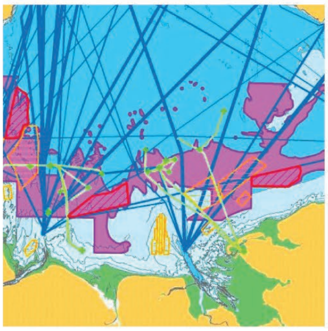
White Paper

Marine Net Gain

Moving towards a practical framework and metric for the marine environment

July 2019

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Summary

Net gain aims to leave the environment in a better state following development and to secure wider benefits for people and the environment. Net gain has been proposed as a mechanism for contributing to the restoration of natural habitats to reverse biodiversity decline.

In 2012, the Defra Biodiversity Metric was developed to assess habitat loss from terrestrial development to allow the biodiversity impact of a development to be quantified so that an offset requirement could be clearly defined (Defra, 2012). An update to this metric, the Defra Biodiversity Metric 2.0 was published in 2018 (Natural England, 2018) for use in England to support delivery of 'net gain' for projects considered under the planning system. However, progress with the development of a marine net gain metric has lagged behind its terrestrial counterpart.

This White Paper proposes a simple and practical approach to marine net gain through the development of a Marine Net Gain Metric. The aim of the metric is to provide a method to calculate net gain on developments requiring a marine licence, providing a simple method for informing net gain decisions. As with the terrestrial metric, the marine metric should be introduced on a statutory basis to facilitate its application.

Similar to the terrestrial metric, the marine metric is based on an interpretation of: '**Area X Quality**' to quantify the biodiversity value of a habitat area. It can be used to calculate the losses and gains in biodiversity from actions such as development, or from positive conservation management. While there is aspiration to broaden such metrics to include wider environmental considerations, the introduction of a biodiversity metric as a first step, is seen as more robust and defensible.

For the marine metric, we have also considered the scope to include species impacts and temporary habitat impacts, for example, habitat disturbance. The suggested species metric seeks to provide a unit value for different species groups reflecting their importance and difficulty in offsetting impacts in order to calculate a developer net gain contribution (£). The suggested temporary habitat impacts metric seeks to quantify the spatial and temporal loss of habitat condition in order to estimate a habitat net gain requirement. However, there are significant technical issues with progressing such additional metrics as well as fundamental issues of equitability across marine sectors. This is likely to limit progress with the development and implementation of these additional metrics.

The ideas set out in this White Paper are intended to promote discussion and debate within the UK marine community and are not intended to represent a definitive solution. Informal comments are very welcome (vicky.west@abpmer.co.uk).

The metric presented in the White Paper is relatively simple to apply, although we recognise there are challenges in gaining buy-in to such an approach. In our view, it is better to implement a clear metric which can be delivered proportionately, and which can be improved upon over time, rather than to have no metric at all. Continuing to do nothing is the worst option for marine biodiversity.

Addressing aspects such as habitat disturbance and species impacts in the marine environment in a robust and equitable way remains problematic at this time.

1 Introduction

1.1 Background to this White Paper

This White Paper proposes a simple, practical approach to marine net gain with a view to advancing national discussions on this emerging subject area. It builds on a previous ABPmer White Paper which argued for introducing a statutory system of marine net gain (ABPmer, 2019). The proposals draw on approaches used in the 'Defra Biodiversity Metric 2.0', which is being adopted for terrestrial net gain, modified and simplified for the marine environment. As with the terrestrial metric, the marine metric should be introduced on a statutory basis to facilitate its application.

We recognise that there are challenges in developing and applying a marine metric. However, in our view, it is better to implement a clear metric which can be delivered proportionately (and which can be improved upon over time through adaptive management), rather than to have no metric at all. Continuing to do nothing is the worst option for marine biodiversity and simply perpetuates an unacceptable situation.

Continuing to do nothing is the worst option for marine biodiversity

1.2 Background to Net Gain

The application of net gain is a relatively new concept in the UK. It was identified in the Government's 25-Year Environment Plan (HM Government, 2018) which included a commitment to '*embed an 'Environmental Net Gain' principle for development including housing and infrastructure*' within England. Its application is designed to leave biodiversity in a better state and secure wider benefits for people and the environment. The net gain approach is additional to the mitigation hierarchy where it aims to offset impacts that are residual, those that cannot be avoided or mitigated.

In 2012, the Department for Environment Food and Rural Affairs (Defra) consulted on the proposal to introduce a system of biodiversity offsetting within the planning system in England[1]. However, the policy was not taken forward at the time. Then, in 2018, the Government consulted on proposals to improve the planning system in England, introducing a mandatory system to achieve Biodiversity Net Gain for development under the Town and Country Planning Act[2]. The Chancellor announced in March 2019 the Government's favourable view on mandating biodiversity net gain for developments in England (Gov.UK, 2019).

This mandate means that coastal and intertidal habitats will have to be considered, down to the mean low water mark, to account for the whole regime of the Act. While the principles of net gain in the marine environment are not explicitly included in these statements, there was reference to a longer-term ambition of extending biodiversity net gain to marine projects. In January 2019, the Natural Capital Committee (NCC) in its sixth report, also recommended that the net environmental gain principle should be extended to cover development and activities in the marine environment.

A key element of the 'net gain' approach is the development of a metric: a tool that allows biodiversity losses and creation of offsetting habitat to be measured. By using a metric, the ability to measure net gain is improved and standardised.

1 https://www.gov.uk/government/publications/technical-paper-the-metric-for-the-biodiversity-offsetting-pilot-in-england
2 https://consult.defra.gov.uk/land-use/net-gain/

2 Developing a Marine Metric

2.1 Status and Scope

Progress with the development of a marine net gain metric has lagged behind its terrestrial counterpart. It has been argued that development of a marine net gain metric is more difficult than for the terrestrial environment, but in our view, it has simply suffered from a lack of focus.

Many of the concepts developed for the terrestrial biodiversity net gain metric can be translated across to the marine environment for application to activities for which a development licence is required. However, this approach wouldn't apply to commercial fishing activity and land-based sources of pollution which are two of the greatest pressures in the marine environment but do not require a marine licence.

A system of marine net gain should be equitable across marine sectors

There are therefore important issues to be addressed relating to the scope for marine net gain if it is to make a meaningful contribution to reversing the decline in marine biodiversity. Simply applying marine net gain to activities requiring a marine licence will not, on its own, be enough to reverse marine biodiversity decline and would not be equitable in terms of the polluter-pays principle. While this paper focuses on applying net gain to activities requiring a marine licence, it remains vital that effective progress is made to establish mechanisms for achieving net gain from other key pressures in the marine environment.

As with the terrestrial metric, requirements for development affecting Marine Protected Areas (MPAs) (particularly legislation such as the Wild Birds and Habitats Directives and the Marine and Coastal Access Act) will need to be complied with. As around 80% of UK estuaries and 50% of coastline are subject to such designations and impacts to features associated with these sites will need to be managed in accordance with the relevant legislation this will limit the application of any developed marine metric. However, consideration could be given to requiring net gain to be applied to residual impacts of developments within MPAs even where these are not judged to constitute an adverse effect on the site.

2.2 Natural England's Intertidal Metric

Natural England is seeking to extend the Defra Metric 2.0 to include intertidal habitats on the basis that some planning applications include areas of foreshore. They have been working with a range of parties to develop their proposals and recently (May 2019) began an informal consultation on their proposals (Natural England, 2019).

The approach that Natural England has adopted has, necessarily, applied elements of the terrestrial metric, some of which are not directly applicable to the marine environment or which do not reflect its particular characteristics. However, trying to force intertidal habitats to conform to a terrestrial model is, in our view, inappropriate. Furthermore, it creates an artificial, unnecessary disjoint between marine intertidal and subtidal areas. An unhelpful outcome of this approach would be the need to apply different metrics to intertidal and subtidal marine environments. This would create duplication for developers and, more importantly, could preclude trade-offs between intertidal and subtidal habitats if the metrics were not comparable.

For these reasons we consider that a specific marine metric should account for the distinctiveness of the marine environment and pressures within marine systems. Additionally, covering both intertidal and subtidal habitats, is a better solution for those using the metric and for achieving better outcomes for the marine environment.

2.3 Biodiversity versus Environmental Net Gain

The Defra Metric 2.0 is focused on delivering biodiversity net gain for terrestrial habitats. The 25-year Environment Plan identifies an aspiration to move towards environmental net gain in the future which considers a wider range of impacts and benefits based on a natural capital approach. In its recent report, the Natural Capital Committee (NCC, 2019) was critical of the failure of the Defra Metric 2.0 to incorporate wider environmental considerations.

From a marine perspective, it is similarly desirable to go beyond a simple biodiversity metric and to incorporate wider environmental net gain. However, while progress is being made in developing thinking on the application of a natural capital approach in the marine environment, there remain significant scientific uncertainties concerning the quantification and assessment of marine natural capital and ecosystem services. Therefore, any metric based on marine natural capital would have high levels of uncertainty, may be contentious and could take a long time to develop.

In developing proposals for a marine metric, we have therefore chosen to focus on biodiversity net gain. The biodiversity net gain approach offers a simpler metric which can be more easily applied and facilitate proportionate regulation. Such a metric could provide a starting point for moving towards an environmental net gain metric as knowledge and experience of its application grows.

A biodiversity net gain approach can facilitate proportionate regulation

2.4 Marine Species

The Defra Metric 2.0 only applies to habitats; there is currently no direct consideration of species impacts, although creation or restoration of habitats will provide space for species. In the marine environment, there can often be impacts to species that do not have implications for habitats. For example, underwater noise may disturb or injure fish and marine mammals without having any impact on habitats. Our marine metric therefore suggests how net gain might be applied to species impacts, where these are not associated with habitat impacts.

2.5 Temporary Deterioration of Habitats

Development pressures within the marine environment may lead to temporary or longer-term deterioration in the condition of a habitat as distinct from the direct loss of a habitat. For example, sediment plumes associated with dredging or construction activity may be transported considerable distances from their source before being redeposited on the seabed.

These types of far-field impact are less prevalent in the terrestrial environment but can be significant in the marine environment. A marine metric therefore might also seek to account for these changes in condition, which may be temporary. In this White Paper we suggest how this might be achieved.

2.6 Irreplaceability

Many of the wider principles adopted in the Defra Metric 2.0, for example, relating to the mitigation hierarchy, are generally applicable to the marine environment and are endorsed. However, the concept of irreplaceability in the marine environment requires further thought, particularly as many subtidal habitats will be extremely difficult to recreate and would generally need to be recreated on top of other subtidal habitats. Clearly there are some subtidal habitats such as maerl beds, cold water corals and carbonate mounds that society generally agrees should be inviolate and therefore should be excluded from any system of net gain.

There may be options to consider the scope for reducing human pressures (principally fishing) on other subtidal habitats as a way of achieving net gain, or, alternatively simply encouraging trading between subtidal and intertidal habitats. Indeed, given the significant loss of intertidal habitats, their importance to marine ecosystem functioning and their greater accessibility to people, re-creation of intertidal habitat is likely to be of significant benefit to marine ecosystems.

2.7 Existing Legislation

In the short-term we recognise that compliance with existing legislation such as the Wild Birds and Habitats Directives and Marine and Coastal Access Act provisions in relation to Marine Conservation Zones, needs to take priority over requirements for net gain. In the longer-term, however a more integrated approach to delivery of marine biodiversity objectives would be strongly preferable. This could be achieved by applying a single system of net gain irrespective of location. For example, this might include having a range of pre-selected strategic measures and criteria that if pursued would help to drive a net improvement in the quality of marine, coastal and/ or estuarine environments. The actions set out in the Improvement Programme for Natura Sites (IPENS) documents[3] are an example of this. An integrated approach would then include pursuing measures from this established 'shopping list' of options and opportunities with reference to the scale and nature of the developmental impacts being mitigated, compensated or pursued to achieve net gain.

It may also be desirable to apply net gain to residual impacts to Marine Protected Area (MPA) features in circumstances where those effects are not deemed significant. This may be particularly relevant for habitat disturbance or species impacts. For example, net gain could be applied to pressures such as fish mortality associated with power station cooling intakes, or bird strike or cetacean disturbance from offshore windfarms, effects for which, to date, no offsetting has been required in the UK.

2.8 Scope of a Marine Biodiversity Net Gain Metric

The aim of a marine biodiversity metric is to provide a tool that can be used to calculate net gain for licensable development[4] in the marine and coastal environment, thereby providing a simple and objective method for informing net gain decisions. The metric can be used to quantity the biodiversity value of a habitat area and can be used to calculate the losses and gains in biodiversity from actions such as development or from positive conservation management.

3 https://www.gov.uk/government/publications/improvement-programme-for-englands-natura-2000-sites-ipens

4 This might apply to projects requiring a marine licence or deemed marine licence as well as development under the Petroleum Act.

The biodiversity 'value' of a habitat parcel is evaluated on the basis of its area and the relative 'quality' of its habitat. The assessment of quality comprises an assessment of:

- Distinctiveness; and
- Condition.

The initial calculation determines the 'baseline' or 'pre-intervention' value in biodiversity units. The process is then repeated using a 'post development' or 'post-intervention' scenario to account for the impact of a development or intervention (including any on site measures to retain, enhance or create additional biodiversity within the development site).

At this point additional factors to account for the risk associated with creating, restoring or enhancing habitats are considered. A risk factor is used to account for the likelihood of failure of offset actions. The risks are:

- Delivery – the difficulty of creating or restoring habitat;
- Temporal – the risk associated with a delay in creating fully functioning habitat; and
- Spatial – the risk of undermining aspects of connectivity and function if the created habitat is at a distance from the place of impact.

The following section describes a potential method for developing a biodiversity metric for both marine habitats and species. This has been developed and proposed with a view to informing debate on this important and emerging policy concept. Where there are uncertainties, limitations, information gaps or issues to be resolved then these are indicated.

3 Marine Biodiversity Metric Development

3.1 Marine Habitat Metric

In the terrestrial environment, habitat has formed the primary basis for calculating and evaluating biodiversity offsets. A similar approach can be applied in the marine environment, although some modifications are necessary to account for the particular characteristics of coastal and marine environments. The following sections review some of the issues relevant to habitat metric development in the marine environment, with reference to the Defra Metric 2.0.

3.1.1 Habitat Type

Defra Metric 2.0 proposes the use of level 4 of the UK Habitat (UKHab) classification for most terrestrial habitats; however, this classification includes a limited number of habitats for marine ecosystems with some clear omissions. The draft intertidal metric (Natural England, 2019) instead proposes to define habitat units using the European Nature Information System (EUNIS) classification. Although EUNIS is commonly used in the marine environment and is compatible with marine protected area monitoring data, the classification does not closely align with Section 41 habitats[5]. Additionally, level 3 descriptors (e.g. 'high energy infralittoral rock') are too broad to result in meaningful assessment, while Level 4 classifications are too specific for accurate area assessment for use in development planning.

[5] i.e. habitats considered to be of principal importance for the conservation of biodiversity in England, under the 2006 Natural Environment and Rural Communities (NERC) Act.

We propose an alternative framework based on the Integrated Habitat System (IHS) for habitat classification (IHS, 2007). IHS represents an integration of existing classifications used in the UK with particular emphasis on Biodiversity Broad Habitat Types, Biodiversity Priority Habitat Types, Annex 1 of the Habitats Directive and Phase 1 habitat survey. IHS also more closely aligns with Section 41 habitat classification than the EUNIS level 3 classification.

IHS defines habitat units on a more usable level for offsetting and covers all habitat types, including natural and artificial habitats, and marine, coastal and terrestrial systems. A full list of marine and coastal habitats is defined in Appendix A.

3.1.2 Habitat Disturbance

Within the terrestrial environment, Defra Metric 2.0 focuses wholly on habitat loss. Within the marine environment, temporary or permanent habitat disturbance may often occur within or beyond the footprint of a development, either directly or mediated by the prevailing physical processes.

Such impacts can often be spatially extensive, for example, sediment disturbance caused during the development of a sea wall or during cable laying, but the offsetting of these disturbance impacts is rarely if ever required. It could therefore be appropriate to incorporate aspects of temporary and permanent habitat disturbance within a marine habitat metric. Suggestions are made below about how this might be done.

3.1.3 Habitat Distinctiveness

Distinctiveness is based on a habitat's distinguishing features and considers parameters such as a habitat's ability to support species diversity and/ or richness, and habitat rarity (at local, regional and national levels). To inform the metric, habitats have been assigned to one of five bands, based on their habitat distinctiveness (Table 1). A full list of the assigned habitat scores are provided in Appendix A.

For coastal and intertidal habitats, some will be small-scale man-made features and these need to be distinguished from naturally occurring habitats[6]. We propose such man-made habitats are added to the metric with a distinctiveness score of Low or Very Low to represent their origin, however, for those performing important natural functions, the condition parameter will increase their overall biodiversity value in the metric.

In addition to the five classifications listed in Table 1 below, some habitats have been proposed to be excluded from offsetting based on their scarcity and ecological value. These include:

- Maerl beds;
- Peat and clay exposures with piddocks [littoral];
- Peat and clay exposures with piddocks [sublittoral];
- Carbonate mounds;
- Cold-water coral reef (*Lophelia pertusa);*
- Chalk reef; and
- Seamount communities.

6 This includes introducing rock pools into sea walls for example. We would emphasise that many, often larger-scale and sustainable initiatives such as wetland restorations (e.g. through managed realignment projects) or seabed habitat management actions (e.g. enforcing fisheries exclusion areas) should not be viewed as man-made in this way. Even though human intervention has, of course, been required to achieve these, it will rarely be appropriate to treat habitats arising from these interventions as distinct from, or any less natural than, other comparable habitats.

Table 1. Distinctiveness definitions

Habitat Distinctiveness	Distinctiveness Score	Terrestrial Habitat Descriptions (Defra 2.0)	Marine Habitat Descriptions
Very High	8	Priority habitats as defined in Section 41 of the NERC Act that are highly threatened, internationally scarce and require conservation action e.g. blanket bog	Habitats of principle importance as defined in Section 41 of the NERC Act that are highly threatened, internationally scarce and require conservation action e.g. File shell beds
High	6	Priority habitats as defined in Section 41 of the NERC Act requiring conservation action e.g. lowland fens	Habitats of principle importance as defined in Section 41 of the NERC Act requiring conservation action e.g. intertidal under boulder communities OR Habitats which contain priority species defined in Section 41 e.g. Pink Sea-fan
Medium	4	Semi-natural vegetation not classed as a priority habitat e.g. hazel scrub	Marine or coastal habitats not classified as priority e.g. Shingle above high tide mark
Low	2	Semi-natural or modified vegetation not classed as a priority habitat and of lower relative value to most wildlife e.g. Temporary grass and clover ley; intensive orchard.	Enhanced artificial or man-made habitats of lower relative value to natural habitat e.g. enhanced rock armour, vertipools
Very Low	0	Habitats and land cover or little or no value to wildlife e.g. Developed land sealed surface	Artificial habitats of little or no value to wildlife e.g. concrete breakwater, piles

3.1.4 Habitat Condition

The parameter of condition is an indication of the quality of the habitats described. Condition assessment requires that we have agreed standards and a related methodology for measuring habitat condition. There is currently no standard habitat condition assessment tool, although various methods are used for specific purposes. In the terrestrial biodiversity metric, condition assessments are done at UKHab level 2 (or equivalent), with levels ranging from Good to Poor (3 to 1) and in some cases falling to 0 when habitats are considered to be of no value.

There are limitations to condition assessments in the marine environment due to frequently limited information and data. However, some assessment of habitat condition needs to be included in the metric. Condition assessment considers the fragmentation/ patchiness and structural complexity of a habitat, which can be determined by evidence and expert judgement. It also considers any indication of the pressure being placed on habitats.

Additionally, it is important to consider other sources of information on condition of the area where the net gain metric is going to be used. Information on the status of biological quality elements under the Water Framework Directive could be used to indicate the condition of the water body in which the habitat is located. Where developments are located within coastal SSSIs, site condition information could also be used to help inform an overall judgement of habitat condition. Therefore, the state of the water body and of the different indicators should be considered in these definitions when possible, as failing water bodies for water quality might not allow for successful restoration or creation of habitats. Descriptions of condition categories are presented in Table 2.

Table 2. Condition categories

Category	Score	Condition Definition
Good	3	No evidence of negative anthropogenic impact or pressure. Habitat provides high structural complexity and/ or no evidence of fragmentation WFD status: High/ Good SSSI unit condition: Favourable
Moderate	2	Evidence of slight pressure e.g. potting activity, recreational impacts Some habitat patchiness or fragmentation WFD status: Moderate SSSI unit condition: Unfavourable (recovering)
Poor	1	Evidence of significant pressure e.g. high trawling disturbance, area subject to regular maintenance dredging Habitat highly fragmented and no structural complexity WFD status: Poor / Fail SSSI unit condition: Unfavourable

While the condition metric can be applied in situations where there is habitat loss, it could also be used to assess permanent or temporary changes in condition. Thus, for example, a developer could be required to achieve net gain where there is a change in permanent or temporary habitat condition based on the change caused, its extent and duration, although there are challenges with this approach.

3.1.5 Strategic Significance

Strategic significance was included within the original Defra Metric and has been incorporated into the Defra Metric 2.0. The strategic significance parameter of the metric gives extra value to habitats that are located in optimum locations for biodiversity and other environmental objectives. The greater inherent connectivity within the marine environment suggests that there is potentially more flexibility in the application of this element within the marine environment and the issue may be sufficiently covered by the locational aspect of spatial risk (see Section 3.1.7). To keep the metric as simple as possible, we suggest that this component of Defra Metric 2.0 does not need to be included in a marine metric.

3.1.6 Habitat Connectivity

Habitat connectivity is the relationship of a particular habitat patch to other surrounding similar or related semi-natural habitats, which could be facilitating flows of species and ecosystem services. The approach for terrestrial habitats in the Defra Metric 2.0 is based upon the 'structural connectivity' model within the National Biodiversity Climate Change Vulnerability Model. However, this model does not cover marine and coastal environments. As above, we consider that this concept can be adequately covered by the locational aspect of spatial risk (see Section 3.1.7) and suggest that this component does not need to be included in a marine metric.

However, we note that some habitats and species require functional connectivity and may need to be considered in more detail during net gain decisions, such as the connectivity of feeding and roosting habitats to support bird populations.

3.1.7 Uncertainty and Risk

There is uncertainty and risk that offsets provided will fail to meet the required biodiversity units, and these are accounted for in the metric. There are three main types of risk which need to be considered:

- **Delivery risk:** That associated with the implementation of the offset due to, for instance, uncertainty in the effectiveness of restoration or habitat creation/ management techniques;
- **Spatial risk:** This reflects ecological risk deriving from the change in location of the habitat or resource. For example, recreating a type of habitat in a new location may reduce its biodiversity value; and
- **Temporal risk:** In delivering offsets, there may be a mismatch in the timing of impact and offset, i.e. the difference in time between the negative impact on biodiversity and the offset reaching the required quality or level of maturity, which results in a temporary loss of biodiversity.

Where risks cannot be mitigated, some form of insurance is likely to be needed similar to the terrestrial metric. This could take the form of an increase in the area of habitat creation/ restoration provided for a given number of units. As such the use of multipliers to assess risk can be incorporated in the biodiversity metric.

Delivery risk

Delivery risk reflects the uncertainty in the effectiveness of techniques used to restore or create habitat. Technical as well as natural difficulties are considered (for example, ecological/ physical factors needed to create the required habitat).

The difficulty and uncertainty of successfully creating, restoring or enhancing a habitat is recognised in the multiplier as shown in Table 3 (these are the same as those adopted for the Defra Metric 2.0). Classification of delivery risk for each habitat is defined in Appendix A.

Table 3. Proposed multipliers for accommodating delivery risk

Difficulty of Habitat Creation/ Restoration	Multiplier
Very High	0.1
High	0.33
Medium	0.67
Low	1

Spatial risk

Spatial risk reflects the fact that habitat created at a great distance from the site of habitat losses carries a risk of depleting local areas of natural habitats. It links closely to the concept of habitat connectivity as discussed above. In this case the multipliers proposed (as listed in Table 4) are not the same as those applied in the Defra Metric 2.0 because of the greater level of inherent connectivity that exists within the marine environment compared with terrestrial conditions. In this case new multipliers have been developed which are higher than the Defra Metric, as spatial risk is generally considered to be of less concern. Both are shown in Table 4.

Table 4. Proposed multipliers for accommodating spatial risk

Location parameters	Defra Metric 2.0 Multiplier	Proposed Marine Multiplier
Offset is in the same functional system as development (e.g. within the same estuary, water body, coastal sediment cell)	1	1
Offset is within the same marine plan area as development	0.75	0.9
Offset is outside of the development marine plan area	0.5	0.8

For example, mudflat and saltmarsh are prevalent habitats within estuaries and minor losses will not significantly affect overall functioning of the estuary system. Thus, recreation of such habitats remote from the point of impact does not pose a significant spatial risk for these habitats. However, it is acknowledged that some aspects of wider function, such as bird usage may be more strongly dependent on location. This may need consideration on a case by case basis.

Temporal risk

Temporal risk accounts for the loss of biodiversity for the period between a negative impact on biodiversity occurring and the offsetting habitat reaching the required quality or level of maturity. This issue can be managed by the creation of the offsetting habitat ahead of the impact taking place, for example by starting offset work well ahead of development.

However, this is not always possible, and where a time lag does occur, a temporal risk multiplier is applied as shown in Table 5. The metric presented here follows that used in the Defra Metric 2.0. As with the terrestrial metric, to keep the metric simple and usable, two assumptions have been made:

1) Offset habitat 'jumps' from baseline condition to target condition – incremental increases in habitat quality are not accounted for; and
2) There is a maximum risk multiplier of 32+ years.

Many things influence how quickly habitat restoration and creation does occur, these are often site dependent and related to the difficulty factor, however, for the purposes of creating a metric a reasonably conservative average figure needs to be used, accepting that there will be variation from this estimation. Suggested average times to target condition for habitat types are presented in Appendix A, based on information from Tillin *et al.* (2010) and Tyler-Walters *et al.* (2018).

Table 5. Proposed multipliers for accommodating temporal risk

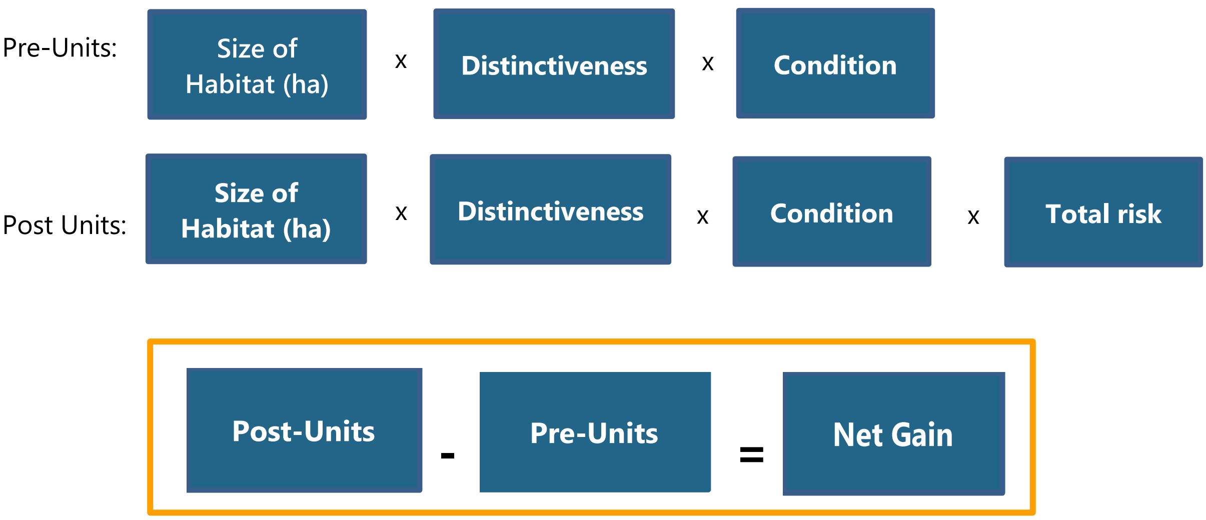
Years to Target Condition	Multiplier	Years to Target Condition	Multiplier
0	1.000	17	0.546
1	0.965	18	0.527
2	0.931	19	0.508
3	0.899	20	0.490
4	0.867	21	0.473
5	0.837	22	0.457
6	0.808	23	0.441
7	0.779	24	0.425
8	0.752	25	0.410
9	0.726	26	0.396
10	0.700	27	0.382
11	0.676	28	0.369
12	0.652	29	0.356
13	0.629	30	0.343
14	0.607	31	0.331
15	0.586	>32	0.320
16	0.566		

Total risk

Using the multipliers set out in the preceding sections, an overall value for the total risk would then be derived as the product of all three risks (i.e. Delivery risk × Spatial Risk × Temporal Risk).

3.1.8 Final Habitat Biodiversity Metric

Based on the sections above, a suggested metric for marine habitat net gain might be as follows:



To indicate how this might be applied, a case example for a project affecting saltmarsh and mudflat habitat is shown in Appendix B.1. In line with the terrestrial metric, an overall uplift of 10% could be added to the habitat to be provided to ensure delivery of net gain. As the costs of creating intertidal habitat are well known, it would be possible to assign a monetary value to the net gain requirement, should this be required.

For permanent or temporary impacts to habitat quality, it would be possible to use the condition metric to assess the change in habitat quality and to determine offsetting requirements based on the duration of any impact. For simplicity, the temporal risk metric (Section 3.1.7) could be used to inform the scale of offsetting required. For example, a change from good to moderate condition of 100 ha of subtidal mud habitat as a result of physical disturbance with a recovery period of five years, might potentially require an offset of 100 × 1 × (1-0.837[7]) = 16.3 ha equivalent. However, there are likely to be significant challenges in applying this type of the metric and in determining which impact pathways to include within the metric and when a *de minimis* cut off should apply.

Furthermore, such an offset might be seen as disproportionate and inequitable – bottom trawling from commercial fishing activity also causes temporary habitat damage, on a regular cycle and on a much larger scale. If the same kind of metric was applied to that sector the offset requirement might be many orders of magnitude greater.

[7] The appropriate temporal risk factor from Table 5.

3.2 Species Metric

Following Defra's Biodiversity Metric (Defra, 2012), some stakeholders expressed the desire to include species within the metric. This section suggests a simple metric to account for species offsetting.

Species cannot easily be incorporated within the habitat metric, as the component parts of the habitat metric are not applicable to species in the same way. Some work has been done to estimate the equivalent area of lost production (EALP) in relation to fish impingement at power stations (for example, California Energy Commission, 2005), but there is low confidence in the outputs of such assessments. No equivalent metrics exist for other species groups.

We therefore present an alternative metric which could be used to assess developmental impact/ disturbance on the number of individuals in particular species groups.

The metric seeks to provide a unit value for different species groups, reflecting their importance and the difficulty in offsetting impacts. The unit value can then be used to determine a monetary value of the offset required, based on the nature and duration of the impact. The developer would then offset through developer contributions which could be used to fund a strategic approach to Net Gain.

3.2.1 Species Group

To simplify the metric, species have been separated into high level ecological groups to define their relative importance and difficulty in offsetting impacts. In the longer term it may be possible to refine the categories and weightings applied. For fish, it is proposed that the metric be based on the Equivalent Adult Value (EAV) concept to recognise the high natural mortality rates for juvenile fish (Turnpenny, 1989).

Table 6. Species Group

Species Group	Multiplier
Non-migratory fish	0.02
Migratory fish (salmonids and clupeidae)	500
Migratory fish (eels, lamprey, osmeridae)	5
Cetacean	1,000
Seal	50
Bird	50

3.2.2 Impact

The impact assesses the length of time and level of disturbance caused to individual species during development. The scale of impact is accounted for using the multiplier as shown in Table 7. There are likely to be significant challenges in applying this aspect of the metric and in determining which impact pathways to include within the metric and when a *de minimis* cut off should apply.

Table 7. Scale of impact

Level of Disturbance	Multiplier	Definition
High	10	Direct mortality to species
Medium	3	Long-term disturbance to species (>6 months to years)
Low	1	Short-term temporary disturbance to species (<6 months)

3.2.3 Final Species Metric

The offsetting cost could be calculated as follows:

$\sum$	No of Individuals Affected Annually	x	Species Group	x	Scale of Impact	= **Offset value £**

As with the habitat metric, an overall uplift of 10% could be added to the offset value to ensure delivery of net gain.

As an example, a case study assessing the impact of a power station's cooling water abstraction on fish populations has been provided in Appendix B.2.

The offset payment could be used, for example, to fund fisheries work within a catchment/ region, or used to meet some other marine biodiversity priority.

Refinement of the weightings could be made through a process of adaptive management, based on the costs of implementing restoration measures.

However, we recognise that there are significant issues around the equitability of such concepts. For example, the number of fish killed or injured by power station cooling water abstractions is a tiny fraction of the number of fish harvested by the commercial fishing industry. Similarly, commercial fishing activity has a greater impact on marine mammals and sea birds than activities requiring a marine licence. It may be that a more limited species metric could be progressed which, for example, focused solely on migratory fish species but this is likely to remain a challenging area in which to deliver net gain in an equitable manner.

4 Conclusions

Many aspects of the approach used for the terrestrial Defra Metric 2.0 to assess habitat loss from development projects can be translated across to marine projects. However, there are some aspects of the terrestrial metric which are not immediately applicable to the marine environment. For example, the model used to assess connectivity does not incorporate the marine environment, and the approach to strategic significance draws on information that cannot be replicated. Given the greater connectivity within the marine environment, it is considered that issues of spatial location can be adequately covered by the spatial risk component of the metric. This considerably simplifies the application of the marine metric.

There may be some scope to include species impacts and temporary impacts as part of a marine metric, although both are potentially challenging to frame and implement. There are also fundamental issues of equitability across different marine sectors, particularly with the commercial fishing sector.

Within the marine environment, many subtidal habitats, and some intertidal ones, are very difficult to recreate. Indeed, new subtidal habitats can largely only be created on top of existing subtidal habitat. It is likely that the concept of irreplaceability applied in the terrestrial metric will need to be modified to reflect marine circumstances. Within the marine environment, there is likely to be a greater need to achieve net gain using different habitats, including offsetting subtidal impacts with intertidal gains. However, given the historic losses of intertidal habitat and the relative ecological value of intertidal habitats, overall this may be beneficial for marine ecosystems.

As with the terrestrial metric, existing requirements for development affecting MPAs (particularly legislation such as the Wild Birds and Habitats Directives and the Marine and Coastal Access Act) will need to be complied with. It is acknowledged that this will significantly limit application of the metric as around 80% of UK estuaries and 50% of coastline are subject to such designations and impacts to features associated with these sites will need to be managed in accordance with the relevant legislation. However, consideration could be given to requiring net gain to be applied to residual impacts of developments within MPAs even where these are not judged to constitute an adverse effect on the site. Additionally, there are a number of impact pathways assessed within Environmental Assessments in relation to disturbance of species which are of a minor nature. There needs to be some agreement on minimum thresholds of disturbance and agreement of when these fall within net gain assessment.

Applying the marine metric only to licensable development activities will make only a minor contribution to halting or reversing marine biodiversity decline. Consideration needs to be given to applying net gain to other activities affecting the marine environment, particularly including commercial fishing and land-based sources of pollution. Solely targeting licensable development activities would not be equitable or rational.

There is no perfect metric; better to start now and improve over time

Adaptive management is likely to be a key mechanism for developing and improving a marine net gain metric and its implementation. We assert that it is better to start making a difference now and improve the system over time, rather than do nothing and wait for a perfect metric (there isn't one).

The scale of marine ecosystems and their connectivity means that a strategic and co-ordinated approach to marine net gain is likely to deliver greater environmental benefit than a piecemeal approach. In particular, public co-ordination could usefully help identify regional priorities and locations for intervention. Indeed, it may be better to have a system of developer contributions that are used to fund a strategic programme of publicly managed projects.

To maximise the ecological and environmental benefit of interventions, an element of experimentation will be required. If it is left to developers to decide how to deliver net gain, it is likely that they will avoid interventions that are less certain. This will mean that an important element of learning about how to recreate more difficult features such as native oyster reef and seagrass beds could be lost. A publicly managed marine restoration fund financed by developer contributions might better support such learning as the risks associated with learning would be owned by marine managers and could be balanced and managed across a portfolio of restoration projects.

5 References

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6 Abbreviations/Acronyms

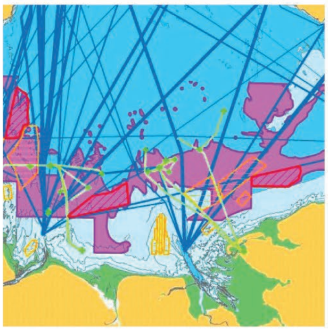
CWS	Cooling Water System
Cefas	Centre for Environment, Fisheries and Aquaculture Science
Defra	Department for the Environment, Food and Rural Affairs
EALP	Equivalent area of Lost Production
EAV	Equivalent Adult Value
ES	Environmental Statement
EUNIS	European Nature Information System
FRR	Fish Recovery and Return
HM	Her Majesty's
HPC	Hinkley Point C
IHS	Integrated Habitat System
IPENS	Improvement Programme for Natura Sites
MCZ	Marine Conservation Zone
MPA	Marine Protected Area
NCC	Natural Capital Committee
NERC	Natural Environment Research Council
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UKHab	UK Habitat Classification
WFD	Water Framework Directive

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices




Innovative Thinking - Sustainable Solutions

ABP mer

A Habitat Classification

Table A1. Marine and coastal habitats modified from the IHS habitat classification scheme with assessed distinctiveness and risk scores

IHS Code	IHS Classifications	Section 41 Habitat	Habitat Distinctiveness Score[1]	Delivery Risk: Habitat Creation	Delivery Risk: Habitat Restoration	Average Temporal Risk
CF	**Coastal and floodplain grazing marsh**					
CF1	Coastal and floodplain grazing marsh (PHT)		4	Medium	Medium	10-15 years
CS	**Continental shelf slope**					
CS0	Continental Shelf Slope (BHT)		4	Very High	Very High	30+ years
CS1	Carbonate mounds	✓	Excluded	-	-	-
CS1	*Lophelia pertusa* reefs (PHT)	✓	Excluded	-	-	-
CS2	Deep-sea sponge communities	✓	8	Very High	Very High	30+ years
CSZ	Other Continental Shelf Slope (IC)		4	Very High	Very High	30+ years
IR	**Inshore rock**					
IR0	Inshore sublittoral rock (BHT)		4	Medium	Low	5-10 years
IR1	Reefs (AN1)		6	Medium	Medium	10-15 years
IR11	Chalk reefs (AN1)		Excluded	-	-	-
IR1Z	Other subtidal reefs (IC)		6	Very High	High	20-30 years
IR2	*Sabellaria spinulosa* reefs (PHT)	✓	6	High	Medium	5-15 years
IR3	Sheltered sublittoral cliffs (in rias) (PHT)		6	Very High	Very High	30+ years
IR4	Subtidal surge gullies and caves (PHT)		8	Very High	Medium	10-15 years
IR41	Submerged or partly submerged sea caves (AN1)		6	Very High	Medium	10-20 years
IR4Z	Other subtidal surge gullies and caves (IC)		6	Very High	Medium	10-20 years
IR5	Tidal rapids (PHT) Tide-swept channels [subtidal]	✓	6	Very High	Medium	10-15 years
IR6	Sublittoral chalk (PHT)	✓	6	Medium	Medium	10-15 years
IR7	*Modiolus* beds (PHT)	✓	8	High	High	25-30+ years
IR8	Peat and clay exposures with piddocks [sublittoral]		Excluded	-	-	-
IR9	Submerged or partly submerged sea caves		Excluded	-	-	-
IRZ	Other sublittoral rock (IC)		4	Medium	Low	5-10 years

IHS Code	IHS Classifications	Section 41 Habitat	Habitat Distinctiveness Score[1]	Delivery Risk: Habitat Creation	Delivery Risk: Habitat Restoration	Average Temporal Risk
IS	**Inshore sediment**					
IS0	Inshore sublittoral sediment (BHT)		4	Medium	Low	1-10 years
IS1	Mud habitats in deep water (PHT)	✓	6	High	High	1-10 years
IS2	Sublittoral sands and gravels (inshore) (PHT)	✓	6	Medium	Medium	1-10 years
IS21	Sandbanks which are slightly covered by sea water all the time (AN1)		4	Medium	Medium	1-10 years
IS2Z	Other sublittoral sands and gravels (inshore) (IC)	✓	6	Medium	Medium	1-10 years
IS3	Seagrass beds (*Zostera marina & Zangustifolia*) (PHT)	✓	6	High	High	5-15 years
IS4	Maerl beds (PHT)	✓	Excluded	-	-	-
IS5	Saline Lagoons [= Coastal lagoons (AN1)] (PHT)	✓	8	Medium	Medium	5-10 years
IS6	Serpulid reefs (PHT)	✓	8	High	High	25-30+ years
IS7	Blue mussel beds on sediment [sublittoral]	✓	6	Medium	Medium	5-15 years
IS8	File shell beds	✓	8	Very High	Very High	30+ years
ISZ	Other inshore sediment (IC)		4	Medium	Low	1-10 years
LR	**Littoral rock**					
LR0	Littoral Rock (BHT)		4	Medium	Low	5-10 years
LR1	Littoral chalk (PHT)	✓	6	Medium	Medium	10-15 years
LR2	Intertidal surge gullies and caves (PHT)		6	Very High	Medium	1-10 years
LR2	Tide-swept channels [intertidal]		6	Very High	Medium	10-15 years
LR21	Submerged or partly submerged sea caves (AN1)		6	Very High	Medium	1-10 years
LR2Z	Other intertidal surge gullies and caves (IC)		6	Very High	Medium	1-10 years
LR3	*Sabellaria alveolata* reefs (PHT)	✓	6	High	High	1-10 years
LR4	Fragile sponge and anthozoan communities on rocky habitats	✓	8	High	High	5-10 years
LR5	Intertidal underboulder communities	✓	6	High	Medium	5-10 years
LRZ	Other littoral rock (IC)		4	Medium	Low	1-10 years
LS	**Littoral sediment**					
LS0	Littoral Sediment (BHT)		4	Medium	Low	5-10 years
LS1	Blue mussel beds on sediment [littoral]	✓	6	Medium	Medium	1-10 years
LS2	Seagrass beds (*Zostera noltii*) (PHT)	✓	6	High	High	25-30+ years
LS3	Coastal saltmarsh (PHT)	✓	6	High	Medium	10-20 years
LS31	Salicornia and other annuals colonising mud and sand (AN1)	✓	6	Medium	Low	1-2 years
LS32	Spartina swards (*Spartinion maritimae*) (AN1)	✓	6	Medium	Medium	4-10 years

IHS Code	IHS Classifications	Section 41 Habitat	Habitat Distinctiveness Score[1]	Delivery Risk: Habitat Creation	Delivery Risk: Habitat Restoration	Average Temporal Risk
LS33	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) (AN1)	✓	6	Medium	Medium	4-10 years
LS35	Inland salt meadows (*Sarcocornetea*) (AN1)		8	Medium	Medium	5-15 years
LS36	Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*) (AN1)		6	Medium	Medium	10-20 years
LS3Z	Other saltmarsh (IC)	✓	6	Medium	Medium	10-15 years
LS4	Mudflats (PHT)	✓	6	High	Medium	4-10 years
LS41	Mudflats and sandflats not covered by sea water at low tide (AN1)	✓	6	High	Low	1-10 years
LS5	Sheltered muddy gravels (PHT)	✓	6	Medium	Low	5-10 years
LS6	Peat and clay exposures with piddocks [littoral]	✓	Excluded	-	-	-
LSZ	Other littoral sediment (IC)		4	Low	Low	5-10 years
MA	**Machair**					
MA1	Machair [= Machair (AN1)] (PHT)	✓	6	High	Medium	10-20 years
MC	**Maritime cliff and slope**					
MC1	Maritime cliff and slopes (PHT)	✓	6	Very High	Medium	5-10 years
OC	**Oceanic seas**					
OC1	Seamount communities	✓	Excluded	-	-	-
OCZ	Other oceanic seas		4	Medium	Medium	10-15 years
OR	**Offshore shelf rock**					
OR0	Offshore Shelf Rock (BHT)		4	High	Medium	15-25 years
OS	**Offshore shelf sediment**					
OS0	Offshore Shelf Sediment (BHT)		4	High	High	15-25 years
OS1	Sublittoral sands and gravels (Offshore) (PHT)		4	Medium	Low	10-15 years
OSZ	Other offshore Shelf Sediment (IC)		4	High	High	10-15 years
SR	**Supralittoral rock**					
SR0	Supralittoral Rock (BHT)		4	Medium	Low	10-15 years
SR1	Vegetated maritime cliff and slopes (PHT)		6	Very High	Medium	10-15 years
SR11	Vegetated sea cliffs of the Atlantic and Baltic coasts (AN1)		6	Very High	Medium	10-15 years
SR1Z	Other vegetated cliffs and lichen dominated cliffs (IC)		4	Very High	Medium	10-15 years
SR2	Boulders and rock above the high tide mark (PH1)		4	Low	Low	5–10 years
SR3	Soft rock sea cliffs		4	Very High	Medium	5-10 years
SRZ	Other Supralittoral rock (IC)		4	Medium	Low	10-15 years

IHS Code	IHS Classifications	Section 41 Habitat	Habitat Distinctiveness Score[1]	Delivery Risk: Habitat Creation	Delivery Risk: Habitat Restoration	Average Temporal Risk
SS	**Supralittoral sediment**					
SS0	Supralittoral Sediment (BHT)		4	Medium	Medium	5-10 years
SS1	Coastal sand dunes (PHT)	✓	6	High	Medium	10-20 years
SS11	Embryonic shifting dunes (AN1)		6	High	Medium	10-20 years
SS12	Shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes") (AN1)		6	High	Medium	10-20 years
SS13	Fixed dunes with herbaceous vegetation ("grey dunes") (AN1)		8	High	Medium	10-20 years
SS14	Decalcified fixed dunes (AN1)		6	High	Medium	10-20 years
SS141	Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (AN1)		8	High	Medium	10-20 years
SS142	Decalcified fixed dunes with Empetrum nigrum (AN1)		8	High	Medium	10-20 years
SS15	Dunes with Salix repens ssp argentea *(Salicion arenariae*) (AN1)		6	High	Medium	10-20 years
SS16	Dunes with Sea buckthorn (*Hippophae rhamnoides*) (AN1)		6	High	Medium	10-20 years
SS17	Humid dune slacks (AN1)		6	High	Medium	10-20 years
SS18	Coastal dunes with Juniperus spp (AN1)		8	High	Medium	10-20 years
SS1Z	Other sand dunes (IC)		6	Medium	Medium	10-20 years
SS3	Shingle above high tide mark (PH1)		4	Medium	Low	1-5 years
SS31	Coastal vegetated shingle (PHT)	✓	6	High	High	5-10 years
SS311	Perennial vegetation of stony banks (AN1)		6	Medium	Medium	10-15 years
SS312	Annual vegetation of drift lines (AN1)		6	Medium	Medium	10-15 years
SS3Z	Other shingle above high tide mark (IC)		4	Medium	Medium	5-10 years
SSZ	Other supralittoral sediment (IC)		4	Medium	Medium	5-10 years

[1] Excluded = feature excluded from offsetting metric on grounds of scarcity or ecological importance

Source: IHS, 2007, Tillin *et al*., 2010, Tyler-Walters *et al*., 2018

B Case Studies

B.1 Habitat Metric

This case study aims to illustrate the application of a possible marine habitat metric. This is a theoretical example that has been specifically designed to include a range of different habitat types, habitat conditions as well as distinct approaches to habitat restoration and creation which have differing levels of associated risk. As set out in the main text the following metric equations were applied in sequence:

1. **Pre-intervention Units** = Size of habitat x Distinctiveness x Condition

2. **Post-intervention Units** = Size of habitat x Distinctiveness x Condition x [Total Risk as derived from Delivery Risk × Spatial Risk × Temporal Risk]

3. **Habitat Biodiversity Metric** = 'Post-Units' – 'Pre-Units' = Net Gain

For developing the pre-intervention calculation, it has been assumed for this hypothetical example that there is a loss saltmarsh at the top of a shoreline from a seawall development. The construction of these new defences will cause a direct loss of 5 ha of Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) and a further 2 ha of *Salicornia* and other annuals colonising mud and sand. These habitats are deteriorating/eroding and are in a moderate/fragmenting condition (Condition Score = '2' for both habitat types).

The decision to enhance the defences will also result in indirect losses of 3 ha of mudflat from projected sea level rise over the next epoch. In this case it is assumed that the lower shore mudflat at distance from the sea wall is of good quality (Condition Score = '3').

The habitat distinctiveness score for all three habitats is '6'. On this basis, the sum value for the Pre-Intervention Unit would be '138' as follows:

Pre-Intervention Units
Salt Meadow = 5 x 6 x 2 = 60 +
Salicornia = 2 x 6 x 2 = 24 +
Mudflat = 3 x 6 x 3 = 54
Total = 138

Before moving on to the post-intervention calculation, it is recognised that for many locations across the UK, such intertidal muds and marshes are likely to be already protected under Habitats Regulations which enforce the Wild Birds and Habitats Directives. The provisions of these regulations would therefore take priority over any net gain initiative (see Section 2.7). It is also anticipated that, under the Habitats Regulations, any project of the scale described (i.e. affecting 10 ha of habitat directly or indirectly) would be required to deliver compensation measures. Such compensation could include restorative measures (e.g. the removal of redundant infrastructure to extend intertidal habitat) within the designated site where the development impact will occur or the creation of new habitat (e.g. though managed realignment) in an area that is as close as is feasible to the areas of loss.

For the purposes of developing the post-intervention calculation as part of this case example, it is assumed that a similar combination of restoration and habitat creation would be conducted. Saltmarsh habitats are to be created in a distant managed realignment outside of the development's marine plan area (Spatial Risk Score = '0.8'). This is definitely being implemented (perhaps to achieve habitat banking functions for multiple contributory projects) and managed realignments are known to be highly successful in marsh creation (Low Delivery Risk Score = '1'). The mudflat is to be restored close to the site though removal of redundant infrastructure.

The proposed restoration of mudflat habitat, is also expected to be successful (Low Delivery Risk Score = '1'). The only delivery concern in this case is that the mudflat habitat might change to marsh over time depending upon how the works are implemented. However, under the net gain approach, habitat offsetting does not have to be on a like-for-like basis. As long as the distinctiveness scores for both habitats are the same, which is true of mudflat and saltmarsh (Distinctiveness = '6') then offsetting can be considered appropriate. This would allow natural development of habitats as long as distinctiveness scores remained the same. Therefore, the delivery risk for the current project under net gain would remain as Low (Score = '1').

In terms of the temporal risk, all three habitats can develop very quickly if the conditions are right. *Salicornia* species are known to colonise new environments rapidly (within just 1 to 2 years) and as such this habitat has a high Temporal Risk Score of '0.931'. Atlantic Salt meadow and mudflat can take a few more years to mature and achieve a fuller diversity of species. The average temporal risk range for both these habitats is 4-10 years but it is known that the benthic invertebrates within mudflat habitat often mature after around 4 years and, in a restoration project, a very rapid rate of recovery (four year to target condition = Temporal Risk Multiplier '0.867') to a good condition (Score '3') is to be expected.

Atlantic Salt meadow plants can also colonise within 4 years, but there is some research to say that certain poorly-dispersive species may take decades to colonise. However, based on the evidence from past realignments it is known that marshes can achieve a high rate of plant colonisation and a high level of ecosystem functionality (and a good condition (Score '3') within just a few years. For this analysis it has been assumed that there would be eight years to target condition (midway between 4 and 10 years) and that the Temporal Risk Multiplier would be '0.752'.

It has also been assumed that around 5 to 6 ha of marsh habitat could be created through managed realignment but, as noted above, in a separate marine plan area (hence Spatial Risk Score = '0.8'). By contrast only 2 ha of local mudflat could be restored but that is also in the locality of the development so would have a higher Spatial Risk Score of 1). Based on these values the sum value for the Post-Intervention Unit would be '163' as follows:

Post-Intervention Units

Distant realignment creating Salt Meadow = 6 x 6 x 3 x [1x0.8x0.752] = 6 x 6 x 3 x [0.60] = **64.8** +
Distant realignment creating Salicornia = 5 x 6 x 3 x [1x0.8x0.931] = 5 x 6 x 3 x [0.74] = **66.6** +
Local project restoring Mudflat = 2 x 6 x 3 x [1x1x0.867] = 2 x 6 x 3 x [0.867] = **31.2**
Total = 163

On this basis the habitat biodiversity metric is '25' which represents an 18 % net gain as follows:

Habitat Biodiversity Metric
Post-Unit **163** – Pre-Unit **138**
Total = 25

This case example indicates that biodiversity net gain could be achieved from creating 13 ha of habitat for the loss of 10 ha which would appear to be proportionate. In trialling this metric a simple worksheet tool was developed (see Image B1) to test its sensitivity. For example, it was used to test the outcome in the event that the spatial risk scores from Defra metric 2.0 were applied. This led to the need for a further 6.5 hectares to be created to achieve an equivalent level of net gain. This is probably disproportionate (twice as much habitat created as lost) and perhaps helps to bear out the rationale for selecting the different spatial risk scores when dealing with the marine environment. When testing this tool it was also clear how the metric is sensitive to many other inputs. This indicates that there will be a need for a lot of further discussion, and guidance, to create a transparent and universally-applicable methodology.

		Pre-intervention units			Total	Post-intervention units			Risk			Total
IHS Code	Name	Habitat Area (ha)	Distinctive-ness	Condition		Habitat Area (ha)	Distinctive-ness	Condition	Delivery Risk	Spatial Risk	Temporal Risk	
LS33	Atlantic Salt Meadow	5	6	2	60	6	6	3	1	0.8	0.752	65.0
LS31	Salicornia and other annuals	2	6	2	24	5	6	3	1	0.8	0.931	67.0
LS41	Mudflats and sandflats	3	6	3	54	2	6	3	1	1	0.867	31.2

Total Habita Loss	10
Total Habitat Gain	13
Pre-intervention unit total	138
Post-intervention unit total	163
Habitat Biodiversity Metric	**25**
% Gain	**18%**

Image B1. View of simple worksheet tool used to test metric sensitivity in this case example.

B.2 Species Metric

This case study aims to illustrate the application of the possible marine species metric using an example development. The case study assesses fish impingement at Hinkley Point C (HPC), based on information contained in an updated Environmental Statement (ES) issued for consultation by HPC in May 2019 (NNB Geo, 2019).

Hinkley Point C is a proposed development to build and operate a new nuclear facility at Hinkley Point, Somerset. As part of the development, a cooling water system (CWS) is required to condense the turbine steam and provide essential and auxiliary cooling water flows. The proposed CWS at HPC will abstract large volumes of water from the adjacent Bristol Channel, and there is therefore the potential for fish and crustacea to be entrapped in the system via the cooling water structures.

Table B1 indicates the predicted fish species and numbers likely to be impacted by the development. A variety of fish species are found within or migrate through the estuary, including those protected under European Directives and/or national legislation (e.g. Atlantic salmon (*Salmo salar*), twaite shad (*Alosa fallax*), allis shad (*Alosa alosa*), river lamprey (*Lampetra fluviatilis*), sea lamprey (*Petromyzon marinus*), sea trout (*Salmo trutta*) and eel (*Anguilla anguilla*)). The estuary is also considered internationally important for eels, supporting 98% of the UK elver run. The broader fish population of the Severn Estuary and Bristol Channel is of similar species composition to that of other estuaries and coastal regions in south-west England (Henderson and Holmes, 1989).

As part of the design of the CWS, a Fish Recovery and Return (FRR) system will be built, that will include a tunnel extending approximately 600 m under the foreshore, to return impinged fish back to the sea. The fish return system also incorporates a means to sample the fish so that assessments can be made in respect of numbers and types of fish caught as well as fish survivorship through the system.

FRR systems have been reported to achieve 80% to 100% survival rates for robust epibenthic species and moderate rates for demersal species (50% to 60%). However, for delicate pelagic species such as herring and sprat, survival rates are relatively low (<10%) (Cefas, 2019).

Table B1. Predicted number of fish species impacted by CWS at Hinkley Point C

Species	Number Impinged	FRR Mortality	Mortality with FRR
Sprat	518,264	100%	518,264
Whiting	194,517	55%	106,012
Dover sole	85,898	20%	17,523
Cod	2,819	55%	1,559
Herring	2,982	100%	2,982
Bass	2,505	70%	1,747
Plaice	627	43%	266
Thornback Ray	669	41%	271
Blue Whiting	103	55%	56
	808,384		**648,680**
Twaite Shad	19	100%	19
Allis Shad	5	100%	5
Salmon	0	55%	0
Sea trout	0	55%	0
	24		**24**
Eels	782	20%	156
Marine Lamprey	117	20%	23
River Lamprey	46	20%	9
	945		**188**
Total	**809,353**		**648,892**

NNB Geo, 2019

This case study has applied the species metric to assess the impact on fish species with and without the implementation of FRR system to show how the metric could also be used a tool for developers to assess cost-benefits of implementing additional ecological enhancements to developments. The results of the case study are presented in Table B2. Under the proposed metric, the offsetting cost of the Hinkley Point C project would equate to approximately £280,073 per year in developer contributions based on the predicted number of fish impacted, presented in Table B1.

Table B2. Offset cost for Hinkley Point C using the proposed Species metric

Number of Fish Impinged Without FRR	Number of Fish Affected With FRR
Non-migratory fish (mortality) = 808,384 x 0.02 x 10 = £161,677	Non-migratory fish (mortality) = 648,680 x 0.02 x 10 = £129,736 (disturbance) = 159,704 x 0.02 x 3 = £9,582
Salmon/ migratory clupeids (mortality) = 24 x 500 x 10 = £120,000	Salmon/ migratory clupeids (mortality) = 24 x 500 x 10 = £120,000
Eels and lamprey (mortality) = 945 x 5 x 10 = £47,250	Eels and lamprey (mortality) = 188 x 5 x 10 = £9,400 (disturbance) = 757 x 5 x 1 = £11,355
Total = £328,927	**Total = £280,073**

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