gov.uk/pdf/JNCC_NetworkProgressInSoSWaters2016_Methods_Final.pdf

far more effective than creation. There are three possible categories for any habitat (low, medium, high). Factors that influence the outcome of any action have been set, assuming that the site for net gain delivery has been carefully chosen and is suitable for the proposed action.

i. Technical difficulty of creation/restoration:

This parameter takes in consideration the technical difficulty of any action. Creation or restoration of a habitat can involve a range of interventions from land abandonment to significant engineering works.

ii. Hydrological Requirements

All intertidal habitats are highly dynamic, subject to daily movement of water of varying salinities. Some intertidal habitats (and their associated species) are tolerant of variable water levels with longer periods of tidal exposure, whilst some require more stable conditions with shorter periods of exposure. In saltmarsh habitats, for example, elevation and slope lead to variable inundation and exposure times, with creeks and channels providing areas with longer phases of submersion. When habitats have specific hydrological requirements, the difficulty of recreation or restoration increases. In addition, the ability to initiate restoration of suitable hydrological requirements may depend on complex engineering projects.

iii. Hydrophysical regime

The hydrophysical regime of an intertidal area is the net result of all factors affecting water movement. This will determine the physical integrity of the sedimentary systems, in particular its dynamicity. Intertidal areas can be exposed to a wide range (very low to very high) of energy levels depending on their geographic location and position along the coast. An understanding of the hydrodynamic (current) regime is important as it has the primary role of delivering particles, food and dispersal stages of organisms to and from an area (Elliott et al 1998[10]).

The restoration/creation of habitats that require high energy environments will carry higher risk.

iv. Salinity regime

Intertidal habitats extend from estuaries to open coast. All intertidal habitats will be able to withstand some degree of changes in salinity. However, species distribution can be largely

[10] M.Elliott, S.Nedwell, N.V.Jones, S.J.Read, N.D.Cutts, K.L.Hemingway. 1998. Intertidal Sand and Mudflats & Subtidal Mobile Sandbanks (volume II). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project). 151 Pages.

dominated by salinity ranges. For example, estuaries and coastal lagoons are primarily controlled by salinity and topographical features (McLusky, 1989[11]). The modification of salinity by changes to the hydrophysical regime is likely to lead to changes in species' distributions, especially the degree of landward penetration of marine organisms as well as the species composition of coastal lagoons. Habitats, and their associated species, that occur in a range of salinities will be easier to recreate or restore.

v. Elevation/Aspect

Elevation is related to several other factors. Elevation is indirectly related to duration and depth of tidal inundation and usually directly related with energy levels and drainage. Inclination and aspect can play important roles in determining the communities present through species' tolerance to the degree of exposure to sunlight and drying conditions in a habitat. For example, on rocky shores, overhangs and crevices shaded from the sun will allow for overall damper conditions compared to those directly exposed to the sun. The more restricted the requirement of a habitat is, in terms of the elevation and complexity, the more difficult it will be to restore or create.

vi. Seed Source or Biological Material Requirements

The availability of organisms that comprise the habitat will restrict the success of a restoration/creation and the speed at which it occurs. Many habitats such as mussel beds, oyster reefs, or seagrass beds require a supply of propagules (seeds/spats/larvae) to exist. Habitats that do not need human intervention and natural succession can occur once the right conditions are in place, may have greater chance of successful restoration and are given a 'low' score. Where initial seeding, maintenance of larval supply or promotion is needed, a 'medium' score is applied. A 'high' score is applied to those habitats that will require complex seeding and establishment techniques.

vii. Future constraints including Climate Change:

Several unmanageable pressures will limit the success of a restoration or creation project for sensitive habitats. To take account of known current climatic trends, a temperature change of plus 2°C with sea level rise in all emissions scenarios. Species have already been responding to the 1°C increase we have had in the last 40 years. According to the UN's Intergovernmental Panel on Climate Change[12], it is predicted that warming will bring a sea level rise of up to one metre by 2100. Moreover, it is virtually certain that global mean sea level rise will continue to rise beyond 2100 to a level that will depend on future emissions. This parameter highlights how these and other future constraints will affect the new or restored habitats success. In the intertidal, habitats will be very sensitive to sea level rise

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[11] McLusky, D. S. 1989: The Estuarine Ecosystem. 2nd edition. Blackie and Son Ltd... 215pp. ISBN 0-216-92672-6 (U.K.); ISBN 0-412-02101-3

[12] https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter13_FINAL.pdf

and other factors associated to climate change (temperature, acidification, wave energy, oxygen availability etc.).

viii. Trophic Status Conditions

Trophic Status describes bodies of water based on the amount of biological activity they sustain.

- **Oligotrophic:** have the least amount of biological productivity and are nutrient-poor;
- **Mesotrophic**: a moderate level of biological activity, with moderate nutrient input;
- **Eutrophic**: the highest amount of biological activity, with high levels of nutrient input.

The categories above are used to describe the overall state of fertility or "trophic status" of aquatic ecosystems. Contrarily, eutrophication describes a process rather than a trophic state, when there is an increase in the rate of supply of organic matter (OM) to an ecosystem.

The restoration or creation of cleaner habitats (i.e. those that are oligotrophic) will be expected to be more complex, due to existing issues of water quality and nutrient enrichment from anthropogenic sources.

ix. Water Quality Needs

Water quality affects the intertidal and the quality of any habitat within it. When water quality is poor, species composition and biodiversity can be compromised as many habitats and species are reliant on a good water quality. Some habitats will only exist in areas with good water quality, some others might be more tolerant and can exist in areas of poorer water quality.

Ongoing Management Requirements

When little or no ongoing management is required, it is expected that habitat restoration and creation will be easier. This highlights those habitats that will need regular management, and is expected to be related to the complexity of the habitat.

Habitats are assigned a score for each parameter considered to be relevant to in order evaluate the degree of difficulty of restoration/creation actions (table 2) and the sum of the scores is calculated (Table 3). The parameters that score the same across all habitats (see parameters in red in table 3: future constrains, water quality, and management requirements) are not accounted for in the final score calculation. All intertidal habitats are understood to be very sensitive to climate change and associated pressures (such as sea-level rise, acidification, increased wave energy, etc.), require good water quality and most do not need the levels of maintenance that terrestrial habitats require, so none of these three parameters (Future constraints incl. Climate Change, Water Quality Needs and Ongoing Management Requirements) are included in the calculation of the final difficulty score. It is important to be clear that this is not to dismiss the importance of those parameters but to allow for an assessment that includes a degree of variability, so that the remaining factors have greater significance in the overall score. The factors not included in the final calculation still should be considered in the project specific net gain conversations.

Table 2. Degree of Difficulty of Restoration/Creation: Parameters and their Assessments

PARAMETER	**Low**	**Medium**	**High**
	1	**2**	**3**
Technical difficulty of Restoration	Abandonment	Limited Preparation	Significant Engineering
Technical difficulty of Creation	Abandonment	Limited Preparation	Significant Engineering
Hydrological Requirements	Basic	Moderate	Complex
Hydrophysical regime required	Low energy	Medium energy	High energy
Salinity regime tolerated	Wide range	Medium Range	Specific
Elevation/aspect required	Wide range	Medium Range	Specific
Seed Source / biological material requirements	Natural Succession	Initial seeding	Extensive planting and seeding
Future constraints including Climate Change	Low	Medium	High & or Sea Level Rise
Trophic Status Conditions tolerance/presence	Eutrophic (High levels of nutrients present)	Mesotrophic (Moderate levels of nutrients present)	Oligotrophic (Very low levels present)
Water Quality Needs	Not specific	Fair	Good
Ongoing Management Requirements	no maintenance	light maintenance	high maintenance

The evaluation of difficulty of creation/restoration for each habitat type is set out in Table 3. The minimum score for difficulty of habitat creation or restoration is 7 and the maximum is 21. It is important to note that in these calculations habitat creation takes a more precautionary line, as the creation of habitats in the intertidal is largely untested. Therefore, habitat restoration with an overall risk score between 7 and 11 will be considered low risk, a score between 12 and 16 will be medium risk, and between 17 and 21 high risk. However, for habitat creation, a risk evaluated between 7 and 11 will be of low risk, 12 to 15 of medium risk and 16 to 21 of high risk.

Table 3. Scoring for difficulty of restoration and creation of intertidal habitats. The parameters categorical assessment and assessment and its corresponding value are shown for each parameter.

Habitat	Overall risk score for restoration (creation)	Technical difficulty of Restoration	Technical difficulty of Creation	Hydrological Requirements	Hydrophysical regime	Salinity regime	Elevation/aspect	Seed Source / biological material requirements	Future constraints inc. Climate Change	Trophic Status Conditions	Water Quality Needs	Ongoing Management Requirements
		[Land Abandonment; Limited Preparation; Significant Engineering]	[Land Abandonment; Limited Preparation; Significant Engineering]	[Basic, Moderate, Complex]	[low energy, medium energy, high energy environment]	[variable, medium range, specific salinity requirements]	[variable, medium range, specific inclination requirements]	[Natural succession, initial seeding, extensive planting/seeding]	[low, medium, high or sea-level rise]	[Eutrophic, mesotrophic, oligotrophic]	[poor, fair, good]	[no management, low maintenance, high maintenance]
Coastal lagoons	**med(med)**	Significant engineering	Significant Engineering	Moderate	Low energy	medium range	medium	Natural succession	High	Eutrophic	good	Low maintenance
	12/12	3	3	2	1	2	2	1	3	1	3	2
High energy littoral rock	**med(high)**	Limited Preparation	Significant Engineering	Moderate	high energy environment	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	15/16	2	3	2	3	2	3	1	3	2	3	2
High energy littoral rock - on bedrock including chalk, peat or clay	**med(N/A)**	Limited Preparation	N/A	Moderate	high energy environment	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	15/13	2	-	2	3	2	3	1	3	2	3	2

NOTE: The overall risk assessment does not include the parameters in red.
KEY: 'N/A' and '-' indicate that an option is not possible or permitted within the metric calculation. Parameters in red are those that score the same across all habitats and are not included in the overall score

Habitat	Overall risk score for restoration (creation)	Technical difficulty of Restoration	Technical difficulty of Creation	Hydrological Requirements	Hydrophysical regime	Salinity regime	Elevation/aspect	Seed Source / biological material requirements	Future constraints inc. Climate Change	Trophic Status Conditions	Water Quality Needs	Ongoing Management Requirements
Moderate energy littoral rock	**med(high)**	Limited Preparation	Significant Engineering	Moderate	medium energy	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	14/15	2	3	2	2	2	3	1	3	2	3	2
Moderate energy littoral rock - on bedrock including chalk, peat or clay	**med(N/A)**	Limited Preparation	N/A	Moderate	medium energy	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	14/12	2	-	2	2	2	3	1	3	2	3	2
Low energy littoral rock	**low(med)**	Limited Preparation	Significant Engineering	Moderate	low energy	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	11/14		3	2	1	2	3	1	3	2	3	2
Low energy littoral rock - on bedrock including chalk, peat or clay	**med(N/A)**	Limited Preparation	N/A	Moderate	low energy	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	13/11	2	-	2	1	2	3	1	3	2	3	2
Features of littoral rock	**med(high)**	Limited Preparation	Limited Preparation	Moderate	medium energy	specific salinity requirements	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	15/15	2	2	2	2	3	3	1	3	2	3	2
Features of littoral rock - on bedrock including chalk, peat or clay	**med(N/A)**	Limited Preparation	N/A	Moderate	medium energy	specific salinity requirements	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	15/13	2	-	2	2	3	3	1	3	2	3	2

Habitat	Overall risk score for restoration (creation)	Technical difficulty of Restoration	Technical difficulty of Creation	Hydrological Requirements	Hydrophysical regime	Salinity regime	Elevation/aspect	Seed Source / biological material requirements	Future constraints inc. Climate Change	Trophic Status Conditions	Water Quality Needs	Ongoing Management Requirements
Littoral coarse sediment	**med(high)**	Limited Preparation	Significant Engineering	Moderate	high energy environment	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	15/16	2	3	2	3	2	3	1	3	2	3	2
Littoral sand and muddy sand	**med(high)**	Limited Preparation	Significant Engineering	Moderate	Medium energy environment	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	14/15	2	3	2	2	2	3	1	3	2	3	2
Littoral mud	**med(med)**	Limited Preparation	Significant Engineering	Moderate	low energy environment	medium range	Specific	Natural Succession	High	Eutrophic	good	low maintenance
	12/13	2	3	2	1	2	3	1	3	1	3	2
Littoral mixed sediments	**med(high)**	Limited Preparation	Significant Engineering	Moderate	medium energy environment	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	14/15	2	3	2	2	2	3	1	3	2	3	2
Coastal saltmarshes and saline reed beds	**med(high)**	Limited preparation	Significant Engineering	Complex	Low energy	medium range	Specific	Natural succession	High	mesotrophic	good	light maintenance
	14/15	2	3	3	1	2	3	1	3	2	3	2
Littoral sediments dominated by aquatic angiosperms	**high(high)**	Limited Preparation	Limited Preparation	Complex	low energy environment	specific salinity requirements	Specific	extensive planting/seeding	High	Oligotrophic	good	low maintenance
	18/18	2	2	3	1	3	3	3	3	3	3	2

Habitat	Overall risk score for restoration (creation)	Technical difficulty of Restoration	Technical difficulty of Creation	Hydrological Requirements	Hydrophysical regime	Salinity regime	Elevation/aspect	Seed Source / biological material requirements	Future constraints inc. Climate Change	Trophic Status Conditions	Water Quality Needs	Ongoing Management Requirements
Littoral sediments dominated by aquatic angiosperms - on bedrock including chalk, peat or clay	**high(N/A)**	Limited Preparation	N/A	Complex	medium energy	specific salinity requirements	Specific	extensive planting/seeding	High	Oligotrophic	good	low maintenance
	19/17	2	-	3	2	3	3	3	3	3	3	2
Littoral biogenic reefs	**med(high)**	Limited Preparation	Limited Preparation	Moderate	medium energy	medium range	Specific	initial seeding	High	Mesotrophic	good	low maintenance
	15/15	2	2	2	2	2	3	2	3	2	3	2
Littoral biogenic reefs - on bedrock including chalk, peat or clay	**med(N/A)**	Limited Preparation	N/A	Moderate	medium energy	medium range	Specific	initial seeding	High	Mesotrophic	good	low maintenance
	15/13	2	-	2	2	2	3	2	3	2	3	2
Features of littoral sediment	**med(med)**	Limited Preparation	Limited Preparation	Moderate	medium energy	medium range	Specific	Natural Succession	High	Mesotrophic	good	low maintenance
	14/14	2	2	2	2	2	3	1	3	2	3	2

9. Temporal Risk:

When there is a time lag between the development causing the negative impact on biodiversity and the compensation habitat reaching the required quality or level of maturity, there will be an overall loss of biodiversity for a period of time. On the biodiversity units' calculation for a proposed net gain delivery action, a devaluation factor needs to be applied to account for this. This devaluation relates to the number years it takes for a habitat to reach a given condition. As mentioned on the overall guidance, this issue can be managed by creation of compensation habitat ahead of the impact taking place, either through the setting up of habitat banks or, for projects with a long lead in, by starting the offset work well ahead of the development.

For most intertidal habitats there is either no previous experience of restoration and creation, or it is very limited. Hence, the time to target condition are indicative and based in some instances purely on expert judgement. It is important to note that the values given assume that the location chosen for a habitat is suitable for its restoration/creation. Moreover, for the purposes of the intertidal metric an average figure needs to be used, accepting that there will be variation from this central estimation. These figures are mostly based on expert judgement, hence, as evidence and monitoring data becomes available, these values might need to be revised and if needed adjusted. Figures for the temporal risk included in the metric are in Table 4.

Table 4. Time to target condition for creation and restoration of intertidal habitats. Irreplaceable habitats are given the maximum time to target condition (i.e.. >32 years) but they will be excluded from calculation of losses or creation

Area Habitat	**Time (years) to target condition for habitat creation**					**Time to target condition (years) for restoration**									
	Good	Fairly Good	Moderate	Fairly Poor	Poor	Poor - Fairly Poor	Poor - Moderate	Poor - Fairly Good	Poor - Good	Fairly Poor - Moderate	Fairly Poor - Fairly Good	Fairly Poor - Good	Moderate - Fairly Good	Moderate - Good	Fairly Good - Good
Coastal lagoons	10	8	5	3	1	1	4	6	10	3	6	9	4	6	4
High energy littoral rock	15	10	5	1	1	1	3	5	10	2	4	9	2	7	5
High energy littoral rock - on bedrock including chalk, peat or clay	32+	32+	32+	32+	32+	1	3	5	10	2	4	9	2	7	5
Moderate energy littoral rock	15	10	5	1	1	1	3	5	10	2	4	9	2	7	5
Moderate energy littoral rock - on bedrock including chalk, peat or clay	32+	32+	32+	32+	32+	1	3	5	10	2	4	9	2	7	5
Low energy littoral rock	15	10	5	1	1	1	3	5	10	2	4	9	2	7	5
Low energy littoral rock - on bedrock including chalk, peat or clay	32+	32+	32+	32+	32+	1	3	5	10	2	4	9	2	7	5
Features of littoral rock	15	10	5	1	1	1	3	5	10	2	4	9	2	7	5
Features of littoral rock - on bedrock including chalk, peat or clay	32+	32+	32+	32+	32+	1	3	5	10	2	4	9	2	7	5
Littoral coarse sediment	3	2	1	1	<1	1	1	1	2	1	1	1	1	1	1
Littoral sand and muddy sand	4	3	2	2	1	1	2	2	2	1	2	3	2	3	2
Littoral mud	6	4	3	2	1	2	4	5	6	2	2	4	2	2	2

Area Habitat	Time (years) to target condition for habitat <u>creation</u>					Time to target condition (years) for <u>restoration</u>									
	Good	Fairly Good	Moderate	Fairly Poor	Poor	Poor - Fairly Poor	Poor - Moderate	Poor - Fairly Good	Poor - Good	Fairly Poor - Moderate	Fairly Poor - Fairly Good	Fairly Poor - Good	Moderate - Fairly Good	Moderate - Good	Fairly Good - Good
Littoral mixed sediments	5	4	3	2	1	1	2	2	2	1	1	2	1	2	1
Coastal saltmarshes and saline reed beds	20	15	10	5	1	5	10	15	>20	>20	10	20	>20	>20	>20
Littoral sediments dominated by aquatic angiosperms	20	15	10	5	2	3	6	>10	>20	>10	10	15	>10	>10	>10
Littoral sediments dominated by aquatic angiosperms - on bedrock including chalk, peat or clay	32+	32+	32+	32+	32+	2	4	>7	>10	2	>3	>8	>3	>6	>3
Littoral biogenic reefs	15	10	5	3	3	2	4	>7	>10	2	>3	>8	>3	>6	>3
Littoral biogenic reefs - on bedrock including chalk, peat or clay	32+	32+	32+	32+	32+	2	4	>7	>10	2	>3	>8	>3	>6	>3
Features of littoral sediment	10	7	5	3	3	1	2	3	5	1	2	4	1	3	2

10. ANNEX I: Condition tables

Rocky Shore Quality Condition Table

Rocky Shore Habitat description

The geology and wave exposure of the rocky shore influence the form of the habitat, which can include vertical rock, shore platforms, boulder shores, or rocky reefs surrounded by areas of sediment. These two factors are also major influences on the associated marine communities (plants and animals). In general, rocky shores tend to be colonised by algae in wave-sheltered conditions, and by limpets, barnacles and mussels as wave-exposure increases. Relatively soft rock such as chalk and limestone can support boring species, whereas colonisation of basalt and granite is limited to the rock surfaces. In all cases there is a distinct zonation of species down the shore, which principally reflects the degree of immersion by the tide. Biogeographic differences are also apparent, with the littoral rock areas of South-west England tending to be richer in species than similar rocky habitats in the North and East.

Quality Assessment Criteria for Rocky Shore

1. **Extent & Distribution:** Total extent of rocky shore (measured in either m2/km2), and spatial distribution defined on a map.
2. **Presence / absence of listed notable communities/biotopes:** Spatial distribution of communities/biotopes across the feature according to agreed map (Phase 1))
3. **Presence / abundance⁺ of key structural and influential species:** Density of key structural species (or frequency of occurrence) (Methods aligning to those for community composition) and Presence / absence of influential species across the feature
4. **Non-native species and pathogens:** Presence/ Absence of non-native species across the feature (Mainly focussing on the MSFD non-native species list) and Abundance of selected non-native species across the feature (Mainly focussing on medium to high risk MSFD non-native species list)
5. **Species composition of component communities:** Species counts (or % cover) in quadrats across the feature, for multivariate or univariate analysis
6. **Water quality:** Species richness of macroalgae in specific locations across the feature, compared to the WFD's Reduced Species List for the Macroalgae Tool*.

* The rocky shore macroalgal index enables an assessment of the condition of the rocky shore by looking at the macroalgal taxonomic composition and cover.

+Abundances estimated using SACFOR abundance scales: http://archive.jncc.gov.uk/pdf/04_05_introduction.pdf

Quality	Assessment Criteria	Score
Good	• No evidence of pollution along the shore • Macroalgae Tool suggests water quality is 'High'. • None of the non-native species are present above 'Rare' on the SACFOR scale. Non-native seaweeds should occupy no more than 1% of the rocky shore. No High Risk undesirable species present. • Rocky shore communities/biotopes are as expected for that stretch.	3
Fairly good	• Only discrete and very localised pollution • Macroalgae Tool suggests water quality is 'Good'. • One or more non-native species are present at no more than the 'Occasional' level on the SACFOR scale. Non-native seaweeds should occupy no more than 1-9% of the rocky shore. No High risk undesirable species present. • Rocky shore communities/biotopes are as expected for that stretch.	2.5
Moderate	• Clear evidence of pollution. • Two or more non-native species are present at a 'Frequent' level on the SACFOR scale. Non-native seaweeds may occupy no more than 10-19% of the rocky shore. No High risk undesirable species present. • Macroalgae Tool suggests water quality is 'Moderate'. • Rocky shore communities/biotopes are missing one or more notable/structural/key species.	2
Fairly poor	• Evidence of pollution • Two or more non-native species are at a 'Common' level on the SACFOR scale. Non-native seaweeds occupy no more than 20-40% of the rocky shore. May contain isolated records of High Rick undesirable species, with other characteristics as Moderate – GBNNSS should be notified, • Macroalgae Tool suggests water quality is 'Poor'.	1.5

	• Rocky shore communities/biotopes are missing two or more notable/structural/key species.	
Poor	• Evidence of widespread pollution • Two or more non-native species are present at an 'Abundant' level on the SACFOR scale. Non-native seaweeds occupy more than 40% of the rocky shore. Contains High Risk undesirable species – GBNNSS should be notified. • Macroalgae Tool suggests water quality is 'Poor' • Rocky shore communities/biotopes are two or more notable/structural/key species.	1
	<u>High risk undesirable species</u> *Didemnum vexillum* – Carpet sea squirt *Hemigrapsus* spp. – Asian Shore crabs (*H. sanguineus, H. takanoi or H. penicillatus*) **Stebbing, P.; Murray, J.; Whomersley, P.; and Tidbury, H. 2014. Monitoring and surveillance for non-indigenous species in UK marine waters. Available** here	

Coastal Lagoons Condition Table

Coastal Lagoons Habitat description

- Coastal lagoons are areas of typically (but not always) shallow, coastal saline water which are wholly or partially separated from the sea by either natural or manmade barriers including sandbanks, shingle banks, sluices and weirs.
- They always retain a proportion of their water, even at low tide and may develop as brackish, fully saline or hyper-saline water bodies. They are found around the UK coast.
- Coastal lagoon can form naturally through percolation of sea water through sand or shingle barriers, or artificially through development of man-made barriers, such as sluices, that separate the lagoon from the direct influence of the tide. Freshwater input to coastal lagoons usually occurs from drainage of surrounding land or through groundwater seepage.
- The substrate of coastal lagoon is mostly soft sediments.
- Coastal lagoons support a number of rare species of invertebrates and plants that are adapted to survive in lagoons where the environment can be stressful. These species include animals such as the lagoon sand shrimp (*Gammarus insensibilis*), tentacled lagoon worm (*Alkmaria romijni*), lagoon sea slug (*Tenellia adspersa*), starlet sea anemone (*Nematostella vectensis*), lagoon sand worm (*Armandia cirrhosa*) and plants such as the foxtail stonewort (*Lamprothamnium papulosum*). These species or their habitat are protected under the Wildlife and Countryside Act 1981 (as amended). Other species characteristic of coastal lagoons include the lagoon cockle (*Cerastoderma glaucum*) and the crustacean *Idotea chelipes.*
- Coastal lagoons provide a highly important resource for large numbers of birds that use the habitat for feeding, nesting and roosting at high tide including the avocet (*Recurvirostra avosetta*). Islands in coastal lagoons are an important nesting habitat for a few bird species with very restricted breeding distributions, including some species of tern.
- Coastal lagoons are of considerable conservation interest, and in the UK many are protected under various national and international designations.
- The risk to coastal lagoons due to climate change is high. Increasing storminess and rising sea levels combine to threaten lagoons, particularly on the south and east coast of England. Drought conditions may also threaten lagoons, as sources of freshwater are reduced, Extreme weather events may lead to substantial changes in coastal lagoons, from their disappearance to the formation of new lagoons as changes occur in coastal geomorphology

Condition Assessment Criteria for Coastal lagoons

1. Water should be retained in a lagoon throughout the year, although it should be borne in mind that some lagoons are naturally very shallow.
2. The extent of the lagoon water body at all times of the year should be at least at least 60% of the winter maximum, recorded at high tide. This should be assessed at the end of the summer (late August- early September) and gives an indication of the amount of water that is present at all times of the year. It should be noted that some lagoons are naturally very shallow.
3. Salinity in the lagoon should be within the range of 15-40. Species adapted to lagoons have individual optimal salinity ranges for survival but a salinity value of 15-40 enables a range of species to survive.
4. The water in lagoons should be free of turbidity, algal blooms and signs of organic or inorganic pollution. The water should be sufficiently clear to enable light penetration and an allowing submerged plants to photosynthesise**.** Increased water turbidity is a result of material suspended in the water, including sediment, plankton, pollution or other matter washed into the lagoon from the sea or nearby terrestrial sources. Lagoons act as sinks for contaminants from surrounding areas and restricted water exchange means that lagoons are very sensitive to impacts from toxic contamination. Even small quantities of pollutants resulting from dumping of waste in lagoons can have significant impacts due to the closed nature of lagoonal systems. There should not be evidence of organic enrichment – i.e. algal blooms.
5. Biological communities should include at least some species adapted to the lagoon environment. Examples can be found in the Bamber (2010)*
6. The presence, nature and integrity of the isolating barrier, whether it is natural, e.g. a shingle bank or man-made e.g. a sluice, is fundamental to the structure and function of a lagoon because it controls the quantity and dynamics of exchange of saline water betweenbetween the sea and the lagoon.
7. Non-native and invasive species should be are absent or infrequent – i.e. rare (1%-5%) or occasional (5%-9%) – see the SACFOR scale JNCC http://jncc.defra.gov.uk/page-2684. Non-native species may displace native organisms by preying on them or out-competing them for resources such as for food, space or both.
8. The lagoon banks should not show signs of physical damage to the lagoon due to excessive poaching, damage from machinery use, damaging management or public access activities.

* BAMBER, RN (2010) *Coastal saline lagoons and the Water Framework Directive.* Natural England Commissioned Reports, Number 039. http://publications.naturalengland.org.uk/publication/44008

Condition	Assessment Criteria	Score
Good	• Meets the majority of the criteria with only minor variation. • None of the indicators of poor condition are present. • There are no evidence of organic or inorganic pollution within the reach and no substantial filamentous algal growths present that are likely to be attributable to nutrient enrichment. There are no signs of direct effluent discharges. The water is clear. • No evidence of non-native species (plants or animals) • The isolating barrier is fully functional and permitting tidal inundation of the lagoons. • Water is present in the lagoon regardless of the time of survey. • Salinity is within the range of 15-40. • A diverse range of species adapted to the lagoon environment is present.	3
Fairly good	• Meets the majority of the criteria with only minor variation • Some evidence of low-level pollution. Small amounts of sewage fungus may be present or patches of filamentous algal growth that are likely to be attributable to low levels of nutrient enrichment. • One or more non-native species are present in small numbers or spatial extent. Non-native plants should occupy no more than 5% and be rarely encountered during searches. • The isolating barrier is fully functional and permitting tidal inundation of the lagoons • Water is present in the lagoon regardless of the time of survey. • Species adapted to the lagoon environment are present.	2.5
Moderate	• Meets most of the criteria with only minor variation • Some evidence of low- moderate levels of pollution -filamentous algal growth is present and water clarity is reduced. Sources of nearby pollution are evident – either terrestrial or marine. • The isolating barrier is slightly damaged but some water exchange is still occurring. • One or more non-native species have a significant presence, occupying up to 10% of the lagoon. • Water is present in the lagoon regardless of the time of survey • Some species adapted to the lagoon environment are present but other species that are not characteristic of lagoons are also present.	2
Fairly poor	• The isolating barrier is damaged but limited water exchange is still occurring • One or more non-native species have a significant presence, occupying up to 15% of the lagoon • Evidence of moderate levels of pollution. Patches of filamentous algae suggest nutrient enrichment. Sources of nearby pollution are evident – either terrestrial or marine. • The lagoon water is turbid • Salinity values are at the ends of range of acceptable for lagoons (15-40) • Species adapted to the lagoon environment are infrequent but other species that are not characteristic of lagoons are also present. • Water levels may be low.	1.5
Poor	• Most of the condition criteria are being failed. • The isolating barrier is not functioning with no water exchange occurring, Lagoon is hypersaline. This may also due to water abstraction or discharge, tidal inundation or very hot dry weather. • Species characteristic of lagoon are very rare and species characteristic of an anoxic environment may be present as well as other species that are not characteristic of lagoons. • One or more non-native species are widespread in the lagoon. • Major pollution issues are evident - either from terrestrial or marine sources. Very high levels of filamentous algal growth are present throughout the lagoon and water poor water clarity is poor (not just after heavy rain). • If the lagoon is dry or almost dry then this is poor condition. • Salinity values are tend to either hypersaline or hyposaline, possibly due to extreme wet or dry weather, water abstraction or discharge or tidal inundation. • Water present in the lagoon is turbid.	1
	Survey recommendations: The suggested surveying period for lagoons is ideally in late summer or early autumn –i.e. August and September. This is likely to be the time when the water levels are at their lowest and it is possible to get an estimate of how much water remains all year. However, lagoons may be assessed at other times during the spring and summer if this is essential to the progress of works being undertaken. Methods of assessment other than ground survey include use of aerial photography /other remote sensing methods. **Undesirable species for lagoons include:** 1. Invasive Non-Native Species: For lagoons* these include the following:	

- Trumpet tube worm (*Ficopomatus enigmaticus*)
- Asian tunicate; leathery sea squirt, club tunicate (*Styela clava*)
- Orange-tipped sea squirt (*Corella eumyota)*
- Devil's tongue weed, gracie, red menace and red tide (*Grateloupia turuturu)*
- Asian kelp, wakame *(Undaria pinnatifida)*
- Orange ripple bryozoan (*Schizoporella japonica)*
- Wire weed (*Sargassum muticum)*
- Asian shore crab (*Hemigrapsus sanguineus)*

2. Species characteristic of anoxic environments e.g. presence of Capitellid worms

3. Blooms of filamentous algae

Sources of physical damage include: Signs of point source pollution or nearby sources of diffuse pollution, damage to lagoon banks excessive poaching and damage, excessive water levels due to storms and rising sea-levels leading to loss of lagoons (but potentially new lagoons being created elsewhere, depending on the structure and degree of modification of the coast), damage to the isolating barrier, water abstraction or discharge

[8] Macleod, A., Cook, E.J., Hughes, D. & Allen, C. (2016) Investigating the Impacts of Marine Invasive Non-Native Species. A report by Scottish Association for Marine Science Research Services Ltd for Natural England & Natural Resources Wales, pp. 59. Natural England Commissioned Reports, Number223. http://publications.naturalengland.org.uk/publication/5091100843311104?category=44007

For assessment of Invasive Non-Native Species and species characteristic of anoxic environment, further information on the SACFOR scale can be found on the Joint Nature Conservation Committee website at http://jncc.defra.gov.uk/page-2684

Coastal saltmarsh Condition Table

Coastal Saltmarsh Habitat description

- Saltmarshes are wetlands dominated by angiosperms (vascular plants) that can develop in the intertidal zone of sedimentary coastlines

- Saltmarsh development is controlled by tidal regimes. Degree of inundation and exposure will vary depending on the tidal state and influenced by weather and wave conditions. The vegetation develops on a variety of intertidal sandy and muddy sediment types sometimes mixed with coarser material. The character of the saltmarsh communities is influenced by vertical and horizontal position within the intertidal area. The vegetation is commonly present in a zonation pattern related to the degree or frequency of tidal inundation. The saltmarsh plant community includes both a halophyte element (species more or less confined to this particular kind of saline environment) and a glycophyte element (species which are widespread in inland, non-saline habitats). The plant species habitat tolerances largely determine which zone (or zones) they occur in.

- Coastal saltmarshes typically develop between mean high water neap tides and mean high water spring tides. One option to define the lower (seaward) limit of saltmarsh is by using the lowest position of pioneer saltmarsh (*Salicornia*-dominated, but also with *Spartina anglica*) vegetation (but excluding seagrass *Zostera* beds, assessed as part of the Intertidal Sediment Condition Table) and the upper, landward limit as one metre above the level of highest astronomical tides to ensure inclusion of transitional zones. The metric needs to be applied to all types of saltmarsh habitat including transitions, as saltmarsh often extends beyond the level of mean high water spring tides to the level of highest astronomical tide where it may support upper or 'high' marsh communities, inundation grassland and other brackish communities such as reed beds. It can be difficult to define the vegetation communities of this element of the saltmarsh habitat, as community boundaries are often diffuse and there can be a gradient along the transition to more terrestrial habitats; a number of plants (glycophytes) can occur in both freshwater marsh, terrestrial grassland and saltmarsh.

- Saltmarsh formation is dependent on the presence of intertidal flats, developing in comparatively sheltered locations that enable sediment and seeds in the water column to be deposited onto the intertidal. A period of tidal exposure is needed to enable germination and plant establishment to occur. These conditions are found where the physiographic situation allows for sediment deposition for example in the following: Open-coast; open coast back-barriers, open embayments; restricted embayments, estuary fringes, estuary back-barriers; and in ria or loch-head situations.

- A natural saltmarsh system shows a clear zonation according to the frequency of inundation. At the lowest level the pioneer glassworts *Salicornia* spp can withstand immersion by as many as 600 tides per year, while transitional species of the upper marsh can only withstand occasional inundation.

- Saltmarsh communities above the pioneer zone show increased diversity towards the mid and upper marsh, although on grazed sites, saltmarsh vegetation can be shorter and dominated by grasses. At the upper tidal limits, true saltmarsh communities are replaced by drift line, swamp or transitional communities which can only withstand occasional inundation. Saltmarsh communities are additionally affected by differences in climate, the particle size of the sediment and, within estuaries, by decreasing salinity in the upper reaches. Saltmarshes on fine sediments, which are predominant on the east coasts of Britain, tend to differ in species and community composition from those on the more sandy sediments typical of the west. The northern limits of some saltmarsh species also influence plant community variation between the north and south of Britain.

- Large expanses of open saltmarsh with varied structure are very important for feeding, nesting and roosting birds. The critical zone for the majority of other species (mostly invertebrates and vascular plants) can be either mosaics of bare mud in a mosaic with upper saltmarsh, where the vegetation structure is varied and/or in the drift line areas.

- Coastal saltmarshes are of considerable conservation interest, and many are covered by national or international protected status

  - The saltmarsh NVC communities (http://archive.jncc.gov.uk/default.aspx?page=4264) include the following:
    - pioneer species (i.e. early colonisers, beginning a chain of ecological succession) such as *Spartina anglica* (often present as a result of deliberate introduction historically) and *Salicornia* spp.;
    - lower and middle marsh species such as *Puccinellia maritima*, *Atriplex portulacoides* and *Limonium vulgare*
    - low-mid marsh species such as *Festuca rubra*
    - upper marsh species such as *Juncus maritimus* or *Elytrigia altherica*
- Additional plant communities which can also be present on or connected with saltmarsh are also covered by the NVC system: these include certain inundation grasslands, brackish reed beds, swamp communities and mires

Condition Assessment Criteria for CoastalCoastal Saltmarsh

NB: Saltmarsh condition needs to be assessed at low tide

1. The characteristics of the habitat allow it to be recognisable as a good example of the relevant habitat and has a close match with published classifications for the specific Priority habitat [i.e. as described by either the Phase 1 Habitat Classification or the UK Hab Habitat. Classification] or the NVC or equivalent EUNIS descriptions, with species typical of the habitat representing the bulk of the vegetation.

2. The vegetation composition is formed of native species typical of the relevant habitat and present in the typical successional stages, being clearly visible throughout the sward, at sufficient cover and frequency to demonstrate the typical zonation.

3. Vegetation structure (sward height variation) is varied and not uniform, reflecting typical community diversity

4. Naturally open ground or bare surfaces such as creeks or pans are present in a mosaic with vegetated areas

5. Coastal processes needed to support the habitat are functional and are not modified by hard engineering or other forms of intervention

6. Habitat management is at appropriate levels for the habitat type – including non-intervention

7. Non-native and invasive species are absent or infrequent (less than 5% cover and not expanding)

8. Other negative indicators of damage or modification are not present. Examples of negative indicators: excessive poaching, damage from machinery use or storage, artificial modifications to creeks, artificial drainage, construction, turf-cutting, dumping waste, trackways, or any other damaging or inappropriate management or public access activities

9. Water quality is good and other visible pollution is not present, no algal mats present in water column or on saltmarsh vegetation at low tide

10. Habitat mosaics and transitions, including natural transitions to landward semi-natural habitats are present and unimpeded

11. Locally distinctive characteristic plant or animal species are present

Condition	**Assessment Criteria**	**Score**
Good	• Area under consideration and any adjoining saltmarsh habitats meets the majority of the criteria with only minor variation. • None of the indicators of poor condition (see below) are present • No evidence of pollution or algal growths that are likely to be attributable to nutrient enrichment. No direct effluent discharges. • No evidence of non-native species (plants or animals) • Tidal inundation regime unaffected by artificial structures or actions • Zonation of vegetation is present and continuous • Vegetation has a mixed structure reflecting variation in species composition or light seasonal grazing	3
Fairly good	• Evidence of low-level pollution. Small amounts of algal growth visible that could be attributable to nutrient enrichment. • One or more non-native species are present in small numbers or spatial extent. (Non-native or invasive plants should occupy no more than 5%). • indicators of poor condition are present but localised • zonation of vegetation is present but may have gaps or be incomplete • Processes appear to be functioning and not compromised by artificial structures	2.5
Moderate	• One or more non-native species have a significant presence in some parts of the area under consideration • Indicators of poor condition are present • Zonation of vegetation is not clearly visible • Some zones dominated by just one or more tall species OR vegetation too tightly grazed and forming short, uniform sward in patches • Immediate area under consideration is connected with a wider area of saltmarsh that is 'Moderate' or better condition • Processes appear to be functioning despite presence of artificial structures on edge of marsh	2
Fairly poor	• Large parts of some zones dominated by just one or more tall species OR vegetation too tightly grazed and forming extensive areas of short, uniform sward • Area under consideration is not connected to a wider area of saltmarsh or intertidal • Non-native or invasive species are clearly present and have significant presence throughout the area under consideration	1.5
Poor	• Most criteria are not met	1

	• Evidence of artificial intervention widespread and clearly affecting habitat quality and/or processes • Zonation visibly compromised, a few species dominate • Vegetation structure is uniform across the whole area • Creeks are artificially straightened • Widespread evidence of algal mats smothering saltmarsh vegetation • Non-native or invasive species are dominant throughout the area under consideration and any surrounding habitat	

Survey recommendations: The characteristic plant species of saltmarshes are mostly perennial, which allows them to be assessed over a period of several months. The suggested visiting period is May to October. The exception is the annual vegetation of the pioneer zone which is best assessed from late June to October.

Other methods of assessment include use of air photos/other remote sensing. Would expect all of potentially impacted area to be surveyed, plus adjacent connected areas that might experience indirect effects e.g. loss of tidal inundation or pollution.

NRW publication https://cdn.naturalresources.wales/media/687909/gn030e-benthic-habitat-assessment-guidance-for-marine-developments-and-activities-saltmarsh-eng.pdf provides indicative survey techniques that could be relevant to England

Undesirable species: *Spartina anglica;* other non-native species

Physical damage includes: excessive poaching as result of over-stocking with livestock, damage from machinery use; waste dumping on surface, or any other damaging activities.

Assessment of grazing levels

- light grazing - most of the standing crop is not removed

- moderate grazing - standing crop almost completely removed

- heavy grazing - height < 10 cm, all standing crop removed

- abandoned grazing – tall, matted vegetation, no standing crop removed

Vegetation zones can be described differently but these are the most likely to be found (seaward to landward):

1. **Pioneer** Open communities with one or more of the following – *Spartina* spp., *Salicornia* spp., *Aster tripolium.* Zone covered by all tides except the lowest neap tides. 290-c.600 submersions per year.

2. **Low marsh** Generally closed communities with at least *Puccinellia maritima* and *Atriplex portulacoides* as well as the previous species. Zone covered by most tides.350-400 submergences per year

3. **Middle marsh** Generally closed communities with *Limonium* spp. and/or *Plantago maritima*, as well as low marsh species. Zone covered only by spring tides. 150 to 220 submergences per year

4. **High marsh** Generally closed communities with one or more of the following – *Festuca rubra*, *Armeria maritima*, *Elytrigia* spp., as well as the middle marsh species. Zone covered only by highest spring tides. Minimum 25 submergences, maximum 150 submergences per year.

5. **Transition zone** Vegetation intermediate between the high marsh and adjoining non-halophytic areas. Zone covered only occasionally during extreme storm events, but can have salt spray influence from strong onshore winds.

Intertidal Sediment Condition Table

Intertidal Sediment Habitat Description

- Intertidal sediment covers all sedimentary habitats located between high and low water. The habitat includes shingle (mobile cobbles and pebbles), gravel, sand and mud or any combination of these which occur in the intertidal zone. It does not include saltmarsh, sand dune or vegetated shingle habitats. Many muddy shores are highly productive and this is often signalled by the presence of wading birds.
- The shape and functioning of the littoral sediment is determined both by the coastal processes acting upon it and the influence of these adjacent habitats. Features will change their morphology over time in response to prevailing coastal processes such as sea level rise or the evolution of an estuary.

Source: http://jncc.defra.gov.uk/PDF/CSM_marine_littoral_sediment.pdf

- Intertidal sediments are found across the entire intertidal zone, including the strandline. They can extend further landwards (as dune systems, marshes) and further seawards (as sublittoral or subtidal sediments). Sediment shores are generally found along relatively more sheltered stretches of coast compared to rocky shores. Muddy shores or muddy sand shores occur mainly in very sheltered inlets and along estuaries, where wave exposure is low enough to allow fine sediments to settle. Sandy shores and coarser sediment (gravel, pebbles, and cobbles) shores are found in areas subject to higher wave exposures.
- Topography is defined as the flatness/steepness of littoral sediment, which is fundamental to the structure of the feature and bears a direct influence on the associated fauna. The topography of littoral sediment generally reflects the prevailing energy conditions and overall stability of the habitat, which is in turn reflected in the composition of the infaunal community.
- Intertidal sediments support communities that are tolerant to some degree at least, of exposure, in terms of temperature, salinity and desiccation stress at low tide. Intertidal sediment environments can change markedly over seasonal cycles, with sediment being eroded and deposited at varying rates throughout the year particularly during winter storms. The particle size structure of the sediment may change from finer to coarser fractions during winter months, as finer sediment gets re-suspended in seasonal exposed conditions. This may affect the sediment infauna, with some species only present in summer when sediments are more stable. These changes are most likely to affect sandy shores on relatively open coasts. Sheltered muddy shores are likely to be more stable throughout the year, but may have a seasonal cover of green seaweeds during the summer period, particularly in nutrient enriched areas or where there is freshwater input.

Source: http://jncc.defra.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00000274

- Sediment size will influence the macrofaunal species supported. Very coarse sediments tend to support few macrofaunal species because these sediments tend to be mobile and subject to a high degree of drying when exposed at low tide. Medium and fine sand shores usually support a range of oligochaetes, polychaetes, and burrowing crustaceans, and even more stable muddy sand shores also support a range of bivalves. Finer sediments tend to have a higher degree of stability and retain some water between high tides, and therefore support a greater diversity of species. Mixed sediments often include the richest examples of burrowers.
- Very fine and cohesive sediment (mud) tends to have a lower species diversity, because oxygen cannot penetrate far below the sediment surface. A black, anoxic layer of sediment develops under these circumstances, which may extend to the sediment surface and in which few species can survive.
- Some intertidal sediments are dominated by angiosperms, e.g. sea grass (*Zostera noltii*) beds on the mid and upper shore of muddy sand flats or saltmarshes which develop on the extreme upper shore of sheltered fine sediment flats.
- The degree of exposure also influences species diversity. Sandy shores on exposed shores are often highly dynamic with impoverished communities. With increasing shelter, communities become more diverse.
- Shores subject to moderate tidal flow often may have high species richness.
- Threats to intertidal sediments include the following: sewage release, eutrophication, and oxygen shortage with chronic contamination and bioaccumulation potentially occurring in sediments located in industrial areas. The effects of land reclamation for agriculture and coastal development such as port expansion can lead to changes in water volume and tidal regime. This has led to losses of intertidal mudflats and sandflats. Coastal squeeze continues to result in the gradual loss of intertidal mudflats and sandflats.
- Restoration of this habitat already takes place through managed realignment along areas of coast where the decision has been made not to replace hard flood defences.

Condition Assessment for Intertidal Sediment

1) The total extent of intertidal sediment that is present should be assessed (measured in either m^2/km^2) and mapped, so that future changes can be assessed. The area of intertidal sediment that has been impacted by the development should be recorded. It should be noted that natural changes e.g. saltmarsh encroachment may also be visible. A change in habitat can dramatically alter the species community present, including key and influential species.
2) The characteristics of the habitat should allow it to be recognisable as a good example of the relevant habitat and has a close match with equivalent EUNIS descriptions, depending on species present, grain size and degree of exposure. Sediment character should be assessed. The size of particles and composition of the sediment has a direct bearing upon the distribution and extent of infaunal communities with recognised assemblages of species being directly related to the sediments in which they occur. A

change in sediment character can dramatically alter the infaunal/epifaunal community present including key and influential species.

3) Coastal processes needed to support the habitat should be functional and unmodified by hard engineering. Natural transitions to other intertidal habitats, notably saltmarsh and landward habitats, should be present and unimpeded. The natural transport of intertidal sediment and coastal processes should be unimpeded; i.e. by the presence groynes, breakwaters etc.
4) The habitat should support an established faunal community, the composition of which is influenced by the prevailing environmental conditions, with no one species being dominant. The habitat should support key species for the sediment size including bioturbators such a bivalves for muddy sediments and more mobile taxa for coarser/mixed sediments However, it should be noted that there may be occasions where one species might be particularly dominant but not be an indication of lower quality such as an intertidal mussel bed on soft sediment or a sea grass bed. Such habitats include intertidal seagrasses *Zostera noltii* beds on littoral muddy sand and/or biogenic reefs or beds such as *Sabellaria alveolata*, *Mytilus edulis* or *Modiolus modiolus*. Any notable or scarce species, present at the site should be recorded. Species can be assessed using the SACFOR scale (see below).
5) Negative indicators of damage or modification should not be present. Examples of negative indicators include: presence of excessive litter, signs of point source pollution or more diffuse pollution, signs of organic enrichment; including presence of opportunistic algal mats, dead animals and anoxic sediments at the surface of the sediment, and reduced water quality due to with inputs of wastewater and/or agricultural run-off, or hydrocarbon pollution. There may be signs of inappropriate management and human physical modifications including new groynes/defences/beach huts, engineering works which restrict the natural transport of intertidal sediment and disrupt coastal processes and coastal squeeze due to sea defences, urban encroachment and transport infrastructure. Signs of bait digging should be not excessive. The presence of litter should be recorded. The OSPAR guideline for monitoring marine litter on beaches which provides a practical and cost effective way of monitoring marine litter and supports MSFD. See https://www.ospar.org/documents?v=7260
6) The habitat should does not support large numbers of species whose presence can be indicative of disturbance or pollution e.g. Capitellid worms. A Phase 2 survey with laboratory analysis may determine if the species present include opportunistic indicators of disturbance/stress.
7) Water quality as assessed by the Water Framework Directive, should be of High or Good Ecological Quality. See https://environment.data.gov.uk/catchment-planning/
8) There should not be evidence of organic enrichment due to, for example, agricultural run-off. Opportunistic algal mats should not exceed 10% of the area of the biotope complex and there should be no anoxic sediments at the sediment surface.
9) Non-native and invasive species should be absent or infrequent (less than 5% cover). Non-native species may displace native organisms by predation or out-competing them for resources such as for food, space or both and their presence should be recorded. See section below on Undesirable Species for a list of notable species which may occur in or on intertidal sediments.

Condition	**Assessment Criteria**	**Score**
Good	• Meets the majority of the criteria with only minor variation. • None or very few of the indicators of poor condition are present. • Coastal processes are able to function naturally with no evidence of human physical modifications preventing this from happening. • There are natural transitions to other habitats such as saltmarsh. • No evidence of pollution. There are no substantial algal growths present that are likely to be attributable to nutrient enrichment and no direct effluent discharges visible or signs and sources of inorganic pollution. • No evidence of non-native species (plants or animals) being present • None of the non-native species are present above absent or occupy <1% of the site area. • The ecological status of the overlying water body is classified under the Water Framework Directive as High • There is no or very little litter present.	3
Fairly good	• Evidence of low-level pollution, which is localised. Localised algal growths present that are likely to be attributable to nutrient enrichment and no direct effluent discharges visible. No direct effluent discharges are visible or signs and sources of inorganic pollution. • A low number of the indicators of poor condition are present	2.5

	• Coastal processes are able to function naturally with no evidence of human physical modifications preventing this from happening. • There are natural transitions to other habitats such as saltmarsh • One or more non-native species are present in small numbers or spatial extent. Non-native species should occupy no more than 1%-5% and are rarely be encountered during searches. • The ecological status of the overlying water body is classified under the Water Framework Directive as Good • Litter is present and visible.	
Moderate	• Evidence of low-level pollution, with more widespread with growth of filamentous algal growth or sewage fungus. • Several of the indicators of poor condition are present. • There are some structures present e.g. groynes which impede the natural movement of sediments. • Transitions to other habitats show a low level of disturbance. • Non-native species should occupy between 5%-10% of the site and be infrequently encountered on shores • The ecological status of the overlying water body is classified under the Water Framework Directive as Moderate. • Litter is covering up to 5% of the area of the site.	2
Fairly poor	• Evidence of moderate-level pollution. There may be moderate levels of algal growth or sewage fungus through most of the sediment area and signs of inorganic pollution • Anthropogenic structures and developments are providing visible hindrance to the operation of natural coastal processes. • Transitions to other habitats are frequently impeded. • One or more non-native species have a significant presence, occupying between 10%- 25% of the sediment area and are regularly encountered during searches. • The ecological status of the overlying water body is classified under the Water Framework Directive as Poor. • Litter is present and highly visible	1.5
Poor	• Most of the condition criteria are being failed. • Evidence of widespread pollution. There is widespread algal growth through most of the sediment area and signs of inorganic pollution. • Species present are characteristic of an anoxic environment. • One or more non-native species are widespread, occupying over 25% of the sediment area. • Anthropogenic structures and developments are not permitting the operation of natural coastal processes.	1

- Transitions to other habitats is not possible.
- The ecological status of the overlying water body is classified under the Water Framework Directive as Bad.
- Litter is widespread.

Survey recommendations: The suggested surveying period for lagoons is ideally in late summer or early autumn –is from mid-April to the end of September, although surveys are possible until the end of October. This allows for seasonal trends in organisms life-cycles and is also the time of year when algal bloom are most prominent. Source: http://jncc.defra.gov.uk/PDF/CSM_marine_littoral_sediment.pdf

Methods of assessment other than ground survey include use of aerial photography /other remote sensing methods.

Undesirable species for lagoons include:

1. Invasive Non-Native Species:

For intertidal coarse sediment A2.1 this includes the following (at the time of writing):

- *Ficopomatus enigmaticus* Trumpet tube worm
- *Styela clava* Asian tunicate; leathery sea squirt, club tunicate
- *Corella eumyota* Orange-tipped sea squirt
- *Grateloupia turuturu* Devil's tongue weed, gracie, red menace and red tide

For Intertidal mixed sediment A2.4 this includes the following (at the time of writing):

- *Ficopomatus enigmaticus* Trumpet tube worm

Source: Macleod, A., Cook, E.J., Hughes, D. & Allen, C. (2016) Investigating the Impacts of Marine Invasive Non-Native Species. A report by Scottish Association for Marine Science Research Services Ltd for Natural England & Natural Resources Wales, pp. 59. Natural England Commissioned Reports, Number223.

http://publications.naturalengland.org.uk/publication/5091100843311104?category=44007

Further information on the SACFOR scale can be found on the Joint Nature Conservation Committee website at http://jncc.defra.gov.uk/page-2684

Sources of damage to intertidal sediments include: bait digging, presence of excessive litter, signs of point source pollution or more diffuse pollution, signs of organic enrichment; including presence of opportunistic algal mats, dead animals and anoxic sediments at the surface of the sediment, and reduced water quality due to with inputs of wastewater and/or agricultural run-off, or hydrocarbon pollution, inappropriate management and human physical modifications including new groynes/defences/beach huts, engineering works which restrict the natural transport of intertidal sediment and disrupt coastal processes and coastal squeeze due to sea defences, urban encroachment and transport infrastructure.