Research into Approaches to Measuring Biodiversity in Scotland

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Scottish Government
Riaghaltas na h-Alba

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The learnings and recommendations outlined in this report are the result of consultations with a wide range of interested parties engaged across the four policy areas – agriculture, conservation, planning and development and natural capital in Scotland. Seventy-two participants kindly participated in the engagement process.

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Main Findings

Scotland has a suite of biodiversity indicators that assess broad trends in biodiversity at the national level and measure progress against biodiversity targets. However, at present there is no single agreed Scottish biodiversity metric or measurement tool to assess biodiversity at the site, or project, scale. An agreed Scottish approach to measuring biodiversity would allow for consistent and comparable assessment of losses or gains in biodiversity across sites and allow comparison and trading across sectors.

The development of a biodiversity metric or measurement tool in Scotland has potential use across four main policy areas: natural capital markets, planning and development, biodiversity conservation and monitoring and agriculture. These policy areas are all at different stages of engagement with approaches to measuring biodiversity and are working largely independently within different policy landscapes. It is therefore important that research on a Scottish biodiversity metric evaluates the options that best serve Scottish interests and assesses the priorities across policy areas.

The main research findings include:

- To meet the needs of all four sectors, a framework, or standard, is needed that integrates multiple metrics or tools to monitor biodiversity.
- This framework needs to provide consistent results, while allowing flexibility in its application so metrics and tools within the framework could be tailored depending on different user or policy needs.
- Priority biodiversity indicators include the extent, condition and distinctiveness of habitats; species; ecological connectivity; presence of irreplacable habitat; and ecosystem health and function.
- It is important that the approach to biodiversity metrics be accessible, understandable, and flexible in how it is applied across different uses or spatial scales.
- Biodiversity metrics for Scotland should be clear, concise and transparent, and scientifically robust in terms of measurability.
- Biodiversity metrics for Scotland may benefit from certain elements from existing metrics, but existing metrics do not address the full list of priority criteria identified by stakeholders.
- With refinement, Natural England's Biodiversity Metric 3.1 could be adapted for planning and development use, and as part of a wider set of metrics within a biodiversity framework. These refinements include the coverage of habitats, and adjustments to condition assessment and mutlipliers to reflect Scottish contexts.

Executive Summary

Aims and objectives

This project aimed to review and recommend methodologies for the measurement of biodiversity at the site level in Scotland. In doing so the research considered end-user needs across four key policy areas: agriculture, conservation and biodiversity monitoring, natural capital markets and planning and development. A combination of stakeholder analysis and review of existing tools and metrics was used to develop the recommendations presented in this report.

The main objectives include:

1. To engage stakeholders within four key policy areas to identify and prioritise relevant criteria for assessing existing metrics or tools.

2. To assess a range of biodiversity metrics and tools that could be used to measure biodiversity at the site level and determine which aspects of current approaches meet the needs of end-users in Scotland.

3. To review Natural England's Biodiversity Metric 3.1 to assess its applicability for use in Scotland and in policy areas extending beyond planning and development, and identify any adaptations needed to make Natural England's Metric 3.1 fit for use in Scotland.

4. To engage stakeholders to sense check key findings, identify concerns, and ensure that the recommendations align with stakeholder needs.

5. Drawing on the above, advise on preferred approach and scope of guidance that will be required.

Approach

To address the objectives outlined above, the research was undertaken in several steps:

- A list of assessment critera for evaluating biodiversity metrics was developed and prioritised through two stakeholder workshops. Workshops included representatives from four key policy areas: agriculture, conservation and biodiversity monitoring, natural capital markets, and planning and develoipment.

- Twenty six existing biodiversity tools and metrics were identified and compared using the list of assessment criteria described above. Consideration was given as to whether these tools and metrics could, in whole or in part, be applicable in a Scottish biodiversity metric.

- An in-depth review was completed for Natural England's Biodiversity Metric 3.1, including review of guidance and techical references, land-use change scenario testing, stakeholder discussions, and an evaluation of the data needs underpinning the metric. Through this review we assessed whether

this metric could, in whole or in part, be adapted for Scotland and applied across the four policy areas.

- A final sense-checking workshop was held with stakeholders to review and provide input on the findings and to gain further insights.

Summary of main findings

The results of this report demonstrate both consensus and divergencies in priorities across the four policy areas. To meet the needs of all four sectors, a biodiversity measurement approach or metric will need both common features and some degree of flexibility in its application. A framework, or standard, is needed that can integrate multiple metrics or tools to monitor biodiversity and provide consistent results, while allowing flexibility to tailor metrics and tools depending on different user or policy needs (Figure ES1). This framework could incorporate both new elements and elements from existing tools that are adapted for use in Scotland.

As the four policy areas differ in their needs for measurements of biodiversity, this also means differing requirements for time and effort, level of detail, training and expertise, and regularity of assessment. For example, farm biodiversity audits may only need meaningful, targeted participatory monitoring which is achievable with basic training and resources. This monitoring could rely on a qualitative habitat condition assessment, with more complex (but comparable) approaches scaled for other uses. In contrast, high integrity ecosystem markets such as biodiversity credits require more robust quantification of a broader selection of indicators to fully capture biodiversity. Needs for the planning and development sector may fall somewhere between these policy areas depending on the scale or impact of development being considered. The biodiversity monitoring sector has a need to inform and record indicator data across a range of applications spanning the three other policy sectors. Thus, for any site, the degree of complexity needs to reflect the purpose, the user and the priority outcomes for the habitat, species or ecosystem.

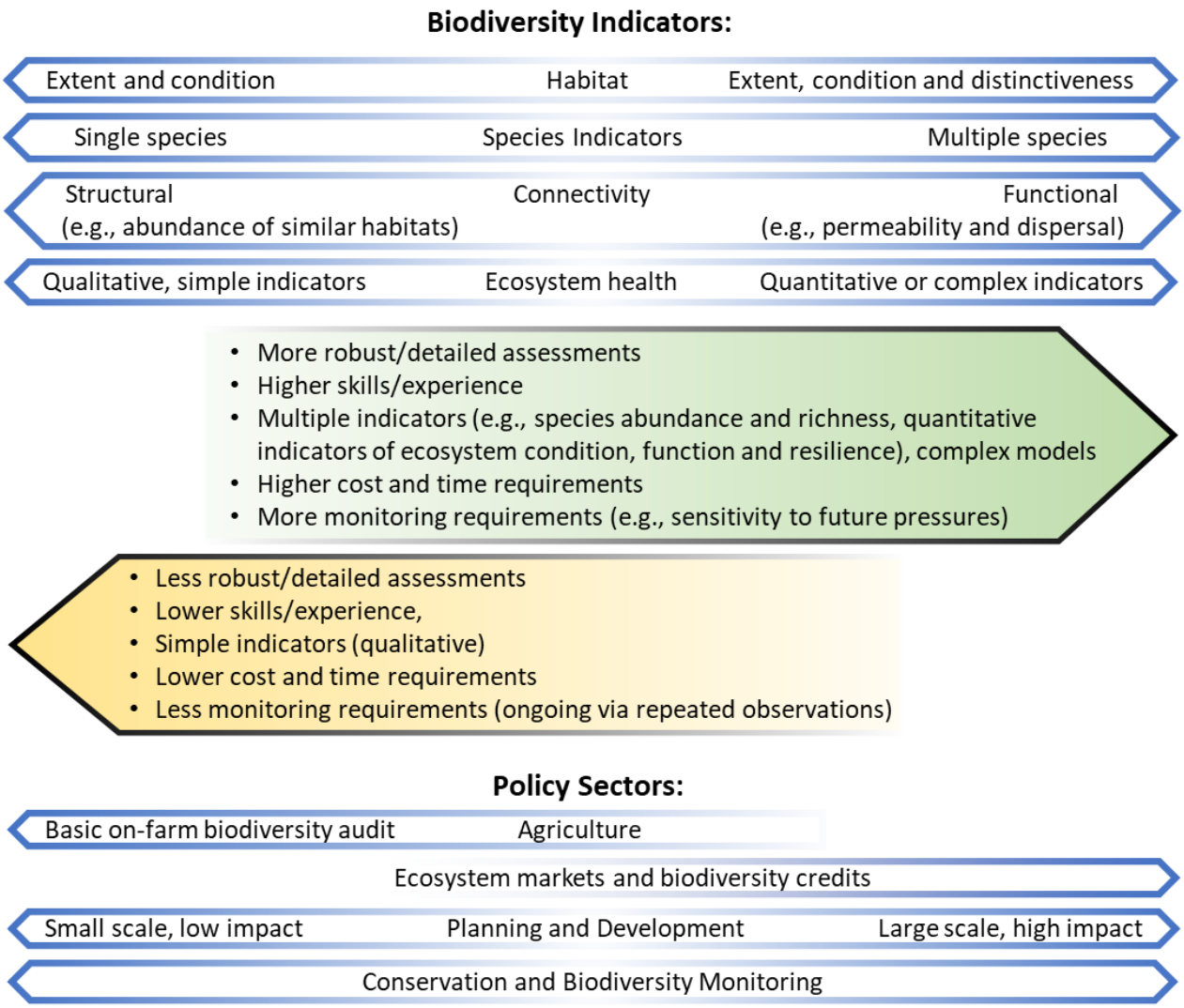


Figure ES1 Conceptual biodiversity metric framework illustrating increasing complexity of assessment from left to right across the range of biodiversity indicators (top) and policy sectors (bottom).

Results from the metric reviews and workshops illustrate that a biodiversity approach for Scotland needs to address a number of elements outlined below:

Habitat and species metrics:

- Including habitat indicators in a biodiversity metric was identified as a high priority across all policy areas. Assessments of habitat condition should be scaled to meet the needs of different end-users and ecological objectives. Irreplaceable habitats should be identified and assessed accordingly within the metric. Habitat classification systems should be flexible to meet the needs, skills, and training of end-users, with appropriate correspondence tables developed to allow translation between classifications (e.g. UK Hab to EUNIS). Natural England's Biodiversity Metric 3.1 could be adapted to meet this need.

- Including species indicators was identified as moderate or high priority across all policy areas.This should be scalable in terms of scope and effort to meet the needs of different end users and objectives. Species based metrics

should reflect the presence of one or more indicator species and the diversity of species or taxa. The choice of species should reflect the context in which a metric is being used. Further research is recommended to identify indicator species and appropriate species-based metrics for Scotland.

Connectivity metrics:

Including connectivity indicators was identified as a high priority across all policy sectors. Further research is recommended to determine appropriate connectivity measures across different habitat and land use contexts and scales. There are multiple ways connectivity can be assessed (e.g., abundance of similar habitats, permeabiity and dispersal) and existing efforts to identify opportunity areas for habitat creation in Scotland that can be built upon.

Ecosystem function, health and integrity metrics:

Including measures of ecosystem health was also identified as high priority, particularly as part of more detailed or robust assessments for monitoring, larger project planning and ecosystem markets. It could also be incorporated into wider system and soil health assessments in the agricultural sector. We recommend that suitable ecosystem health indicators be identified for different habitats and land uses reflecting condition, function, and resilience. Review of Scotland's Environment ecosystem health indicators[1] which reflect a range of nationally available data and reporting at national scale could be a starting point to address indicators for these elements.

Monitoring:

Ongoing or long-term monitoring is important to assess changes in biodiversity, and provides a means of identifying problems and potential interventions to enhance biodiversity outcomes. Chosen metrics or indicators should be amenable to ongoing monitoring or repeated estimation and reflect current and future pressures. This means they should be sensitive to and able to reflect changing impacts. Scoring systems for future biodiversity should also be sensitive to changing pressures (e.g. climate change, disease and pest risks).

Scientific robustness and transparency:

- Results from the metric reviews and workshops highlight the need for the approach to be accessible, understandable, and flexible in how it is applied across different uses or spatial scales. The approach should avoid oversimplification, allowing for robust assessment by experienced and trained staff, but also meaningful where participatory or citizen science approaches are used. Thus, indicators and protocols should allow for repeatable and comparable results, whilst requiring varying levels of effort and expertise for data collection depending on their use. Guidance and training should be appropriate for the range of users and applications.

[1] Scotland's Environment: Ecosystem health indicators

- The methodology and indicator data used to calculate the metric (and estimate biodiversity units) should be accessible and published to aid transparency and understanding.

- Results from the metric reviews and workshops also illustrate that Scottish biodiversity metrics need to be clear, concise and transparent and scientifically robust in terms of measurability. Chosen metrics or indicators should have a robust scientific basis and provide meaningful measures of biodiversity and/or ecosystem health. They should ensure a standardised framework that allows interrogation to reduce the risk of green-washing or gaming.

Wider ecosystem services:

Stakeholders noted the desirability to include wider ecosystem service benefits within a biodiversity metric framework. This has been captured to some extent by Natural England's Environmental Benefits of Nature (EBN) tool, which is designed to work alongside the Biodiversity Metric 3.1 and provides a qualitative assessment of the impact of net gain actions across a range of 18 ecosystem services, evaluated at 1, 10 and 30 years from implementation. Review of the EBN was outside the scope of this study, but it may be adjusted to reflect Scottish circumstances and applications.

Applicability of Natural England's Biodiversity Metric 3.1 in Scotland:

The Biodiversity Metric 3.1 was designed for calculating biodiversity net gain within the planning and development sector. As such it is not fully applicable to other sectors. However, with refinement it could be adapted for planning and development use, and as part of a wider set of metrics within a biodiversity framework.

To adapt Biodiversity Metric 3.1 for use in Scotland, experts would need to engage to ensure elements are fit for use in Scotland, including updating the User Guide/Technical Annexes, updating the list of irreplaceable and Annex 1 habitats to reflect Scottish circumstances, ensuring peatlands are correctly accounted for, reviewing trading rules, considering how UK Hab relates to other classification systems that may be used within a broader framework, and determining the appropriateness of condition criteria for habitats in Scotland. Spatial datasets would need to be assessed to determine where spatial data are lacking, and whether existing local strategies and plans are suitable to inform strategic significance. Environmental conditions vary widely across Scotland, influencing the risks associated with habitat creation. Average risk multipliers, as used in Metric 3.1, are thus not appropriate for Scotland and greater flexibility is needed in assigning risk multipliers. It is also important to ensure multipliers interact appropriately to incentivise the creation of good quality habitats. With ecological connectivity considered a priority across policy sectors, Metric 3.1 should be adapted to include connectivity measures, as well as the other priority indicators identified above (condition, species, ecosystem health, and wider ecosystem benefits).

Consideration should be given to training availability and Scotland's capacity to deliver both from a regulatory perspective and also for on the ground surveys. This would require an assessment of potential skills gaps and where there is a need for training and clear guidelines.

Consideration is also needed for how this type of metric would fit within a broader framework. For example, a standardised approach to condition assessment criteria could align policy sectors, yet still meet the needs of different sectors and uses. Additionally, incorporating management/systems aspects would meet the needs of the agricultural sector. Agriculture takes a systems-approach to land management and consequently aspects relating to management, rotation and spatial/temporal dynamics are important to include to meet the end needs of this sector.

Conclusions and recommendations

To meet the needs of all four policy sectors, a framework, or standard, is needed that integrates multiple metrics or tools to monitor biodiversity. This biodiversity framework should ensure consistency across all policy sectors while maintaining flexiblity around which protocols and indicators to select. The framework should be organised so that relevant existing metrics, protocols or tools can be integrated and used to assess biodiversity. To do this, the framework needs to set expectations around when to select different indicators and protocols, how to integrate existing methods, and how to ensure that results are reasonably consistent across approaches (e.g., different condition assessments need to align or conform to a common expectation of low, moderate and good condition). The framework will also need to outline how the outputs of different metrics or methods relate, particularly for trading or monitoring biodiversity across sectors.

The existing biodiversity metrics reviewed in this report use a variety of ways to measure biodiversity that are not always comparable or adequately capture the full range of biodiversity functions in terms of habitats, species and ecosystem health. Further, many metrics reviewed use proxy, or modeled, measures of biodiversity that are too coarse to be appled at a site scale. An approach for Scotland may benefit from incorporating certain elements from existing metrics, but additional work is needed to fully address the list of priority criteria identified by stakeholders, including habitat condition, species indicators, ecosystem health, ecological connectivity and wider ecosystem benefits. With refinement, Natural England's Biodiversity Metric 3.1 could be adapted as part of a wider set of metrics within a biodiversity framework.

Contents

Introduction

The Scottish Government's National Strategy for Economic Transformation highlights the importance of a nature-positive economy to address both the climate and nature emergencies. Further, Scotland's Biodiversity strategy aims to establish a shared vision for biodiversity: "by 2045 we will have substantially restored and regenerated biodiversity across our land, freshwater and seas". It sets out two high-level goals: to be nature-positive by 2030, bending the curve to halt biodiversity loss; and to restore biodiversity in Scotland by 2045. Two key delivery vehicles are the global 30x30 target of protecting at least 30% of land and seas for nature by 2030 and creating Nature Networks across Scotland to enhance ecosystem health, sustainability, and resilience.

Scotland has a comprehensive suite of biodiversity indicators to assess broad trends in biodiversity at the national level, however, it is lacking a consistent means to assess biodiversity at the site scale. Reversing biodiversity declines will require action across multiple strands of policy. These include agriculture, conservation and biodiversity monitoring, planning and development, and natural capital markets. To enable biodiversity recovery actions and measure their success, robust biodiversity metrics, and associated tools to measure these metrics, are required that are fit for purpose and allow comparision and trading across policy sectors. Biodiversity metrics are also needed in relation to the Natural Environment Bill targets to demonstrate the need for and subsequent effect of interventions.

Looking across the UK and internationally, a number of biodiversity metrics and measurement tools have been developed in recent years to address the needs of end-users across these different policy areas. These include tools to inform biodiversity offsetting or net gain to quantify biodiversity loss due to development alongside biodiversity gain through mitigating actions including habitat creation or enhancement. Other tools are targeted to enable businesses to identify and report on their biodiversity impacts at project, site or corporate level. Approaches range from those requiring on-site surveying to those that draw on modelling and knowledge of biodiversity impacts of different land uses and management actions. Natural capital markets for biodiversity credits are also being underpinned by an increasing number of metrics and standards. These markets include investment opportunities around nature recovery and net gain or offsetting opportunities reflecting both

This initial exploratory study draws on stakeholder knowledge and opinions, alongside an evaluation of existing tools, to provide recommendations on how a Scottish 'biodiversity metric' or framework could be developed to assess Biodiversity at site level (Figure 1).

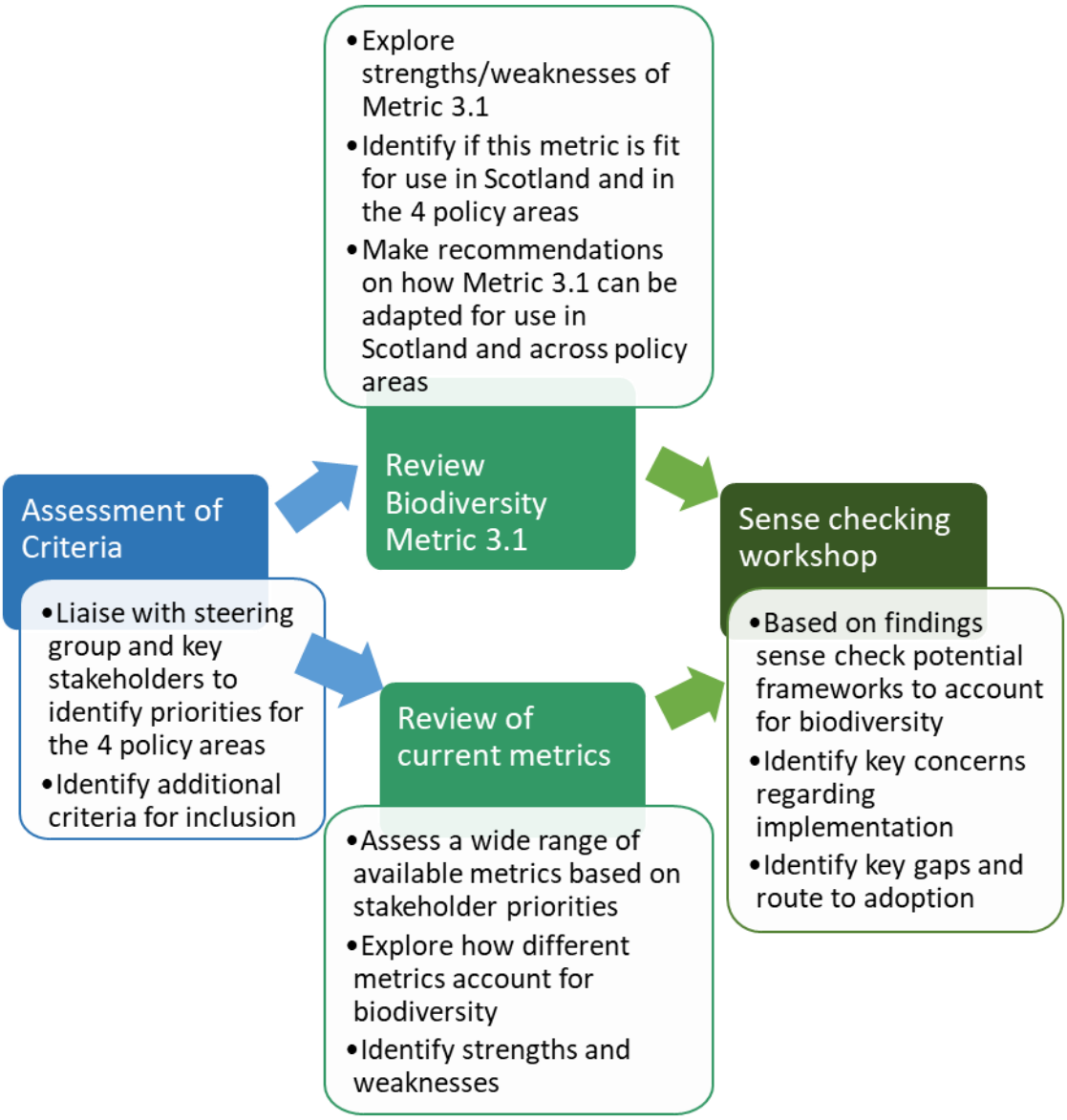


Figure 1: Overview of approach

Aims and objectives

This project aims to provide guidance to aid the development of a framework to enable Scotland to monitor and account for biodiversity at the site level. This framework will consider the end-user needs across four key policy areas – specifically Agriculture, Conservation and Biodiversity Monitoring, Natural Capital Markets and Planning and Development.

Objectives

1. Work with stakeholders to identify relevant criteria against which to assess existing metrics or tools and determine the priority of these criteria with respect to policy area.

2. Assess a wide range of biodiversity metrics and tools targetted to measure biodiversity at the site level and determine which aspects of current approaches meet the needs of end-users in Scotland.

3. Specific analysis of the applicability to Scottish needs of the Natural England's Biodiversity Metric 3.1 being used as the basis of a new biodiversity standard, and possible adaptations that would make it fit for use in Scotland.

4. Work with stakeholders to sense check key findings, identify concerns, and ensure that final guidance aligns with stakeholder requirements and needs.

5. Drawing on the above, advise on preferred approach and scope of guidance that will be required.

Methodology

Assessment of criteria

Our first step was to identify a definitive list of criteria to evaluate a range of biodiversity metrics. Stakeholder workshops were held to prioritise and refine potential criteria for four key policy areas specifically: Agriculture, Conservation and Biodiversity Monitoring, Natural Capital Markets and Planning and Development. This ensured that the resultant assessment criteria were meaningful and deemed important across sectors.

Figure 2: Example of a target and placement of sticky notes from the Natural Capital Markets stakeholder workshop

We identified a range of potential criteria from the invitation to tender, our project proposal and additional sources such as the EU Business @ Biodiversity platform[2] (Table 1; Annex 1; Annex 2). Two online workshops were held to evaluate and prioritise criteria. The first workshop enaged with members of the project steering group (Scottish Government and NatureScot) and the second expanded to 72 stakeholders. Both workshops included representatives from the four identified policy areas.

[2] Lammerant J. et al., Assessment of Biodiversity Measurement Approaches for Businesses and Financial Institutions, Update Report 4 on behalf of the EU Business @ Biodiversity Platform, December 2022

Participants prioritised criteria using an online interactive Miro board[3]. 'Sticky notes' for each criterion were placed in different sectors of a 'target' where the inner-most ring represented the highest priority (Figure 2). In the initial steering group workshop, the 'target' was divided into four quadrants relating to policy area (i.e. Agriculture, Conservation and Biodiversity Monitoring, Natural Capital Markets and Planning and Development). In the subsequent, larger, stakeholder workshop the participants were first divided into breakout rooms based on policy interest. Separate 'targets' were then used for each breakout room to allow for more accurate placement. In both workshops there was the option to add further criteria where omissions were identified.

Table 1: Overview of potential assessment criteria for evaluating metrics. See Annex 2 for a more detailed description of criteria alongside source.

Category	Criteria	Assessment questions (Responses may be yes/no or short text)	Further comments
Habitats and species	Habitat extent	How is habitat extent included (e.g., extent only or extent/condition/significance)?	Short description of condition and significance scoring
	Habitat connectivity	Is habitat connectivity included?	Short description of method or data used
	Habitat: priority or irreplaceable habitats	Are priority habitats and / or irreplaceable habitats identified?	How does the metric deal with priority or irreplaceable habitats, e.g. would scoring preclude development?
	Ecosystem health and function	How is ecosystem function and health included?	Short description of method or data used
	Ecosystem functional diversity	Is the range of species types and traits measured?	Short description of method or data used
	Species	Describe how species are included (e.g., indicator species, priority species, numbers)	List of taxa included in species measurement
	Ongoing monitoring	Does the metric require future monitoring of outcomes?	Short description of required monitoring activities and/or data

[3] Miro interactive board

Category	Criteria	Assessment questions (Responses may be yes/no or short text)	Further comments
	Current and future pressures (e.g., climate change risks)	Does the metric allow for future risks (e.g., buffering of biodiversity units)	What is the buffering margin?
Effort and ease of use	Open access	Are all data and methods open access?	Short description of any proprietary data or methods used
	Scalable: financial	Are there financial implications for? larger scale applications?	For example, would extensive field data collection be necessary?
	Scalable: spatial	Can the metric be applied over multiple spatial scales?	
	Expertise	What level of expertise is required?	Short description of where expertise is required, e.g., overall tool use, condition assessments etc.
	Time requirements	What is the indicative time needed to apply the metric?	Examples from previous applications
	Cost of use	What is the indicative cost needed to apply the metric?	Examples from previous applications, also linked to expertise, i.e., are costs internal or external?
Useability and comparability	Clear, concise, transparent	Can users determine how units or scores have been estimated?	Short description of calculation method and outcome
	Scientifically robust: measurable	Is the metric related to a robust measure of biodiversity or ecosystem function?	Short description of underlying approach (e.g., habitat condition assessment)
	Alignment: current or future policy objectives	Could the metric be used to inform progress towards policy objectives?	

Category	Criteria	Assessment questions (Responses may be yes/no or short text)	Further comments
	Alignment: current or future monitoring	Could the metric be used to inform or be informed by current monitoring?	Linked to ongoing monitoring above, can existing data be used to inform the metric?
	Tradeable (or saleable)	Is the metric designed to produce a tradeable unit (e.g., credit or token)?	Tradeable - changes in one habitat can be compared to and traded for changes in another (i.e., offsetting or net gain) Saleable - measurable biodiversity units are created enabling commercialisation
	Replicable	Can the metric estimation be replicated across similar contexts?	
	Comparable across habitats and sectors	Is common unit or score calculated?	
	Meaningful to all stakeholders	What does the estimated unit or score represent?	
	Maturity	Is the metric in use or under development?	

As a large number of criteria were identified, we divided the prioritisation task into three more manageable exercises that each considered a subset of criteria:

- Habitats and species metrics: this considered what is measured and how.
- Effort and ease of use: this considered the resource requirements for the metrics.
- Useability and comparability: this covered a range of criteria around robustness, transparency and comparability.

In interpreting the results, criteria were sorted into three categories (high, medium and low priority) based on their relative placement on the boards rather than absolute positions. This assessment was used to identify a definitive list of criteria (Table 1) which was then used to assess a total of 26 biodiversity tools and metrics.

Many of the criteria were qualitative and they could be interpreted in different ways. Annex 2 provides a summary of the criteria interpretation reflecting discussions held during the workshops.

Review of current tools

A total of 26 biodiversity tools and metrics were reviewed against the identified criteria (Annex 4). The review was light touch and based on publicly available details from organisational websites and published documents. The majority of the tools were developed to allow businesses to assess the impacts of their operations on biodiversity. This included lifecycle and supply chain analysis, and sector specific applications for agriculture and mining. We take a broad definition of what a 'metric' is, this could include single measures or indicators, or a more complex calculation to derive a measure of biodiversity. This reflects the inherent complexity and multiple aspects of biodiversity, the importance of which will vary across end-users and policy sectors.

Review of Biodiversity Metric 3.1

We conducted an in-depth review of Natural England's tool for quantifying Biodiversity - Biodiversity Metric 3.1. This tool was developed primarily for use in the Planning and Development sector. It calculates biodiversity on a proposed development site, calcuates losses tthrough development/activity and allows developers to explore different outcomes to mitigate loss (both on site and offsite). Here we explored the guidance and technical notes alongside references within these documents. Functionality was tested using several land use change scenarios. To assess its fitness for use in Scotland we explored the availability and appropriateness of data that underpins the metric, potential habitat classifications, and accompanying guidance. Consideration was given to applicability of use in different sectors (i.e. Planning and Development, Natural Capital, Biodiversity and Conservation and Agriculture) and alignment with existing or forthcoming biodiversity assessments. Discussions were held with representatives from industry and planning regulations with experience of using the tool in Scotland.

Sense checking workshop

Following the completion of the assessments a final sense checking workshop was held to gain further stakeholder insights. A total of 59 participants, including the project steering group, attended this workshop. Stakeholders again included all four sectors. Stakeholders were first provided with an overview of the findings to date. Stakeholders were then asked to join one of four breakout rooms based on their policy interest. To prompt discussion

stakeholders were presented with a series of Microsoft Teams polls to identify preferences and an online ideas board using the Padlet[4] platform (Figure 3).

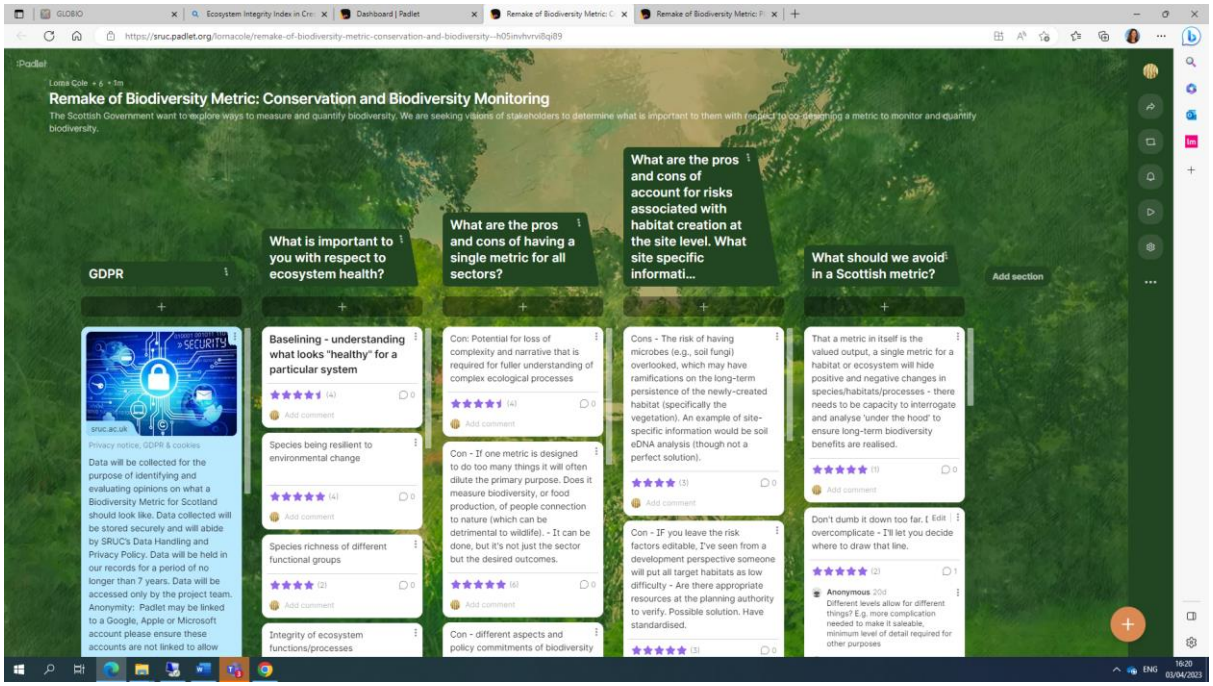


Figure 3: Example of the Padlet board capturing thoughts from the Conservation and Biodiversity Monitoring sector

[4] Padlet visual boards

Results: Assessment of criteria

Workshop outcomes were summarised for the three categories of assessement criteria (Habitats and Species, Effort and Ease of Use and Usability and Comparability). Below is a brief overview of the key findings with more detailed information provided in Annex 3.

Habitats and species

There are a wide variety of ways that tools can account for biodiversity and these typically are based on habitat or species based measurements, with expansion to include ongoing monitoring of habitats and species or account for current and future pressures. With the exception of the Conservation and Biodiversity Monitoring sector, there was a preference for habitat-based metrics over species-based metrics. Habitat-based metrics that combine habitat extent, condition and distinctiveness were prioritised over simple measure that just take into account habitat extent. Genetic diversity was also given a low priority across three areas (i.e. excluding Conservation and Biodiversity Monitoring).

The presence of irreplaceable habitats (e.g. ancient woodland), habitat connectivity, ecosystem health and functional diversity were added in the steering group workshop. Across our four policy areas, these criteria were rated as medium to high priority, with ecosystem health universally rated as high priority. These reflet the key issues of resilience and habitat sustainability from a climate and nature perspective.

Effort and ease of use

Criteria relating to Effort and ease of use were typically rated as high or medium priority, with open access, given a high priority across policy areas. Expertise in terms of ecological knowledge was also a high priority across three of the policy areas. Resource requirements in terms of cost and time were high priority for Agriculture. Scalability either spatially or financially was of high priority for the Conservation and Biodiversity Monitoring and Natural Capital Markets areas.

No additional criteria were added during the initial steering group workshop, however, adaptability over time and additionality were added during the stakeholder workshop. Analogous to carbon markets, additionality relates to governance to ensure that improvements in biodiversity or ecosystem health would not have occurred without intervention.

Useability and comparability

With respect to criteria relating to useability and comparability (i.e. the ability of a metric to meet end-user needs in a comparable way across sectors) Clear, concise and transparent was the only criterion rated as highest priority across all policy areas. Scientifically robust in terms of measurability was

given the highest priority in three of the policy areas (i.e. excluding Conservation and Biodiversity Monitoring).

The steering group workshop identified the need to differentiate Saleable (i.e. the ability to commercialise biodiversity) and Tradeable (i.e. trading biodiversity gains in one habitat or area for loss elsewhere – as in BNG calculations). The Planning and Development and Natural Capital Markets groups put a higher priority on both tradeable and saleable than the Agriculture and Conservation and Biodiversity Monitoring groups.

Assessment Criteria: Summary and recommendations

The assessment of criteria revealed both consensus and divergencies in priorities across the four policy areas and there were no obvious options to reduce or consolidate the list of criteria (Table 2). To meet the needs of all four sectors results indicate that a biodiversity measurement approach or metric will need both common features and some degree of flexibility in its application. This could potentially involve developing a framework of metrics that can address different user or policy needs. It also suggests that bespoke approaches developed for a specific policy area or application may not be directly transferable to use in other areas without some degree of adjustment. The extent to which this is the case should become clearer as we undertake the assessment of identified metrics against the criteria.

The draft template for the assessment of metrics based on the criteria is presented in Table 1. The specific responses were refined as the assessment progressed with the aim of using easily comparable and concise descriptions.

Table 2 Summary of assessment criteria prioritisation across policy areas Shading indicates the priority as high (H), medium (M), or low (L) priority, and blank entries are where additional criteria was suggested by participants for specific policy areas so not evaluated by others.

Category	Criteria		Agriculture	Monitoring	Planning	Markets
Habitats and Species	Habitat	Extent * Condition* Distinctiveness	H	H	H	L
		Extent * Condition	M	M	H	M
		Classification			M	
		Extent	L	L	M	
		Connectivity	H	M	H	M
		Presence of Irreplaceable habitat	H	H	M	H
	Ecosystem	Ecosystem Health and Function	H	H	H	H
		Functional Diversity	M		M	H
	Species	Indicator Species	M	H	M	M
		Priority Species	M	H	M	M
		Number of Individuals	M	M	L	M
	Genetic Diversity			M	L	L
	Ongoing Monitoring	Habitats and Species	H			H
	Adaptability			H		
	Accounts for current and future pressures		M	M	H	L
Efforts and Ease of Use	Open Access		H	L	H	
	Scalable	Financial	M	H	L	H
		Spatial	H	H	M	H
	Expertise		H	M	H	M
	Time Requirements	To apply metric	H	M	H	M
		Habitat creation and monitoring			M	
	Cost of Use		H	M		
	Adaptability			H		
	Public Data sources				M	
	Additionality					H
	Confidence/ Reliance in the metric			H		
Useability and Comparability	Adaptability			M		
	Clear, concise, and transparent		H	H	H	H
	Scientifically Robust	Measurable	H	M	H	H
		Reflects ecosystem function	H	M	M	H

Category	Criteria		Agriculture	Monitoring	Planning	Markets
	Alignment	Current or future policy objectives	H	L	H	M
		Current or future monitoring	M	L	M	M
	Tradeable		L	L	H	M
	Saleable		L	M	H	H
	Comparable	Across habitats and sectors	M	M	H	H
	Meaningful	To all stakeholders	H	H	M	H
	Maturity		L	H	H	M

Results: Metrics review

Biodiversity Metric 3.1 and an adjusted version of that tool used by Scottish and Southern Electricity Networks (SSEN) were the only tools in the review designed specifically for application to biodiversity offsetting /BNG in a development context. Two further tools or approaches were developed specifically to inform natural capital markets for biodiversity credits. And one tool, the Norwegian Nature Index, was designed for monitoring and reporting trends in biodiversity and ecosystem health. The full list of tools and metrics included in this review, together with links to documentation is reproduced in Annex 4.

Habitats and Species

The assessment of metrics against the criteria for Habitat and Species (i.e. what a metric measures) is summarised in Table 3. The darker shades indicate the degree to which each criteria is met, this may be fully, partially or not included. For example, with 'habitat extent', full consideration would include extent, condition and significance/distinctiveness. The full assessment with notes is included in an accompanying Excel file.

Most business focused tools use a partial species-based metric such as Mean Species Abundance (i.e. an indicator of local biodiversity intactness based on the undisturbed state - MSA) or Potentially Disappeared Fraction (i.e. the fraction of species richness that is lost due to environmental impact - PDF). These metrics do not directly measure species presence or abundance. Instead, land use type and intensity are used as a proxy measure, with relationships between land use and species drawn from existing literature or modelling. Typically, the land use is then compared to species abundance in the natural and undisturbed habitat expected in a given location. MSA or PDF relates to the change in the extent and condition of habitat/s affected by the activity being assessed. MSA can be further adjusted to account for the drivers such as climate change or nutrient inputs, the impacts of which will vary across different habitat types.

The main criticisms of approaches such as MSA is that it is not comparable across different ecosystem or habitat types (i.e. it is a measure of relative not absolute species abundance) and it is derived from very high level global assessment based on broad ecosystem types. As such it may not be sensitive to variations and local contexts in site-level habitat assessments.

Biodiversity Metric 3.1 does not directly consider species presence or abundance. It instead uses a proxy measure of biodiversity based on habitat extent, condition and distinctiveness. However, presence of positive or negative indicator species are included within condition assessments of some habitats.

Table 3 Summary of assessment of tools and metrics with respect to Habitat and Species criteria. Darker shades indicate the degree to which each criterion is met, this may be fully (F), partially (P) or not included (N).

Name	HE	HC	HPI	EH & F	EFD	Species	OM	P
Agrobiodiversity Index	N	N	N	N	F	N	N	N
Biodiversity Credits (Wallacea Trust)	F	F	F	F	F	F	F	P
Biodiversity Footprint for Financial Institutions (BFFI)	N	N	N	P	N	P	N	F
Biodiversity Footprint Methodology (BFM)	P	N	N	P	N	P	N	F
Biodiversity Impact Metric (BIM)	F	N	F	P	N	P	N	P
Biodiversity Intactness Index	N	N	N	P	P	F	N	P
Biodiversity Indicator and Reporting System (BIRS) Holcim	F	N	F	P	N	P	F	N
Biodiversity Indicators for Site-based Impacts (BISI)	P	P	P	P	N	P	N	F
Biodiversity Metric 3.1	F	P	F	N	N	P	N	N
Biodiversity Monitoring System (BMS)	N	F	P	N	N	P	F	F
Biodiversity Net Gain Calculator (BNGC)	P	N	N	P	N	P	N	P
Biodiversity Performance Tool (BPT)	F	F	N	P	P	P	F	F
BioScope	N	N	N	P	N	P	N	F
Corporate Biodiversity Footprint (CBF)	P	N	N	P	N	P	N	F
Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)	N	N	N	P	N	P	N	F
Global Biodiversity Score® (GBS®)	P	N	N	N	N	P	N	F
Global Impact Database (GID)	P	N	N	P	N	P	N	F
Integrated Biodiversity Assessment Tool (IBAT)	N	N	F	P	N	P	F	F
LIFE Methodology (LIFE)	P	N	P	P	N	P	N	N
Natural Asset Recovery Investment Analytics (NARIA)	P	F	N	F	F	F	N	N
Norwegian Nature Index	N	N	N	P	P	F	F	P
Product Biodiversity Footprint (PBF)	N	N	N	P	N	P	N	F
ReCiPe	N	N	N	P	N	P	N	F
Species Threat Abatement and Restoration metric (STAR)	N	N	N	N	N	P	N	F
SSE Biodiversity Project Toolkit	F	P	F	N	N	P	N	N
The Biodiversity Integrated Assessment and Computation Tool (BINTACT)	P	N	N	P	N	P	N	F

F	Full	P	Partial	N	None		No information

HE = Habitat Extent	EFD = Ecosystem Functional Diversity
HC = Habitat Connectivity	OM = Ongoing Monitoring
HPI = Habitat: Priority or Irreplaceable	P = Current and future pressures (e.g. climate change risks)
EH & F = Ecosystem Health and Function	

Approaches used for biodiversity credit markets, CreditNature's Natural Asset Recovery Investment Analytics (NARIA) and the Wallacea Trust's Biodiversity Credits methodology use multiple metrics to capture different aspects of biodiversity including habitats, species, connectivity and ecosystem function. The aim is to provide a more robust measure of ecosystem integrity. The Wallacea Trust recommends at least five metrics that can be tailored to suit the context of the habitat or site being assessed. Examples of potential metrics for two different ecosystems are illustrated in Table 4. In addition, the Wallacea Trust approach requires that the metrics must reflect the conservation objectives of the site, contain at least one habitat or floral composition metric for terrestrial sites, cover all ecosystem services likely to be affected, and not include carbon sequestration. The NARIA method uses different measures to produce an overall ecosystem integrity index (Figure 4).

The Norwegian Environment Agency's Norwegian Nature Index is a composite approach using monitoring data, expert evaluations and modelling of 260 species indicators over seven ecosystems. This approach is currently being adapted for use in the Cairngorms National Park and forms the basis of a biodiversity measurement tool being developed by Forest Research for Forestry and Land Scotland.

Table 4: Example metrics for different ecosystems in the Wallacea Trust approach (source: Wallacea Trust)

Lowland arable and livestock farmland converting to rewilding or regenerative farming	Coral Reefs
1. Natural England's biodiversity metric 3.0 to measure uplift in habitats	1. Reef rugosity measured by 3D mapping
2. Biomass of arthropods to measure changes in total food availability for insectivorous birds	2. Coral cover
3. Species richness and abundance of pollinator bees and hoverflies	3. Fish species richness and abundance measured from stereo video fish counting
4. Changes in butterfly and macro-moth species richness and abundance	4. Total macro-invertebrate species richness measured from eDNA sampling
5. Changes in UK Red, Amber or Local Biodiversity Action Plan breeding birds	5. Abundance of commercially exploited invertebrate species on the reef
6. Changes in bat species richness and abundance	

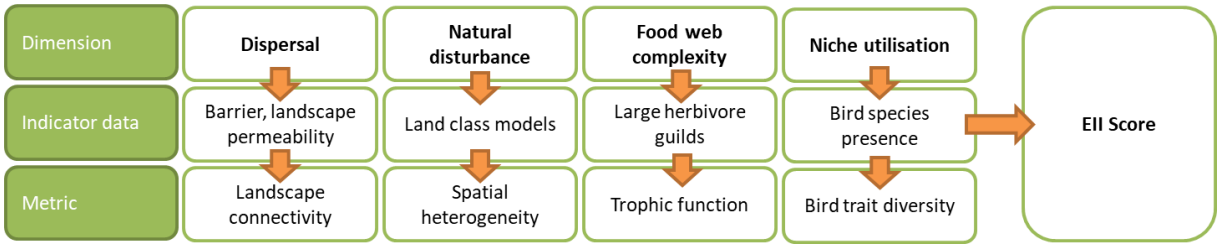


Figure 4: Elements of the Ecosystem Integrity Index in CreditNature's NARIA Framework (source: CreditNature)

Habitat connectivity was an important criterion raised during our stakeholder engagement. Very few of the reviewed metrics directly incorporate this. NARIA directly includes a model of landscape connectivity incorporating barriers and landscape permeability. The agriculture sector tools Biodiversity Monitoring System (BMS) and Biodiversity Performance Tool (BPT) consider connectivity on farms through the presence of linear corridors and distance between semi-natural habitats respectively. Other metrics are partial, for example considering impacts or mitigations in the contexts of their surrounding area, but not directly measuring connectivity.

Few metrics considered the presence of irreplaceable or high value habitats and, when included, this was achieved through scoring the importance or rarity of habitats either at the regional or global level. Ecosystem health and function is only partially considered by most metrics. For example, it may be implicit in the range indicators used, the impact on ecosystem services, or the pressures used to calculate metrics such as MSA. Only NARIA and the suite of indicators required by Wallacea are intended to directly capture ecosystem health. Functional diversity was rarely captured directly although it may be implied from the variety of indicators used, or captured by specific elements of the metric (NARIA) or the variety of metrics used (Wallacea).

Metrics typically did not incorporate ongoing monitoring. The Norwegian Nature Index is directly linked to species monitoring and is intended to produce regular updates. The Biodiversity Indictor and Reporting System (BIRS) requires annual habitat extent with condition assessed every 3 to 5 years. The BMS also required updates every 3 to 5 years. The Integrated Biodiversity Assessment Tool (IBAT) re-evaluates Key Biodiversity Areas every 8 to 12 years. NARIA uses ongoing monitoring to determine biodiversity uplift to confirm biodiversity credits.

As noted above, metrics such as MSA and PDF can include the impact of pressures such as climate change on biodiversity. However, this is not mandated in those metrics and different types of pressure may or may not be used depending on user needs. In addition to climate change, typical pressures that may affect ecosystem health include land use and use intensity, human population, pollution including nutrients, habitat fragmentation and encroachment, pathogens and pests, and alien or invasive species.

Effort and ease of use

Most of the metrics are open access, using publicly available data and methods (Table 5). Some have an open access methodology, but charge for access to data (IBAT and STAR). Others such as NARIA use proprietary models. However, open access metrics may still require expertise in understanding the data or undertaking the biodiversity impact calculations. For tools such as Biodiversity Metric 3.1, use of the spreadsheet user-interface

may not require specific expertise, but ecological expertise is required in the collection of underlying data (e.g. habitat condition assessment).

Table 5: Summary of assessment of tools and metrics with respect to effort and ease of use. Darker shades indicate the degree to which each criterion is met, this may be fully (F), partially (P) or not included (N).

Name	Open access	Scalable: financial	Scalable: spatial	Expertise	Time to use	Cost of use
Agrobiodiversity Index	F	F	F	P		
Biodiversity Credits (Wallacea)	P	F	F	P		
Biodiversity Footprint for Financial Institutions (BFFI)	F	F	F	P		
Biodiversity Footprint Methodology (BFM)	F	F	F	P		
Biodiversity Impact Metric (BIM)	F	F	F	P		
Biodiversity Intactness Index	F	F	N	P		
Biodiversity Indicator and Reporting System (BIRS) Holcim	F	F	F	P	F	F
Biodiversity Indicators for Site-based Impacts (BISI)	F	F	F	P		
Biodiversity Metric 3.1	F	F	F	N		
Biodiversity Monitoring System (BMS)	N			F		
Biodiversity Net Gain Calculator (BNGC)	N	F	F	P		
Biodiversity Performance Tool (BPT)	N		N	P	P	
BioScope	F	F	F	P		
Corporate Biodiversity Footprint (CBF)	F	F	F	P		
Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)	F	F	F	P		
Global Biodiversity Score® (GBS®)	F	F	F	P		
Global Impact Database (GID)	F	F	F	P		
Integrated Biodiversity Assessment Tool (IBAT)	P	P	F	P		N
LIFE Methodology (LIFE)	F	F	F	P		
Natural Asset Recovery Investment Analytics (NARIA)	N	F	F			
Norwegian Nature Index	F	F	F	P		
Product Biodiversity Footprint (PBF)	F	F	F	P		
ReCiPe	F	F	F	P		
Species Threat Abatement and Restoration metric (STAR)	P	P	F	P		N
SSE Biodiversity Project Toolkit	F	F	F	N		
The Biodiversity Integrated Assessment and Computation Tool (BINTACT)	F	F	F	P		

F Full | P Partial | N None | No information

Most of the metrics were able to be spatially scaled without entailing disproportionate costs. The IBAT and STAR tools are partially scalable in

financial terms as assessments over larger or more numerous sites entail larger data purchase fees. Although costs do not rise proportionally with the extent of spatial data available, there is the potential for large cost increases at the thresholds for extent. The BMS and BPT metrics are designed to be used at farm level, consequently there was no information on scaling costs, and spatial scalability was limited as the indicators used in these tools may be location specific.

Very few of the metrics provided information on the time requirements (e.g., number of hours/days for data collection and analysis) or costs of use. BPT provides an estimate of per farm assessment costs. BIRS recognises the time and cost implication of adopting the approach, noting that a higher investment will provide more meaningful results. But overall the BIRS approach is intended to minimise costs. The IBAT and STAR website provide information on subscription costs for access to their datasets.

Useability and comparability

Most of the metrics were scored as 'partial' for being clear, concise and transparent (Table 6). The reason for this scoring, was that although the methodology may be established and well documented, it is nevertheless difficult to determine the relative impacts of different indicators on an overall composite biodiversity score. More transparent metrics such as the Norwegian Nature Index, although having complex underlying calculations, also offer users the opportunity to investigate individual indicators.

The scientific robustness of the metrics was considered high for all of the metrics, reflecting a basis in underlying literature or good descriptions of the methodology that can be scrutinised. However, there may be variations in terms of what biodiversity criteria (see Table 3) are considered and whether the approach is suited to a particular application.

Few of the metrics provided information on their alignment with current or future policy objectives. This may be implicit in the motivation for using a metric, or some of the indicators used. The test for this assessment was whether policy objectives were explicitly mentioned in the accompanying literature. Alignment with current or future monitoring relates to whether the metric uses data from monitoring. The distinction we make with 'ongoing monitoring' under biodiversity measurement, is not whether the metric requires monitoring but whether the underlying data results from monitoring. Most metrics do not, instead relying on data from one-off assessments.

Most metrics are not intended to provide outputs that are tradeable or saleable. Our definition of tradeable is that changes in one habitat can be compared to and traded for changes in another (i.e. offsetting or net gain). Whereas saleable is where measurable biodiversity units are created based on the metric. Very few of the reviewed metrics or approaches have been designed for these purposes.

All of the metrics were replicable, in that the same approach can be applied across different sites and contexts, even though the data and indicators used will vary. This contrasts with comparability across habitats and sectors. Performance against this criterion varied across the metrics. Some, such as the Agrobiodiversity Index, BIM, BMS and BPT are focused on the agriculture sector and use sector- or farm-specific indicators. Others that use MSA as an indicator are partially comparable, this is because MSA measures biodiversity relative to the undisturbed state of a habitat rather than the absolute amount of biodiversity. The Wallacea Biodiversity Units approach is also partially comparable as the suite of metrics varies across habitats, and it is not clear whether the resulting units can be compared.

Meaningfulness proved difficult to determine from the available information. Only one metric, BIRS, specifically mentioned that it aimed to be meaningful to a wide range of stakeholders. However, it might be inferred that metrics using common underlying measures such as MSA or PDF could be meaningful across stakeholders. Most of the metrics were mature with a history of application either of that tool or the underlying methodology. NARIA was not considered mature as it is currently in development.

Table 6a: Summary of assessment of tools and metrics with respect to useability and comparability. Darker shades indicate the degree to which each criterion is met, this may be fully (F), partially (P) or not included (N).

Name	Clear, concise, transparent	Scientifically robust: measurable	Alignment: current or future policy objectives	Alignment: current or future monitoring	Tradeable
Agrobiodiversity Index	P	F	F	N	N
Biodiversity Credits (Wallacea)	P	F		P	F
Biodiversity Footprint for Financial Institutions (BFFI)	P	F		N	N
Biodiversity Footprint Methodology (BFM)	P	F		N	N
Biodiversity Impact Metric (BIM)	P	F		N	N
Biodiversity Intactness Index	F	F	F	N	N
Biodiversity Indicator and Reporting System (BIRS) Holcim	F	F		N	N
Biodiversity Indicators for Site-based Impacts (BISI)	F	F		N	N
Biodiversity Metric 3.1	F	F		N	F
Biodiversity Monitoring System (BMS)		F		N	N
Biodiversity Net Gain Calculator (BNGC)	P	F		N	N
Biodiversity Performance Tool (BPT)	P	F		N	N
BioScope Corporate	P	F		N	N
Biodiversity Footprint (CBF)	P	F		N	N
Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)	P	F		N	N

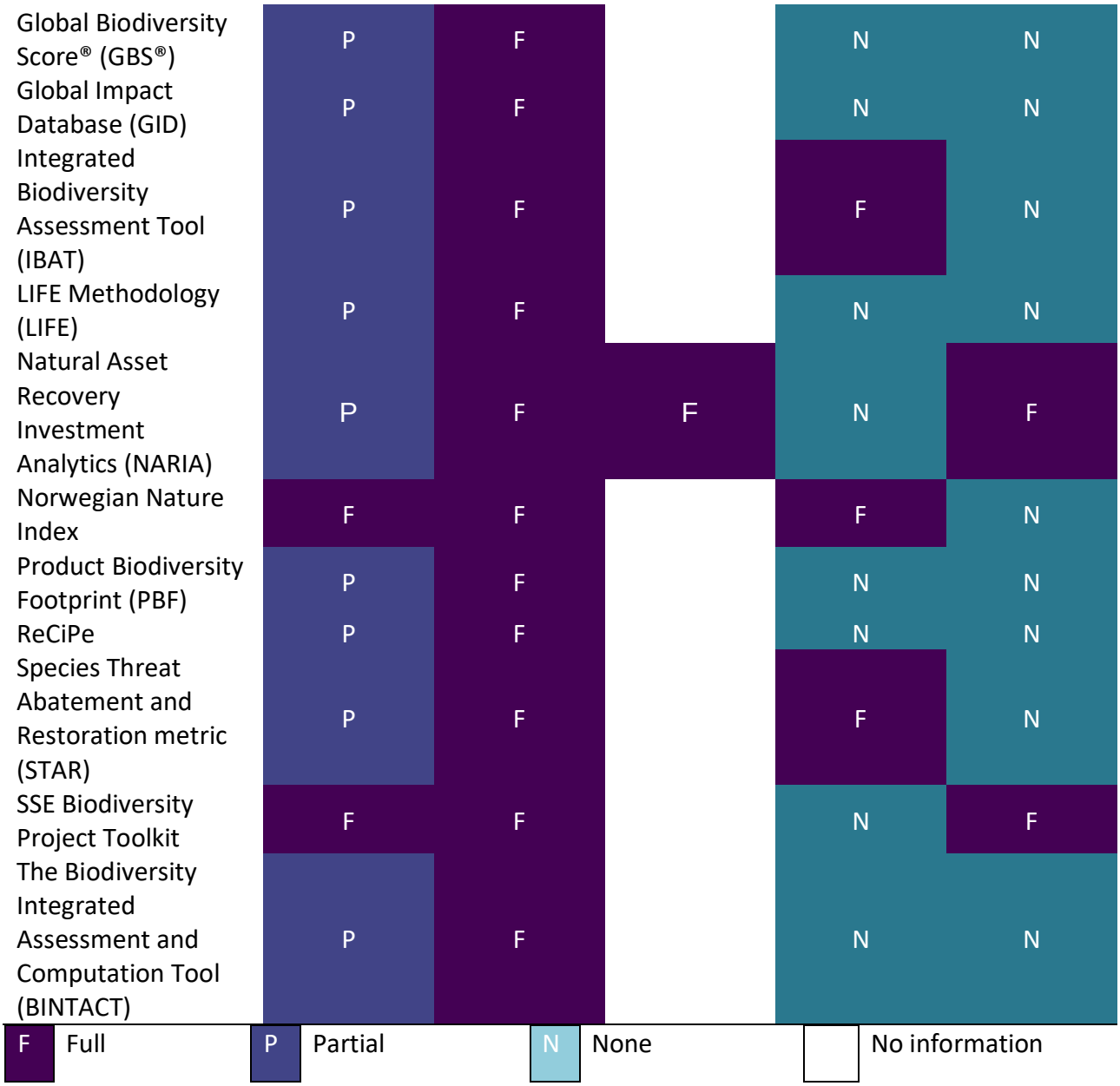
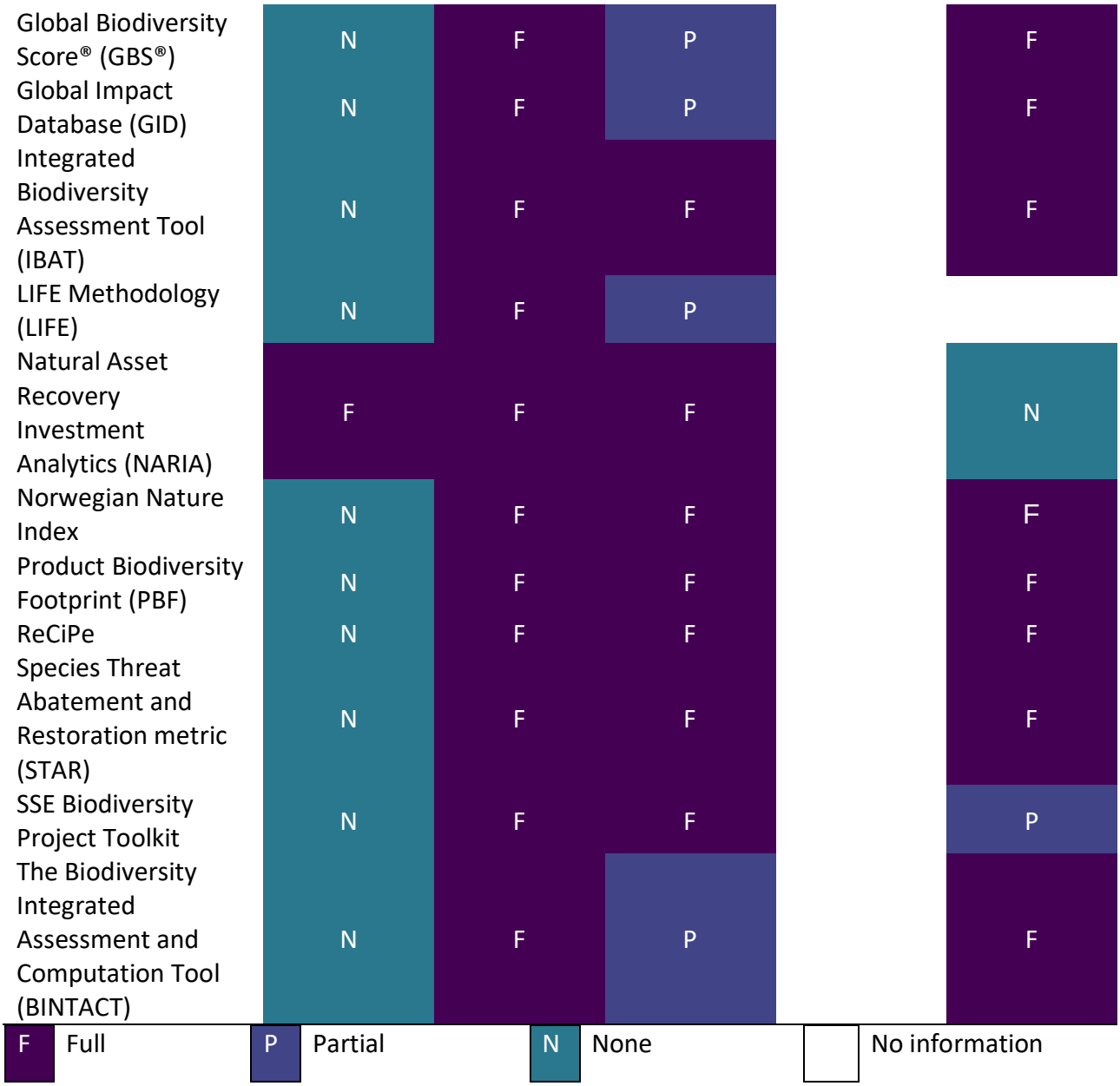

Global Biodiversity Score® (GBS®)
Global Impact Database (GID)
Integrated Biodiversity Assessment Tool (IBAT)
LIFE Methodology (LIFE)
Natural Asset Recovery Investment Analytics (NARIA)
Norwegian Nature Index
Product Biodiversity Footprint (PBF)
ReCiPe
Species Threat Abatement and Restoration metric (STAR)
SSE Biodiversity Project Toolkit
The Biodiversity Integrated Assessment and Computation Tool (BINTACT)
F Full
P Partial
N None
No information

Table 7b: Summary of assessment of tools and metrics with respect to useability and comparability. Darker shades indicate the degree to which each criterion is met, this may be fully (F), partially (P) or not included (N).

Name	Saleable	Replicable	Comparable across habitats and sectors	Meaningful to all stakeholders	Maturity
Agrobiodiversity Index	N	F	N		F
Biodiversity Credits (Wallacea)	F	F	P		P
Biodiversity Footprint for Financial Institutions (BFFI)	N	F	F		F
Biodiversity Footprint Methodology (BFM)	N	F	P		F
Biodiversity Impact Metric (BIM)	N	F	N		F
Biodiversity Intactness Index	N	F	P		F
Biodiversity Indicator and Reporting System (BIRS) Holcim	N	F	F	F	
Biodiversity Indicators for Site-based Impacts (BISI)	N	F	F		
Biodiversity Metric 3.1	N	F	F		P
Biodiversity Monitoring System (BMS)	N	F	N		
Biodiversity Net Gain Calculator (BNGC)	N	F	P		F
Biodiversity Performance Tool (BPT)	N	F	N		
BioScope	N	F	F		F
Corporate Biodiversity Footprint (CBF)	N	F	P		F
Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)	N	F	P		F


Global Biodiversity Score® (GBS®)
Global Impact Database (GID)
Integrated Biodiversity Assessment Tool (IBAT)
LIFE Methodology (LIFE)
Natural Asset Recovery Investment Analytics (NARIA)
Norwegian Nature Index
Product Biodiversity Footprint (PBF)
ReCiPe
Species Threat Abatement and Restoration metric (STAR)
SSE Biodiversity Project Toolkit
The Biodiversity Integrated Assessment and Computation Tool (BINTACT)
N F P F
N F P F
N F F F
N F P
F F F N
N F F F
N F F F
N F F F
N F F P
N F P F
F Full
P Partial
N None
No information

Corporate uses of biodiversity metrics

Many of the metrics reviewed in this report were developed for use by the corporate sector to inform both internal assessments of sustainability and impact on nature, and environmental reporting. The increasing interest in these assessments has also seen the development of formalised frameworks and recommended approaches. It is beyond the scope of this report to undertake a deep review of these frameworks. But we will briefly outline the measurement of biodiversity in the context of two emerging frameworks.

Taskforce on Nature-related Financial Disclosures (TNFD)[5] has developed a framework for identifying and reporting nature-related dependencies, impacts, risk and opportunities. The framework is intended to align with reporting requirements, allowing adaptability and increasing ambition in reporting as well as encouraging early uptake. TNFD sets out a LEAP (locate, evaluate, assess, prepare) process for evaluating environmental impacts and dependences. The TNFD is a framework rather than a standard and is not precriptive about how and whether biodiversity should be measured and reported. Guidance is provided on measuring both ecosystem and species condition (TNFD, 2022a) and example metrics (TNFD, 2022b). These metrics can include those based on Mean Species Abundance, Potentially Disappeared Fraction, IBAT and STAR, and BIRS as included in our preceding review. Direct measurement of species numbers and abundance are also suggested.

Corporate natural capital accounting approaches (e.g. as set out in the British Standards Institute's BSI 8632)[6] do not mandate the inclusion of biodiversity impacts or measurements in accounting frameworks. Instead, impacts and dependences are included according to the needs of the organisation and the decision contexts that will be informed by preparing accounts. For example, natural capital asset registers may list habitats, and risk registers the impacts of business operations on those habitats. The extent to which these measure biodiversity may vary depending on how close the business is to nature, i.e. land-based sectors may have readier access to biodiversity data.

Species information (numbers, abundance) may be included as non-monetised benefits from natural capital. An important issue is that biodiversity and ecosystem integrity can underpin a variety of other ecosystem services. Consequently, direct measurement and valuation of biodiversity carries a risk double counting within natural capital accounting approaches which typically quantify and value ecosystem services.

[5] Taskforce on Nature-related Financial Disclosures: Nature-Related Risk and Opportunity Management and Disclosure Framework

[6] British Standards Institute: BS8632:2021 Natural Capital Accounting See also: YouTube: Introducing BS 8632 - Natural Capital Accounting for Organizations and YouTube: BS 8632:2021 Natural Capital Accounting for Organizations. Specification

Results: Review of Biodiversity Metric 3.1

Introduction

Biodiversity Net Gain (BNG) targets biodiversity decline by ensuring that developments, or changes to land management, contribute positively to nature recovery. BNG has brought biodiversity to the forefront of planning for developments, driving a change in perception. In England, BNG is quantified and legalised under the 2021 Environment Act which stipulates that from November 2023 a mandatory 10% BNG must be achieved for new developments. To assist developers and planners deliver BNG, Natural England have developed various iterations of Biodiversity Metric - a tool which quantifies biodiversity pre- and post-development to calculate BNG. The tool relies on a competent person to assess the extent, condition and distinctiveness of current habitats, whilst maintaining a transparent user-friendly interface. The interface allows developers and planners to explore different different scenarios, and in doing so drives innovation in meeting BNG.

This section provides an overview of Biodiversity Metric 3.1 outlining its history, key components and describing how it quantifies biodiversity, and calculates BNG both on and offsite. The following section assesses the applicability of Biodiversity Metric 3.1 for use in Scotland. It explores the fitness of the metric's components to the Scottish context, and suitability to different sectors (i.e. Planning and Development, Natural Capital, Biodiversity and Conservation and Agriculture).

Biodiversity Metric 3.1- Purpose and History

The Biodiversity Metric was first developed by the UK Government's Department of Environment, Food and Rural Affairs (Defra) in 2012 to provide a standardised approach to quantify the impact of development on biodiversity in England (Defra, 2012). Following this, further iterations were undertaken by Natural England who released Biodiversity Metric 2.0 in 2019, with Biodiversity Metric 3.0 and 3.1 following in 2021 and 2022. Biodiversity Metric 4.0 was published in March 2023, after the analysis for this study was undertaken.

Each new metric has built upon the previous version, through consultation with practitioners and biodiversity experts to ensure the metric provides scientifically robust results applicable to the end user. The Metric will continue to be refined based on consultation and emerging research, and Defra has a long-term strategy to refine and adapt the Metric.

This report assesses the Natural England Biodiversity Metric 3.1 which is an Excel based tool that is accessible, free and easy to use. It provides a standardised means of robustly accounting for biodiversity change (both positive and negative) due to actions on the ground such as development, or

management change. Metric 3.1 does not provide an direct absolute measure of biodiversity but instead uses habitat area, distinctiveness, condition and strategic significance as a proxy for biodiversity (Figure 5). Metric 3.1 uses Biodiversity Units as a currency and identifies three different types of units: hedgerows, rivers and area-based habitats. From an auditing and accounting perspective, 10% BNG must be achieved in all three habitat units.

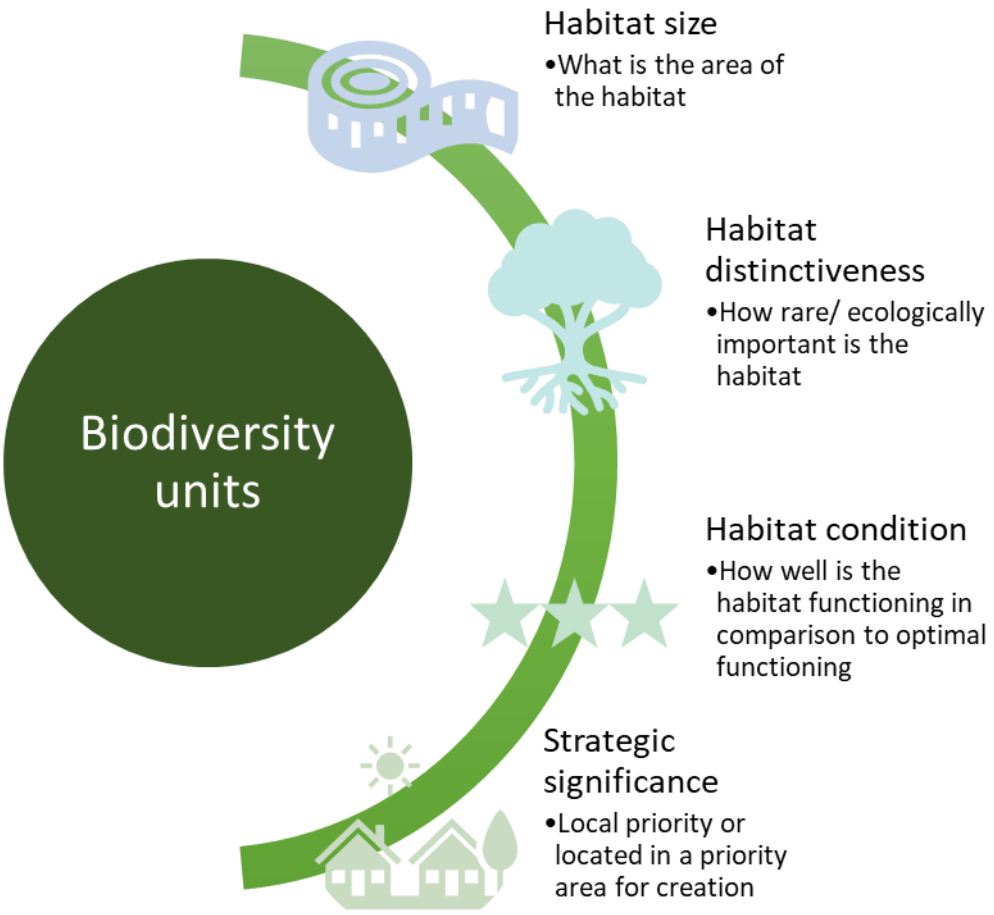


Figure 5: Components used to assess biodiversity units

Metric 3.1 combines ecological surveys to assess the type, extent and condition of habitats with predetermined values for habitat distinctiveness and strategic significance. The metric uses a set of predefined rules to calculate the biodiversity uplift of a planned development and enables the exploration of different scenarios to assist with decision making. To calculate BNG, the metric quantifies biodiversity pre- and post-development and uses previously assigned multipliers to take into account the risks associated with creating and enhancing specific habitats.

Small Sites Metric

To ease the administrative burden of BNG calculations in small developments, Natural England released a simplified version of the metric, The Small Site Metric (SSM) 3.0 in 2021, SSM 3.1 followed in 2022, with the most recent

iteration SSM 4.0 published on 27th March 2023[7]. The SSM applies to developments meeting the following criteria:

- Residential development:
    - fewer than 10 residential units on a site area less than 1 hectare; or
    - the site area is less than 0.5 hectares if the number of residential units is unknown
- Non-residential development:
    - where the floor space to be created is less than 1,000 m^2; or
    - where the site area is less than 1 hectare

The SSM aims to help developers consider the impacts of a development on biodiversity. It differs from Metric 3.1 in having simplified habitat categories, habitat condition is assessed as moderate, and habitats of high distinctiveness cannot be included. The SSM is only used for estimating onsite impacts of biodiversity pre and post development. Developments that impact on habitats that or not included, have high distinctiveness habitats or require off site net gain must use the full Metric.

Biodiversity Metric 4.0

Biodiversity Metric 4.0 was published on 24th March 2023, after the completion of our review of Metric 3.1. It is therefore important to note that conclusions and recommendations drawn from this review are based on Metric 3.1. Reviewing key updates indicates that broad conclusions are likely to remain the same.

The majority of the changes of Metric 3.1 to Metric 4.0 are focused on providing an enhanced user experience and do not have a significant impact on the range of outputs generated. The most notable changes to the metric include the addition of new habitat types “Willow scrub”, “Tall forbs”, “Rural trees” and “Watercourse footprint”. Additionally, “Vacant/derelict land/ bare ground” has been split into “Vacant or derelict land” and “Bare ground”. Multiple habitats have had name changes including adding the Annex 1 code to more notable habitats. For example, previous “Tall herb communities” is now called “Tall herb communities (H6430)”.

Another notable change was the review of the condition assessments conducted by Natural England. This brought changes to the following habitats condition assessments:

- Grassland – low distinctiveness

[7] Natural England: The Small Sites Metric

- Grassland – medium and higher distinctiveness
- Heathland
- Hedgerows
- Limestone pavement
- Line of trees
- Traditional orchards
- Ponds
- Urban
- Woodland
- Wood-pasture and parkland

Furthermore, in Metric 4.0 the spatial risk multiplier for offsite habitats now applies to any overall off-site net gains which makes it easier to achieve off-site gains in many scenarios. The tool to translate Phase 1 habitat categories to UK Hab has also been updated. Metric 4.0 also now requires users to specify details on irreplaceable habitats present on site and trading rules for rivers and hedgerows have been updated.

The Biodiversity Net Gain Approach

BNG: Rules and principles

CIEEM, CIRIA and IEM have jointly developed 10 guiding principles to deliver BNG through development (CIEEM, CIRIA and IEMA 2016) (Figure 6). Fundamental to this is applying the Mitigation Hierarchy ensuring all stakeholders consider biodiversity from the outset, collaborating to limit adverse impacts (Figure 7). The Mitigation hierarchy firstly tries to avoid any adverse ecological impact (e.g. by avoiding sites with high biodiversity value), where loss cannot be avoided then measures should be taken to minimise loss (e.g. by changing the footprint of the development to avoid key habitats). In instances where some loss is inevitable, focus should firstly be on creating or enhancing habitats within the development footprint, and finally, as a last resort, through compensation offsite. Following this hierarchy ensures that best efforts have been made to avoid, limit or mitigate adverse impacts on biodiversity in any development. The BSI outline a framework for implementing BNG in British Standard BS 8683 - Process for designing and implementing Biodiversity Net Gain. This standard aims to encourage best practice, increase standardisation and reduce the risk of ‘greenwashing’.

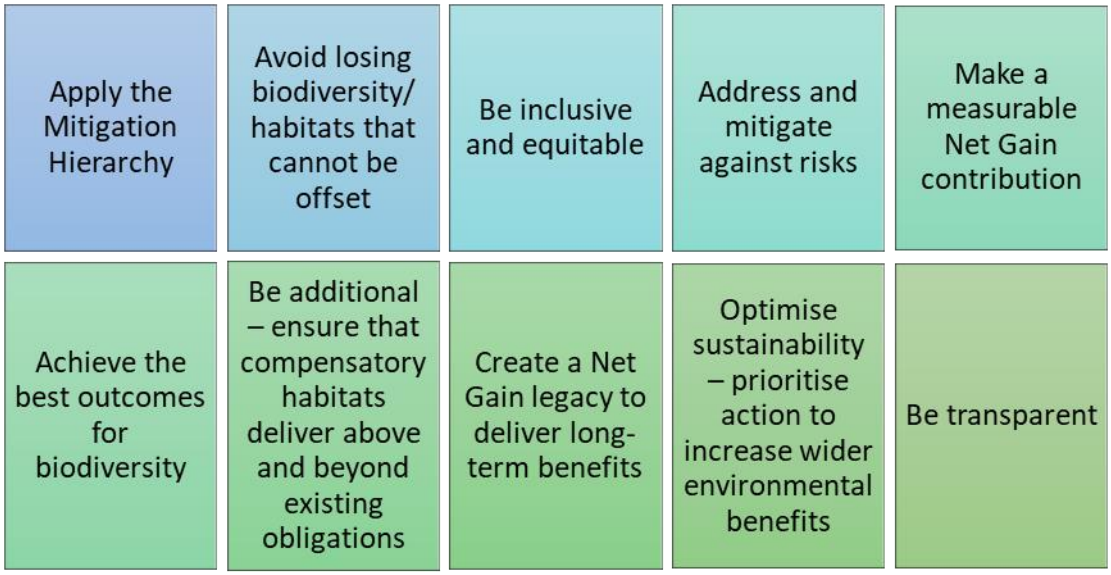


Figure 6: Ten guiding principles to deliver Biodiversity Net Gain through development (CIEEM, CIRIA and IEMA 2016)

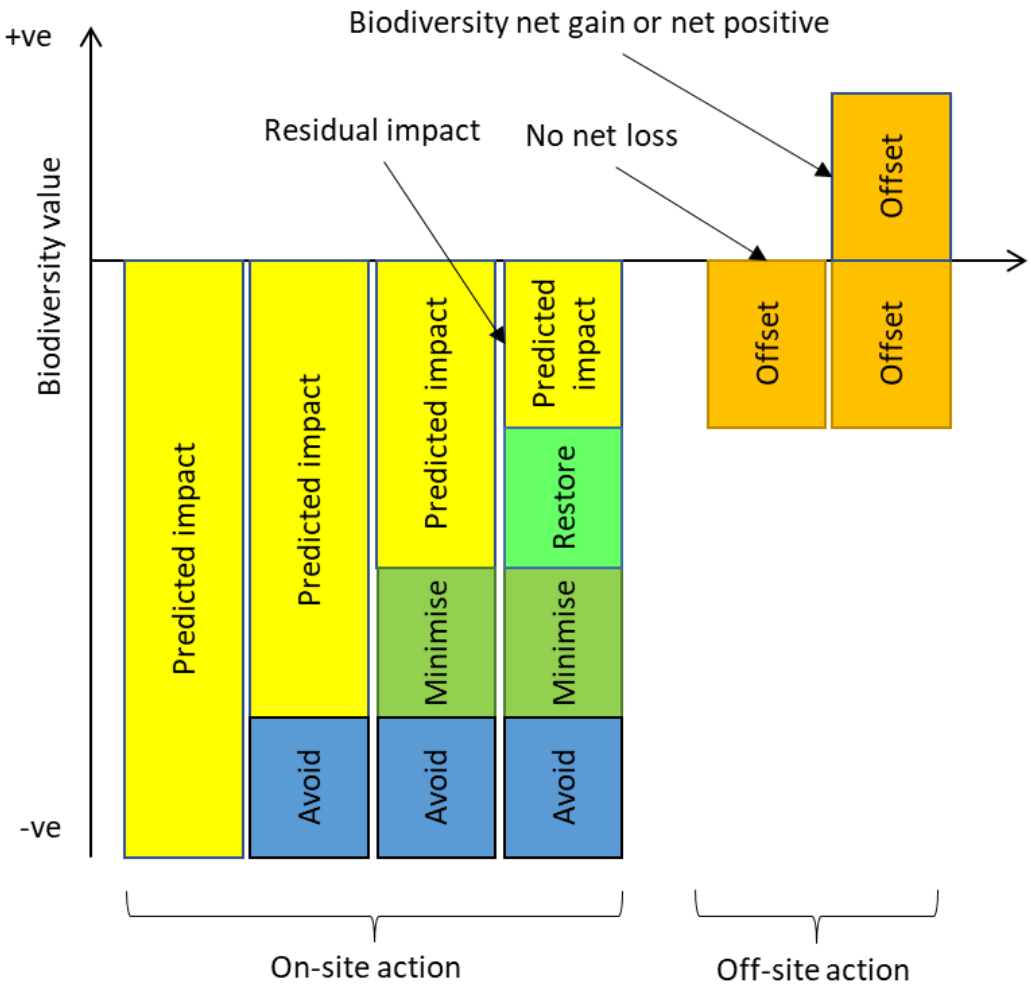


Figure 7: The Mitigation Hierarchy adapted from Business and Biodiversity Offsets Programme (BBOP) Principles on Biodiversity Offsets

The Metric 3.1 is simply a calculation tool and should therefore be used in line with best practice and legislation and local and national policies. The

accompanying Users Guide thus outlines a set of principles and rules (Panks et al. 2022; Annex 5 Biodiversity Metric 3.1). Metric 3.1 does not replace legislation and policies relating to statutory protected sites, irreplaceable habitats and protected species. Environmental Impact Assessments, Strategic Environmental Assessments, and Habitat Regulations Assessments still underpin planning and other consenting decisions.

The Metric outputs, decisions, and management actions should be considered in conjunction with legislation, best practice and professional advice. Decisions should consider wider physical and ecological factors (e.g. landscape composition and configuration, historical land use, and ecological constraints) and social factors to ensure that outcomes provide both biodiversity and societal benefits. While planners can use the metric to explore different scenarios, decision making should be underpinned by professional advice to optimise biodiversity outcomes. Furthermore, practical interventions should be developed through consultation with both ecologists and practitioners, to ensure that they are viable and realistic and long-term monitoring should be conducted to identify and rectify problems. If used correctly, the metric can help inform planning, and decision making to increase the biodiversity benefits achieved from developments and change in land use/management.

BNG: Irreplaceable habitats

In the UK, irreplaceable habitats (i.e. habitats of high biodiversity value which are very difficult and/or take an extremely long time to restore, recreate or replace) and species of conservation concern are protected by existing policy and legislation. There is some debate on what habitats are irreplaceable and Defra is currently formulating a definitive list. This is likely to include ancient woodland, ancient and veteran trees, blanket bog, raised bog and limestone pavements.

In the Planning and Development sector irreplaceable habitats are identified during the initial Ecological/Environmental Impact Assessment stage. BNG cannot be achieved if an irreplaceable habitat is to be adversely impacted and consequently they are considered independently requiring bespoke compensation in line with legislation. Similarly, Habitats that have high ecological value (i.e. Very High Distinctiveness habitats) also require bespoke compensation.

Because irreplaceable habitats require bespoke compensation, Metric 3.1 is not designed to deal with them (Panks et al. 2022). Very High Distinctiveness habitats and Irreplaceable habitats are only included in BNG calculations when these habitats are to be retained and/or enhanced. Irreplaceable habitats are typically categorised as Very High Distinctiveness in Metric 3.1. Ancient woodlands, by definition, include both ancient woodlands and plantations on previous ancient woodland sites and additionally vary in the dominant species. Ancient woodland and Veteran trees are therefore not included in Metric 3.1 as habitats/features in their own right. They are instead

grouped with other Woodlands (High Distinctiveness) or in the case of Veteran trees within a Line of Trees (Ecologically valuable) (Medium Distinctiveness). Ancient woodland is currently protected by existing policy and legislation, and therefore it is assumed that where present this would be identified, relevant protection implemented, and bespoke compensation put in place.

BNG: Long-term monitoring and additionality

The whole premise of BNG is that there is a measurable improvement in Biodiversity from a baseline scenario. For BNG to be realised, habitats created or enhanced must deliver what is proposed in the planning and development stage. Management plans, and agreements to adhere to these plans must therefore reflect a long-term (i.e. 30 years) commitment to safeguard and enhance the habitat. Long-term monitoring is therefore required to identify when habitats are not reaching their projected condition. Where problems arise, the management plan should be adapted to ensure positive outcomes for biodiversity.

When a project results in unavoidable damage, offsetting this loss through habitat creation or enhancement either on or offsite must demonstrate additionality. Additionality ensures that actions undertaken provide direct benefits to biodiversity that would not have occurred otherwise (i.e. without the offset). In designated sites (e.g. SSSI), there is a statutory obligation to maintain features in favourable condition and thus features in unfavourable condition must be enhanced in line with legislation relating to protected sites. When dealing with offsetting biodiversity loss in protected sites, it is therefore questionable if habitat enhancement actually provides additional benefits as arguably such actions should happen anyway. This makes it hard to comply with additionality in designated sites and offsetting on designated sites is typically not permitted in England (Defra 2022).

Additionality must also be considered when it comes to combining payments for the delivery of multiple ecosystems services, known as stacking. The approach taken in England indicates that where multiple payments (e.g. carbon and biodiversity) are being delivered on the same land parcel, that action to receive these payments must provide different or additional outcomes. With land being finite, and habitats providing a range of potential ecosystem services, multifunctionality should be optimised and consideration should be given as to how we can balance additionality with multifunctionality through stacking or ecosystem service uplifts.

Features of Biodiversity Metric 3.1

Metric 3.1: Trading rules

Metric 3.1 adheres to a strict set of trading rules based on the distinctiveness of habitats. These rules stipulate that any habitat lost due to development must be replaced on a like-for-like or like-for-better basis, i.e. you can’t trade down (Table 8). This is implemented to prevent priority habitats for nature conservation with Very High distinctiveness being replaced by habitats of

lower distinctiveness. Further rules are implemented for woodland habitats to encourage woodland habitats of lower distinctiveness to be replaced by woodlands of higher distinctiveness. This is in line with Defra and Forestry Commission targets to increase in woodland cover in England.

Table 8: Habitat trading rules outlining rules applicable to habitats of each distinctiveness category

Baseline habitat distinctiveness	Distinctiveness of replacement habitat required by trading rules (applies to creation and enhancement)
Very high	Losses are not permitted and bespoke compensation is required
High	The same habitat type must be created or enhanced to replace the biodiversity units
Medium	The same broad habitat type or a habitat from a higher distinctiveness band must be created or enhanced to replace biodiversity units
Low	Habitat from the same distinctiveness or higher must be created or enhanced to replaced biodiversity units
Very low	Replacement not required

Metric 3.1: Calculating Biodiversity Net Gain

The Metric 3.1 Calculation Tool is a downloadable interactive excel spreadsheet which is accompanied by supplementary documents to inform and aid use. Supplementary documents include: a condition assessment spreadsheet outlining criteria for on the ground assessments; a technical supplement; a GIS Import tool and supplementary guidance on this; a user guide that outlines strict rules and principles of use; a document detailing the summary of changes from the last version; a document containing frequently asked questions; QGIS templates; and multiple case studies.

To reflect the ecological importance of linear features, Metric 3.1 treats linear features separately from area-based habitats. Metric 3.1 identifies three broad categories of biodiversity units and 10% BNG must be achieved for each of these units separately, specifically:

- Habitats units: area-based habitats (e.g. blanket bogs, lowland heathlands)
- Hedgerow units: linear woody features (i.e. hedgerows, line of trees)
- River units: linear water features (e.g. rivers, ditches, canals)

For each of these three habitat units, the Calculation Tool contains multiple interactive spreadsheets to calculate the biodiversity units for:

- On-site baseline
- Off-site baseline
- On-site post development (separate sheets for Habitat creation and Habitat enhancement)
- Off-site post development (separate sheets for Habitat creation and Habitat enhancement)

Using habitat as a proxy for biodiversity, the number of Biodiversity units is calculated for each habitat parcel for a specific project or development. Metric 3.1 calculates biodiversity impacts by subtracting baseline (pre-intervention) biodiversity units from projected biodiversity units following development or land use change (post-development) (Figure 8). This allows developers and planners to quantitatively predict changes in baselines and explore different options to deliver BNG.

Metric 3.1 calculates Biodiversity units for each habitat parcel by integrating information derived on the ground (i.e. type, area and condition of habitat) with predetermined multipliers (i.e. distinctiveness, strategic significance, and risk multipliers for habitat creation and enhancement) (Figure 5; Table 8). Baseline units are determined pre-intervention on and, where applicable, off-site for each habitat parcel by multiplying area, condition, strategic significance, and habitat distinctiveness. Post-intervention units are determined in the same way but in this case risk multipliers are applied to consider risks associated with establishing new habitats and enhancing the condition of existing habitats. Each habitat is automatically assigned a score based on how difficult it is to create or enhance (technical risk) and the perceived time it will take to achieve the target condition (temporal risk). Finally, where BNG involves offsite action, a spatial risk multiplier is imposed based on the proximity to the intervention site.

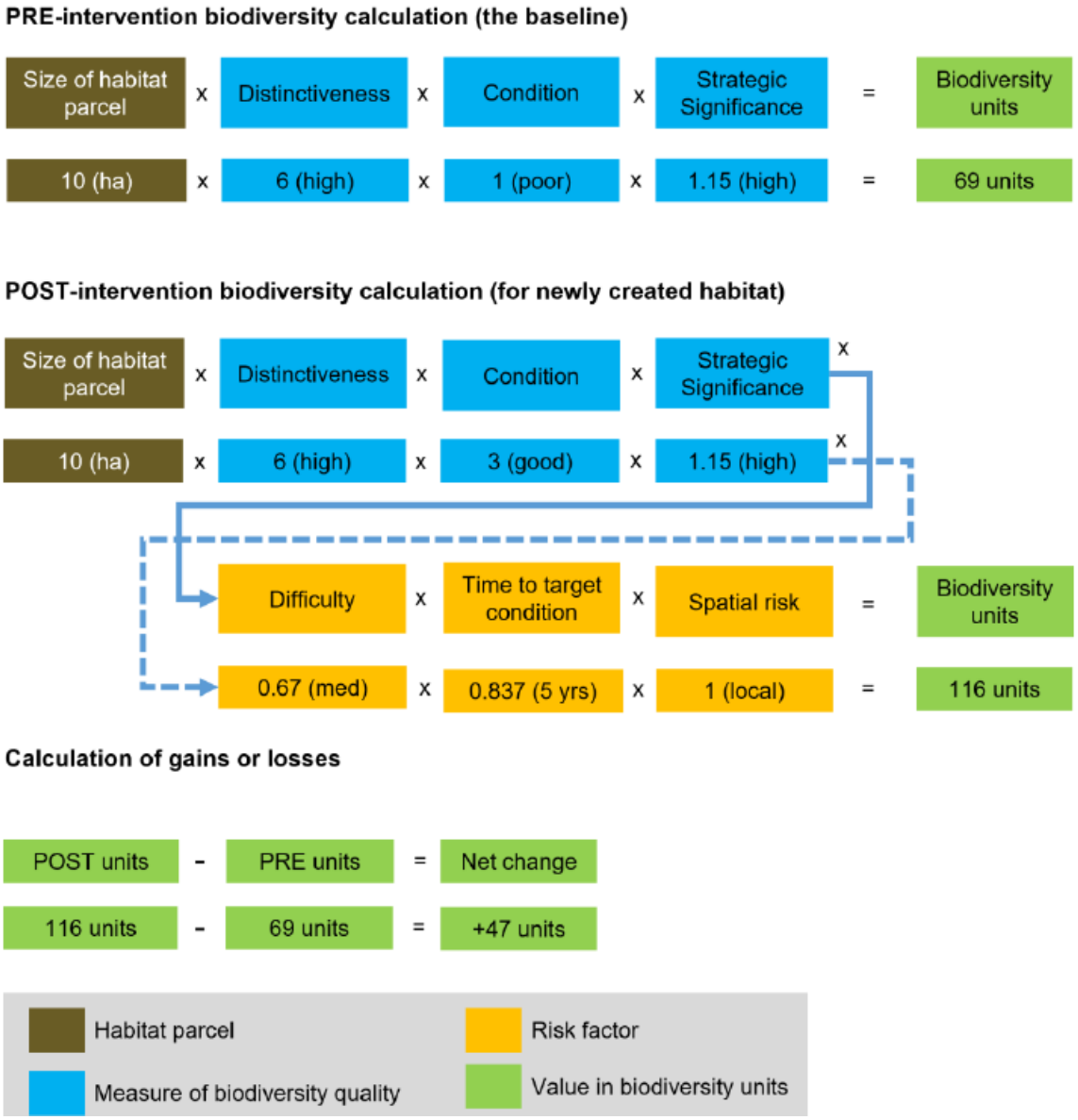


Figure 8: Overview of how Biodiversity Metric 3.1 calculates Pre and Post development Biodiversity (Panks et al. 2020)

Table 9: Overview of factors included in the calculation of Biodiversity Net Gain including details on if each factor is determined at the site level or stipulated by the metric itself. Values for multipliers are given in Annex 4

Factor	Description	Information derived from
Area/length	Area of each independent parcel of habitat/length of linear feature	Derived at site level
Condition	Measure of habitat quality – quantifies differences in condition with a habitat type	Typically based on an ecological survey*
Distinctiveness	Measure of a habitats inherent potential to deliver biodiversity	Predetermined value based on habitat type
Strategic significance	Measure of strategic significance of a habitat with respect to local strategies/ ecological knowledge	Derived at the site level
Technical difficulty multipliers	Multipliers relating to technical difficulties in physically creating or enhancing a habitat	Predetermined value based on habitat type
Temporal	Multipliers relating to the time it takes for a habitat to reach the desired condition	Predetermined value based on habitat and condition
Spatial risk multipliers	Multipliers relating to the location of offsite habitat creation or enhancement	Derived at the site level

*Some habitats have fixed values for habitat condition

Metric 3.1: Habitat classification

Metric 3.1 classifies habitats using a range of different classification systems, in addition to a few habitats that are stipulated by the Metric itself (Table 10). Most terrestrial habitats are based on the UK Habitat Classification System (UK Hab) and coastal/intertidal habitats are based on the European Nature Information System (EUNIS). Both these classification systems take, with more detailed habitat descriptions nested within broader descriptions. Hierarchical classification of habitats allows for surveys to be tailored to fit the scope, budget and/or objectives (e.g. remote sensing provides a more basic level of classification than a detailed ecological site survey).

Metric 3.1 classifies most terrestrial area-based habitats at UK Hab Level 4 (L4). This level aligns with UK BAP Priority Habitats, however, Level 5 is typically required to identify Annex 1 habitats (Butcher et al. 2020a). Consequently, the Technical Supplement provides a list of Annex 1 habitats included under each L4 habitat category (Panks et al. 2022). The inclusion of Annex 1 habitats in this list is however inconsistent, and guidance does not indicate why some habitats were excluded. This could in part be due to how Metric 3.1 deals with irreplaceable habitats and their requirement for bespoke compensation.

Table 10: Overview of the habitat classification systems used in Metric 3.1

Broad habitat	Classification system	Geographical relevance
Most terrestrial habitat	UK Habitat Classification System (UK Hab) Level 4[8]	UK wide
Lakes	Water Framework Directives Lake Typologies UK [9] UK Hab	European
Intertidal, coastal and shore habitats	European Nature Information System (EUNIS) Level 3[10]	European
Waterways	UK Hab with Ditches/Culverts being Metric specific	UK wide
Green roofs, Urban tree	Metric specific	UK wide
Hedgerows	Metric specific: draws from the Hedgerow Survey Handbook [11]	UK wide

Metric 3.1: Habitat distinctiveness

Metric 3.1 accounts for habitat quality in two ways, firstly habitats are given a distinctiveness rating (Very High to Very Low) to capture inherent differences in their conservation value (i.e. to evaluate differences in quality between two different habitat types). In addition, the condition of each habitat is assessed on the ground by a competent person with skills in the identification of habitats and their positive and negative indicator species (i.e. to evaluate differences in quality between two patches of the same habitat, see Metric 3.1: Habitat condition).

The distinctiveness rating in Metric 3.1 is based on habitat type, its conservation status, rarity at the English, UK and International level, and potential vulnerability, i.e. taking into account the amount of habitat protected

[8] UK Habitat Classification (UK Hab)

[9]UKTAG (2004) UK Technical Advisory Group on the Water Framework Directive Guidance on Typology for Lakes for the UK (Draft).

[10] European Environment Agency: EUNIS habitat classification

[11] Defra. 2007. Hedgerow Survey Handbook: A Standard Procedure for Local Surveys in the UK. 2nd Addition. Defra, London.

in SSSIs (Figure 9). For terrestrial habitats, the following criteria is used to determine distinctiveness:

- Amount of priority habitat remaining in England[12]
- Percentage of habitat protected in SSSIs
- UK Priority habitat status[13]
- European Red List categories[14]

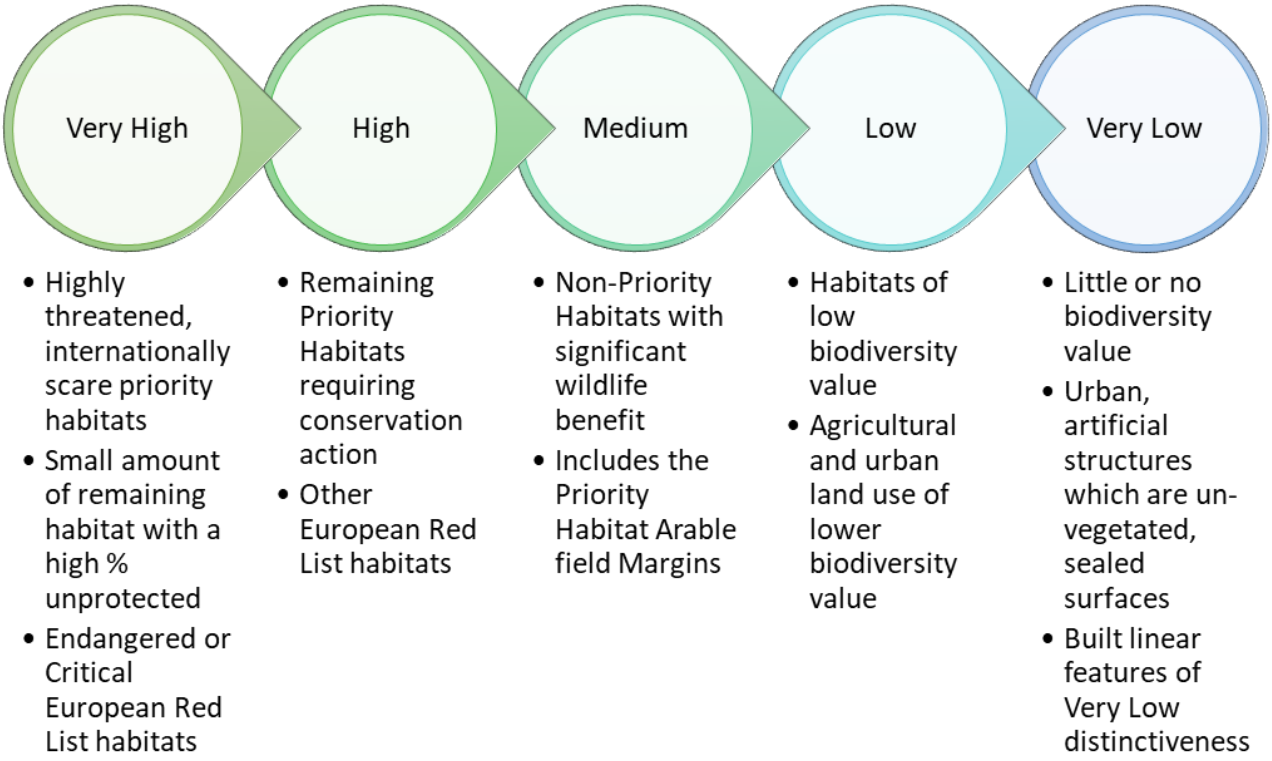


Figure 9: Overview of criteria for distinctiveness categories (Panks et al. 2022)

Intertidal/rocky shore habitats assess distinctiveness in a different way. Intertidal and rocky shore habitats on peat, clay or chalk are rated as Very High due to their unique substrate, lack of resilience and limited ability to recover from impacts. Most other natural intertidal and rocky shore habitats are given a rating of High due to their importance to nature conservation, and artificial intertidal tidal habitats, are given a Low rating (Panks et al. 2022). Artificial hard structures with Integrated Greening of Grey Infrastructure and Littoral coarse sediment and Littoral Sand are giving a rating of Medium.

The degradation of freshwater habitats is primarily due to a change in condition (e.g. a degradation in the abiotic and/or biotic quality) rather than a change in habitat extent. Lake typology is determined based on alkalinity and

[12] Natural England. 2021. Priority Habitat Inventory (England).
[13] JNCC. UK BAP Priority Habitats
[14] EEA. 2019. EUNIS habitat type hierarchical view [online].

this can be determined from the UK lakes portal[15]. Once typology is determined distinctiveness is assessed as with terrestrial habitats. Priority Lakes and Rivers are spatially mapped in MAGIC's interactive map (see Priority Habitat Lakes, and Priority Habitat Ponds inventories)[16].

Distinctiveness categories for rivers and streams are based on priority river habitat classification. Priority rivers exhibit a high degree of naturalness and are spatially mapped with separate maps for headwaters[17] and Rivers[18]. All Priority rivers are given a Very High distinctiveness rating, and these include rivers of high hydromorphological/ecological status, chalk rivers, watercourses with water crowfoot assemblages (Annex 1 habitat H3260), active shingle rivers and headstream rivers. Other streams and rivers are given a High distinctiveness rating, while ditches and canals are classified as Medium distinctiveness and culverts are Low distinctiveness.

Metric 3.1: Habitat condition

Habitat condition provides the second means of assessing habitat quality. Habitat condition allows us to measure a habitat's current quality against its ecological optimum state, enabling us to quantify differences between the quality of different patches of the same habitat type. Condition strongly reflects current and past management. Condition assessments are used to baseline habitat quality before intervention both onsite and, where applicable, offsite. Condition assessments are conducted post-intervention for retained, enhanced and newly created habitats. This follow-up monitoring provides a means of identifying problems, and potential interventions that might enhance the biodiversity outcomes.

Metric 3.1 assesses condition on the ground based on a habitat's physical (e.g. vegetation structure) and biological attributes (e.g. the presence of positive and negative indicators). Condition assessments for rivers and streams must be undertaken by someone who is trained and accredited in the Modular River Survey (MoRPh) methodology. For all other habitats guidelines specify these must be done by a competent person who is able to "identify the positive and negative indicator species for the range of habitats likely to occur in a given geographic location at the time of year the survey is undertaken". There is no formal requirement for accreditation.

To standardise the approach to assess condition, Metric 3.1 outlines a set of criteria for broad habitat categories (e.g. Woodland, Scrub, Coastal, and Wetland). For terrestrial habitats, criteria are largely aligned with UK-wide standards developed for Site Condition Monitoring of Protected Sites outlined

[15] UK Lakes Portal - UK Centre for Ecology and Hydrology (UKCEH)

[16] MAGIC interactive map

[17] Natural England. 2021b. Priority River Habitat - Headwater Areas [online].

[18] Natural England. 2021c. Priority Habitat River Habitat – Rivers [online].

in JNCC's Common Standards Monitoring guidance[19]. With hedgerow criteria drawing from Defra's Hedgerow Survey Handbook (Defra 2007).

The criteria are simple statements relating to habitat quality which are answered with pass or fail, or in the case of intertidal and woodland habitats, a score of 1-3 is given. The resultant score reflects the number of passes, or in the case of woodlands and intertidal habitats provides a summed score. Based on this score, each habitat is assigned to Good, Moderate or Poor condition. Some habitats also have essential criteria which must be met for the habitat to be meet a specific condition.

Lake condition is assessed based on The Freshwater Biological Association's Habitat Naturalness Assessment[20] which assigns lakes to a Naturalness class based on physical, hydrological, biological and chemical attributes. Assessment of the lake considers the lake itself and the riparian zone. Links to the key documents for undertaking a Habitat Naturalness Assessment, together with a conversion table for scores, are provided within the Lake condition sheet.

Metric 3.1 assesses river condition using the MoRPh methodology which first classifies rivers into one of 13 geomorphic river types according to substrate, planform, and valley confinement (Gurnell et al. 2020). A field survey is then conducted following the Modular River Survey (MoRPh) which is targeted to determine the physical features of the river and its margins (including the vegetation structure) in addition to frequency and type of human modifications. The MoRPh methodology thus allows us to interpret the condition of the river obtained through physical assessment in the context of its geomorphic type (Gurnell et al. 2020). The Metric 3.1 does not simply count the waterbody, but also the riparian zone (distance 10 m from the top of the bank) and consequently developments that impinge on this zone must be included in River biodiversity unit calculations.

Condition assessments are not required for a small number of habitats which tend to be low or very low distinctiveness (e.g. Bramble scrub, Rhododendron scrub, Hedge ornamental non-native), or in Cropland habitats including cereal and horticultural crops, alongside a variety of arable field margins (Arable field margins pollen & nectar and Arable field margins tussocky). These habitats are automatically assigned a condition score of Poor.

Where habitats have been degraded it may not be feasible to accurately determine habitat quality (e.g. for example felled woodland). To prevent abuse (e.g. removal of habitats before ecological surveying), habitats degraded since 30 January 2020 are considered to be in their former state when determining on-site biodiversity units (Defra 2022). Aerial images or records can be used

[19] JNCC's Common Standards Monitoring guidance

[20] The Freshwater Biological Association's Habitat Naturalness Assessment

to determine recently degraded habitats and where condition assessments are not feasible, they should be considered to be in Good condition as a precaution.

Metric 3.1: Strategic significance

The strategic significance of a habitat relates to its importance with respect to being considered in local strategies and objectives. This multiplier assigns extra biodiversity value for habitats with strategic significance to the local area. Habitats of High Strategic significance are formally identified in local strategies (e.g. Local Nature Recovery Strategies, Local Biodiversity Plans, Green Infrastructure Strategies, River Basin Management Plans or Shoreline Management Plans). If a habitat is not mentioned in local strategy/objectives but professional judgement determines that it is ecologically desirable (e.g. creation of a woodland that would enhance connectivity between two semi-natural woodland blocks, habitats that are viewed by the community to be of biodiversity value) it is given a Medium score. Finally, a habitat is assigned to be of low strategic significance if it is not identified in local strategies nor deemed as ecologically desirable by professional judgement.

Metric 3.1: Accounting for risk

Many factors influence the risk associated with creating or enhancing a habitat to a desired condition. This includes site topography and hydrology, soil type, structure, pH and nutrient status, previous land use, neighboring habitats and species matrix, and climate. Additionally, implementation and management will be a key factor influencing the success of habitat creation or enhancement.

Metric 3.1 recognises that habitats differ with respect to these risks, and pre-assigns each habitat with multipliers that alter the biodiversity units of a habitat depending on the perceived risks to recreate or enhance that habitat. Standardisation provides transparency and consistency in calculating Biodiversity Units and reduces risk of abuse. Metric 3.1 identifies three risk factors: Technical difficulty in habitat creation or enhancement, time taken for a habitat to achieve its target condition, and spatial risk. The Metric accounts for differences in risk between creating new habitats and enhancing existing habitats (i.e. increasing condition or distinctiveness) by assigning each habitat with different risk multipliers for creation and enhancement. To incentivise habitat creation in advance, habitats that have already been created, and have reached their target condition e.g. through establishing a habitat bank, do not require risk multipliers.

It is worth noting that in post-intervention calculations, a habitat in good condition can in some instances yield lower biodiversity units than the same habitat in poor condition due to additional risks associated with achieving good condition (see Limitations of the Biodiversity Metric 3.1).

Technical difficulty multiplier

Habitats vary in the risks associated with restoration or enhancement due to both ecological and technical constraints and thus each habitat is assigned different multipliers based on available science and expert opinion. For example, a lowland fen is more difficult to recreate than upland heath as it strongly depends on the underlying hydrology. The multipliers result in a reduction in the biodiversity units generated for habitats perceived to be more technically difficult to enhance or create.

When pre-assigning technical difficulty multipliers the factors considered by experts included:

- Hydrological requirements
- Salinity regime
- Elevation and aspect
- Seed source or biological material requirements
- Future constraints (e.g. impacts of climate change)
- Low soil nutrient status
- Trophic status conditions
- Water quality needs
- Ongoing management requirements

Restoring existing semi-natural habitat is typically less risky than creating new habitat. Biodiversity Metric 3.1 therefore gives each habitat two scores based on the technical difficulty in creating the habitat and the technical difficulty in restoring the habitat with difficulty rating ranging from Very High to Low (Annex 5).

Spatial risk

In addition to Strategic Significance, when habitat creation or enhancement is delivered off-site spatial risk is also considered. As a guiding principle, prioritisation should be given to meet BNG within the footprint of the development (i.e. on-site) and where this cannot be achieved to ensure off-site compensation is as close to the development site as possible. Achieving this has both ecological and social benefits. Metric 3.1 therefore implements a Spatial risk multiplier that penalises off-site compensation that is more distant from the site of impact.

When compensation is achieved within the Local Planning Authority, the same National Character Area, the same Marine Plan Area or the same waterbody a multiplier of 1 is used. In England, the Local Planning Authority refers to the administrative area of the local government body exercising planning functions for a particular area. National Character Areas are natural subdivisions of England defined by Natural England. Marine Plan Areas consist of 11 subareas of the English inshore and offshore marine planning regions governed by the Marine Plan.

If compensation is achieved in a neighbouring Local Planning Authority, National Character Area/Marine Plan Area or within the same catchment a multiplier of 0.75 is applied. When compensation is achieved beyond neighbouring areas or outside of a catchment a multiplier of 0.5 is used.

Temporal multiplier

Once a habitat has been removed or damaged, there is a biodiversity deficit during the time it takes for the compensatory habitat to mature to its target condition. To account for this, a temporal multiplier is utilised by the Biodiversity Metric 3.1 – the time to target condition multiplier. This multiplier is based on the years between the intervention (removal/damage of habitat) to the point that the compensatory habitat reaches a predefined target condition.

This multiplier differs between habitat types and depends on whether a habitat is being created or enhanced, and to what condition the habitat is being created/enhanced to (i.e. the creation of a habitat in good condition will take longer than the creation of poor condition). Each habitat is set at a pre-determined value based on the average time taken to achieve desired outcomes. These pre-determined values are based upon expert opinion relating to each habitat under average environmental conditions in England. Additionally, a de-multiplier is applied based on discount rates for the delay in delivered goods such as habitat creation.

Where habitat is created in advance and is progressing towards its target condition, the tool adjusts the temporal multiplier to reflect this lower risk in successful delivery. Whereas if a delay in the creation/enhancement of compensatory units is anticipated, leaving a larger gap of time between the removal of habitat and the creation of new habitat, then the number of years to reach target condition is extended, lowering the multiplier and hence the resultant biodiversity units.

Limitations of the Biodiversity Metric 3.1

Landscape context

While Metric 3.1 is underpinned by expert opinion and ecological evidence, it must be noted that it adopts a relatively simplistic and broad-brush approach to calculating BNG. It uses habitat as a proxy for biodiversity and does not consider landscape structure. Landscape structure underpins ecosystem processes, and the loss of habitat heterogeneity is identified as a key driver of biodiversity decline (Benton et al. 2003). Metric 3.1 fails to capture the intricacies and complexities of ecosystems, how they function, and the interaction between habitats and species within an ecosystem.

Ecological connectivity facilitates species movement between habitat patches to meet resource requirements, to breed (increasing genetic diversity) and to respond to environmental change – consequently connectivity results in more resilient populations and ecosystems (Lawton et al., 2010). Ecological

connectivity is not currently accounted for in Metric 3.1. The closest thing resembling this is the strategic significance multiplier which allows assessors to indicate that a 'Location is ecological desirable but not in local strategy'. Natural England's Biodiversity Metric 2.0, factored in ecological connectivity for habitats with High and Very High distinctiveness. This was supported by a supplementary ecological connectivity tool which drew from a national dataset of UK BAP Priority Habitats. The tool was removed from Metric 3.0 on account of "the connectivity tool was not often used, and the approach did not work for all habitats"[21]. Along with the tool, the drop-down multiplier for connectivity was removed from the excel based calculator.

Translating from Phase 1 to UK Hab

To assist ecologists more familiar with applying the Phase 1 Habitat Classification system, Metric 3.1 has an option to input habitats using Phase 1. A correspondence table then translates these to UK Hab. The translation is very simplistic typically making single links between Phase 1 and UK Hab classification and in some instances translations are inappropriate - for example Phase 1 Bare Peat translates to UK Hab Annex 1 habitat Depressions on Peat substrates (H7150). Similarly, Phase 1 Wet modified bog translates to the Annex 1 habitat Transition mires and quaking bogs (H7140). Such translations will give erroneous estimations of biodiversity units.

Lack of consideration of pests/pathogens in terrestrial assessments

When it comes to assessing the condition of terrestrial habitats, only Woodland habitats (i.e. Line of Trees, Woodlands and Wood-Pastures and Parkland) consider pests and pathogens. Other habitats can also be severely degraded by pests and pathogens, for example heather moorland can be decimated by heather beetle. With climate change increasing the risk of newly emerging pests and pathogens impacting on (semi)-natural ecosystems (Sattaret al., 2021), including pest and pathogens within the condition assessment criteria would improve the metrics performance.

Risk multipliers generating perverse results

Metric 3.1 risk multipliers are largely considered as separate entities, in isolation from each other, and sometimes when these multipliers are all applied the resultant biodiversity units are inappropriate. For example, when creating new habitats, temporal multipliers can in some instances result in higher biodiversity units for habitats with a poorer target condition. This can be seen for woodlands which take a long time to achieve good condition. For example, Other woodland; broadleaved with a target condition of Fairly Poor (7 years to target condition) resulted in higher biodiversity units than the same habitat with a target condition of Good (30+ years to target). Similarly, the technical difficulty multipliers can result in habitats of higher distinctiveness

[21] Natural England. 2021. Summary of changes from Biodiversity Metric 2.0 to version 3.0, Natural England Joint Publication JP039.

(i.e. Lowland mixed deciduous woodland) yielding lower biodiversity units than less distinctive habitats (i.e. Other woodland; broadleaved). See Annex 5 for calculations. There is a need to consider how risk multipliers are integrated to ensure that outputs incentivise the creation high quality habitats.

Habitat enhancement verses creation

Risk multipliers for creating new habitats are higher than those for enhancing existing habitats to reflect the greater ease of enhancement. Metric 3.1, permits the enhancement of a habitat into a different broad habitat type as long as professional justification is provided in the "Assessor comments" and that enhancement results in a habitat of the same, or higher, distinctiveness. With habitat enhancement and creation having very different risk multipliers, a much higher number of biodiversity units can be obtained when enhancing a habitat than creating it. For example, enhancing a site where a coniferous plantation (i.e. Other coniferous woodland - low distinctiveness - poor condition) is felled and the blanket bog restored (i.e. Wetland – Blanket Bog - Very High distinctiveness - good condition) would result in the net gain of +4.97 habitat units. Whereas if this process was calculated as the removal of coniferous woodland (-2 habitat units) and the creation of blanket bog (+0.88), the net outcome would be -1.12 habitat units. See Annex 5 for calculations.

Current guidelines outline that enhancement is applicable when you are improving the condition of an existing habitat, changing distinctiveness of a habitat within a broad habitat type or restoring a remnant high value habitat where there are sufficient habitat remnants apparent on site (e.g. calcareous grassland encroached by scrub). Currently in the later situation there is a need for professional justification, which must then be approved by the determining authority. This is open to interpretation both by the personnel completing the metric calculations and the determining authority. When considering enhancement from one broad habitat type to another, additional guidance outlining appropriate habitat change and restorative actions would help to ensure standardisation and prevent abuse.

Accounting for non-habitat interventions

Metric 3.1 focusses on habitat-based interventions, and therefore fails to take into account the biodiversity benefits of non-habitat based interventions. For example, the installation of bat boxes or providing artificial nesting sites for owls could clearly enhance the potential for a woodland to provide for these species. Including such interventions within in condition assessments, or expanding condition criteria to include a wider range of species indicators, would incentivise a broader range of restoration techniques. The Conservation Evidence website could be reviewed to identify the most promising non-habitat interventions.

Results: Metric 3.1 Applicability Scotland

Introduction

This section explores the suitability of Biodiversity Metric 3.1 as a means of accounting for biodiversity in Scotland. It compares the UK Hab system of classifying habitats, with the EUNIS system. It determines if habitats of conservation concern (at the Scottish and wider European level) are already included in the metric and provides an indication of how transferable habitat distinctiveness ratings are. It also identifies the availability of datasets, and assesses how appropriate the condition assessment and risk multipliers are with respect to the Scottish context. Finally we explore the underpinning capacity required to undertake and administer metric use in order to identify skills, staffing and training needs.

To determine applicability to Scotland, it is important to consider how regulations governing planning differ between Scotland and England. While achieving a minimum 10% BNG will become mandatory in England from November 2023, in Scotland there are no plans for a mandatory or otherwise quantitative target. The National Planning Framework 4 (NPF4)[22] sets out policies to protect biodiversity, reverse biodiversity loss, deliver positive effects from development and strengthen nature networks (Policy 3). To ensure that positive effects for biodiversity are delivered, it is crucial that there is a standardised and transparent way to measure and account for biodiversity.

Metric 3.1 provides a tested means of accounting for biodiversity. While Metric 3.1 has a user-friendly interface to assist decision makers, some ecological knowledge is required. From a regulatory perspective there is concern that Scotland does not have the capacity to assess development proposals to ensure that they demonstrate biodiversity enhancement. To equip decision makers there is a need for clear guidance and to ensure resources are provided to upskill regulators. Furthermore the User Guide (including Principles and Rules that underpin metric use) and Technical Annexes (including Technical Supplement and Habitat Condition Assessment Sheets) that accompanies Metric 3.1 will need to be redrafted to ensure that they are fit for purpose in Scotland.

Key insights and recommendations – sector applicability

- The guiding principles for BNG align with Scotland's commitment to deliver positive effects for biodiversity, however, statutory requirements for 10% BNG linked to frameworks for the purchase of government credits do not apply in Scotland.
- **Recommendation 1.** Ensure supporting information is fit for purpose in Scotland.
- **Recommendation 16.** Determine Scotland's capacity to administrate from a regulatory perspective and provide training to equip decision

[22] Scottish Government's National Planning Framework 4

makers to assess development proposals to ensure they deliver positive effects for biodiversity.

Irreplaceable Habitats: The Scottish context

Here we identify the requirement for a definitive list of irreplaceable habitats in Scotland. We consider the impact of bespoke compensation with respect to industry and regulatory bodies. Finally, we identify datasets that can be used to determine the extent and location of habitats of conservation concern and outline limitations of these datasets.

Irreplaceable habitats require bespoke compensation and are protected through protected species and habitats legislation and policies. As ancient woodlands and veteran trees are not a habitat in their own right these are not specifically identified in Metric 3.1. Using existing spatial datasets (i.e. Native Woodland Survey of Scotland[23], Caledonian Pinewood Inventory[24]) or integrating information on habitat type and condition may allow for ancient woodlands to be more accurately accounted for (see below). For consistency, it is recommended that all irreplaceable habitats are included within a Scottish metric. To achieve this, a comprehensive list of irreplaceable habitats for Scotland would have to be produced and agreed, and this process will should also use spatial datasets of these habitats where available.

The renewables industry have expressed concerns regarding applying the BNG Metric 3.1 approach to large scale projects in the uplands (e.g. windfarms). The large red line boundary of windfarm sites (i.e. total site footprints) together with the prevalence of peatland means developments have a high likelihood of encountering this irreplaceable habitat. Applying BNG to the entire site footprint is considered by the industry to challenge the viability of developments and, from a regulating body perspective, providing guidance on bespoke compensation would require additional staff resourcing. A possible solution is to only apply BNG to the areas directly impacted by development (i.e. tracks and turbines with an appropriate buffer determined via site topography and hydrology). Over 20% of Scotland is covered by peat, to help to ensure a viable solution is reached we recommend consultation with industry, peatland experts and for windfarm sites the Onshore Wind Strategic Leadership Group.

Key insights and recommendations – irreplaceable habitats

- **Recommendation 2.** Refine Natural England's forthcoming list of irreplaceable habitats to reflect such habitats in Scotland.

- **Recommendation 3.** All irreplaceable and Annex 1 habitats in Scotland and those on and the Scottish Biodiversity list should be included in a Scottish Metric and be given an appropriate distinctiveness rating.

[23] Scottish Forestry's Native Woodland Survey of Scotland (NWSS)

[24] Scottish Government's Caledonian Pinewood Inventory

- **Recommendation 4.** Identify a solution to ensure that peatlands are correctly accounted (e.g. through consultation with industry and peatland experts).

Trading rules: The Scottish context

This section outlines the applicability of Metric 3.1's trading rules to the Scottish Context. It explores how Metric 3.1 combines habitats of different conservation values, and highlights the potential to integrate information on Distinctiveness and Condition to better reflect biodiversity value of a habitat.

Metric 3.1's trading rules are based primarily on habitat distinctiveness and thus on a habitat's inherent potential to benefit biodiversity, with additional rules targeted to promote the retention of woodland habitats. The rules are designed to ensure that habitats created or enhanced to meet BNG are of equal or greater inherent value than any habitats lost. This aligns with Scotland's commitment for developments to have positive effects for biodiversity and woodland creation targets (i.e.18,000 ha per year from 2024/25).

Metric 3.1 assigns habitat distinctiveness at UK Hab Level 4, however Level 5 is typically required to identify Annex 1 habitats (Butcher et al. 2020a). Consequently, in some instances Annex 1 habitats are grouped with habitats of lower biodiversity and their value is not recognised. To avoid amalgamating habitats of different conservation value, Scotland could adopt a more detailed classification system in which to base trading rules. However, this would also result in a more complicated tool to use. Trading rules that integrate information on both condition and distinctiveness may allow for greater separation of habitats based on their conservation value without the requirement for more complex categorisation. A stakeholder poll indicated this was more preferential than trading rules solely based on distinctiveness (Annex 5 Figure 19a). Care would have to be taken to ensure that integrating distinctiveness and condition provides a robust means of accounting for biodiversity to ensure that we don't lose inherently valuable habitats due to poor condition.

Key insights and recommendations – irreplaceable habitats

- Metric 3.1's trading rules are in line with Scottish planning, biodiversity and woodland creation policies.

- **Recommendation 5.** The potential to base trading rules on both distincitiveness and condition should explored, this may avoid the need for a more detailed and complex habitat classification system.

Habitat classification: The Scottish context

This section explores how fit Metric 3.1's habitat classification systems are with respect to categorising Scottish habitats. It explores EUNIS as a potential alternative to UK Hab for terrestrial habitats. It delves deeper into the habitats

included in Metric 3.1 to identify if any habitats of conservation concern present in Scotland are not accounted for.

The classification systems that Metric 3.1 adopts are largely derived from systems developed for use in UK or Europe and are thus fit for purpose in Scotland (Table 10). For species-rich hedgerows, the guidance adjusts the number of woody plant species to reflect geographical differences with adjustments including Scotland.

Most terrestrial habitats are classified in the UK Hab system. With some ecologists in Scotland using Phase 1, Metric 3.1's means of crosslinking these two classification system provides flexibility and would alleviate training needs. There are clear problems with Metric 3.1 current crosslinks, and we would prioritise ensuring that these crosslinks are accurate and fit for Scottish habitats.

EUNIS is an alternative pan-European classification system which provides a framework to classify habitats (terrestrial, intertidal, urban), helping EU member states meet the INSPIRE Directive requirements to standardise spatial datasets (Strachan, 2017). There is a comprehensive Manual of terrestrial habitats in Scotland based on this system (Strachan, 2017). EUNIS is used by NatureScot for collating and mapping data, and recent NatureScot spatial datasets adopt this system, providing resources to support metric use.

Space Intelligence have derived the SLAM-MAP[25] of Scotland in the EUNIS classification system by classifying satellite imagery using Artificial Intelligence. This map is open source and provides a habitat map covering all of Scotland. Habitat classifications are, however, at a relatively broad level (EUNIS Level 2), resolution is low (i.e. 20 m) and information on habitat quality is lacking. This map could, however, support on the ground habitat mapping or be used where large-scale assessments are required. Indeed, EUNIS forms the basis of Scotland's Natural Capital Asset Index and the SLAM-MAP has been used to refine this index.

UK Hab and EUNIS take a hierarchical approach to habitat classification, with more detailed habitat descriptions nested within broader descriptions. The Metric classifies most terrestrial habitats using UK Hab L4 which typically provides an intermediate level of detail between EUNIS L2 and EUNIS L3 (Table 11). This trend is, however, not observed for Cropland where categorisation at UK Hab L4 is more refined than EUNIS L3. Metric 3.1 recognises 13 different types of hedgerows, whereas EUNIS L3 only recognises 5 categories of hedgerows. While EUNIS has distinct categories for habitat mosaics, UK Hab typically accounts for mosaics by dividing these into the individual habitat the mosaic is made up from. This undervalues the ecological benefits of habitat mosaics. It is worth noting that open mosaic

[25] Space Intelligence's SLAM-MAP of Scotland is a comprehensive map of Scotland's terrestrial habitats. This map has been derived using artificial intelligence to categories satellite data into habitats (EUNIS level 2 at a spatial resolution of 20m ^{2}).

habitats on previously developed land are treated as a habitat in their own right and give a High distinctiveness rating.

Table 11 Table outlining the hierarchical structure of EUNIS and UK Hab. The number of habitat categories at each level is provided

EUNIS Level 1	EUNIS Level 2	EUNIS Level 3	UK Hab Level 2	UK Hab Level 4
Grasslands and lands dominated by forbs, mosses or lichens	5	18	Grassland	13
Woodland, forest & other wooded land	4	17	Woodland & forest	13
Mires, Bogs and Fens	3	7	Wetland	8
Grasslands and lands dominated by forbs, mosses or lichens	5	18	Grassland	13
Mires, Bogs and Fens	3	7	Wetland	8
Heathland, scrub and tundra Excluding hedgerows Hedgerows*	 5 1	 12 4	Heathland & shrub Hedgerows	 12 13*
Inland unvegetated or sparsely vegetated habitats	4	16	Sparsely vegetated land	8
Regularly or recently cultivated agricultural, horticultural habitats	2	5	Cropland	11
Inland surface waters Excluding surface running waters Surface running waters	 2 1	 12 5	 Lakes Rivers	 11 5
Habitat complexes	17			

*Hedgerow classification is metric specific and draws from Defra's Hedgerow Survey Handbook.

While UK Hab and EUNIS don't directly correspond to each other, it is possible to crosslink habitats via existing correspondence tables (UK Habitat Classification Working Group, 2018). Annex 5 provides a cross reference of EUNIS categories of Scottish habitats (Strachan 2017) with UK Hab. Crosslinking the two classification systems, particularly at more refined levels is, however, complex (Figure 10). For example, in some instances UK Hab L4 classifications link to multiple EUNIS L3 classification, while in other cases a

single EUNIS L3 classification links to multiple UK Hab L4 classifications. Furthermore, while there is a tendency for habitats in the broad EUNIS L1 group Grasslands and lands dominated by forbs, mosses or lichens to be aligned to those in the UK Hab L2 group Grassland this is not always the case. For example, EUNIS L3 Heavy-metal grasslands, fell under UK Hab 2 Sparsely vegetated land. Consultation with stakeholders revealled a familiarity and preference for UK Hab. We discuss Scottish habitats omitted from this classification in the following section.

Key insights and recommendations – habitat classification

- Hierarchical classification systems like UK Hab and EUNIS allow for varying levels of precision providing flexibility to meet the needs of different sectors and applications within a sector.

- Allowing habitat types to be input in different classification systems and crosslinking these systems can be problematic (e.g. as seen with Phase 1 and UK Hab – see Section: Limitations of the Biodiversity Metric 3.1).

- **Recommendation 6.** Ensure crosslinks between Phase 1 and UK Hab work are fit for purpose through consultation with habitat experts.

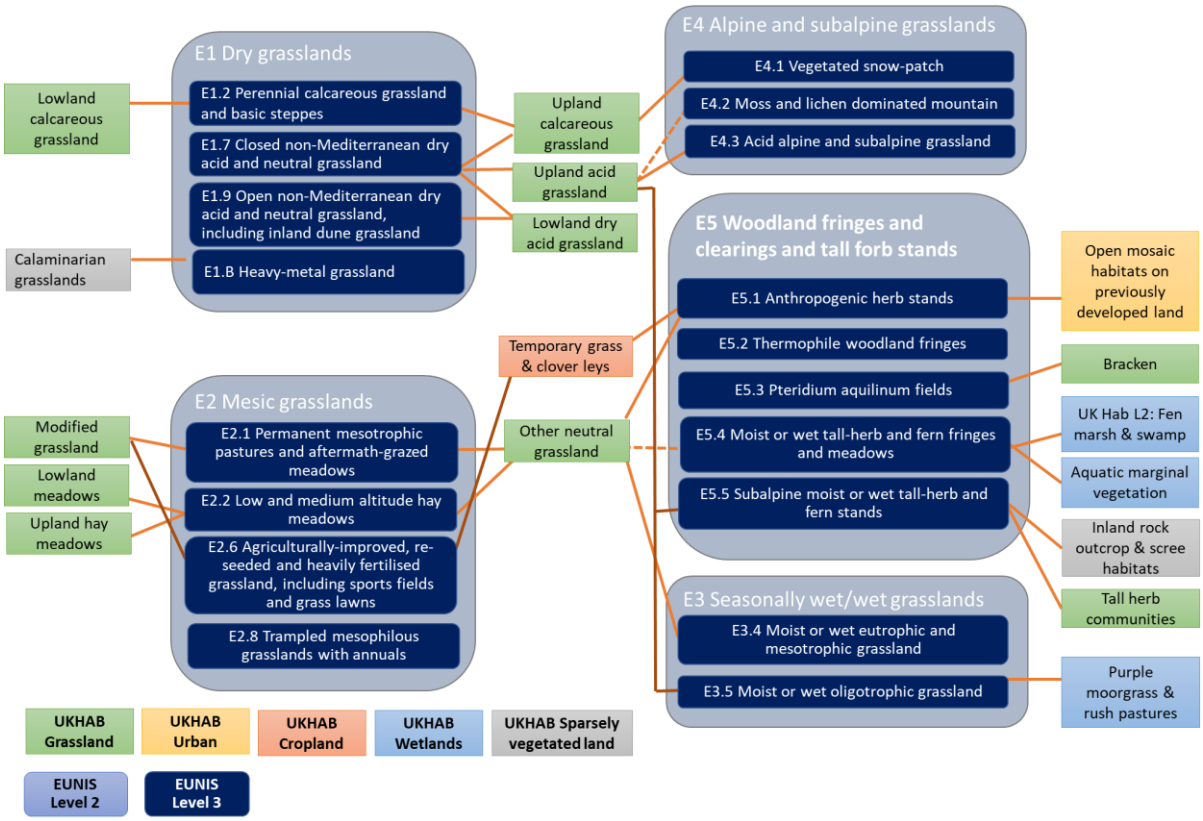


Figure 10: Hierarchical structure for the EUNIS classification of Grasslands illustrating EUNIS L2 and L3 categories. Crosslinks between EUNIS L3 categories and UK Hab L4 are indicated indicating the complexities of relating the two classification systems

Distinctiveness: The Scottish context

In this section, we look at how Distinctiveness classifications could be adapted for Scotland and identify relevant Scottish data sources that could assist in this process. We identify if any habitats of conservation importance within Scotland are missing from Metric 3.1.

For terrestrial habitats, once a habitat classification system for the Scottish Metric is agreed, distinctiveness could be derived from assessing the rarity, protection, and conservation importance of each habitat in Scotland using the approach adopted by Metric 3.1. Rarity could be calculated from the total remaining area within Scotland (this information is presented in rough values in the Scottish Biodiversity List[26]), protection as a percentage of each habitat's coverage within protected sites (SSSI, SPAs, SACs, RAMSAR sites, Marine Consultation Areas, and Marine Protected Areas) and conservation importance could be derived from the Scotland Biodiversity List, UK Priority Habitats, and European Red List.

Several spatial datasets are available to help identify the location of protected sites and location and extent of habitats of conservation concern. These maps are open access and freely available on the Scotland's environment map[27].

Metric 3.1 identifies five broad river categories specifically: Priority Rivers (Very High Distinctiveness), Other rivers and Streams (High), Ditches (Medium), Canals (Medium) and Culverts (Low). While this framework would be applicable, Scotland does not have a Priority Rivers map. The Water Classification Hub[28], however, classifies rivers into five condition categories based on ecology, chemistry and hydrology and could provide a suitable alternative. This dataset was utilised in NatureScot's draft tool for natural capital assessment on farms.

As in England, Scottish lake typology can be determined via the UK Lakes Portal[29] and the assignment of distinctiveness could follow the same approach as Metric 3.1. Similarly, Metric 3.1 takes a relatively straightforward approach to determining the distinctiveness of intertidal habitats based on the rarity of substrate and naturalness. This methodology would be directly transferable to the Scottish Context.

Spatial data include the Scottish Wetland Inventory and Caledonian Pinewood Inventory and information on peatlands (i.e. blanket bogs, lowland raised bogs) are mapped in the Carbon and Peatland map 2016. The Habitat Map of Scotland (HabMoS) provides coverage of:

[26] NatureScot: Scottish Biodiversity List

[27] Scotland's Environment Map portal

[28] SEPA Water Classification Hub map portal

[29] UK Centre for Ecology and Hydrology Lake Portal

- HabMoS Coastal and Vegetated Shingle
- HabMoS Saltmarsh
- HabMoS Sand Dune Vegetation
- HabMoS Native Woodland
- HabMoS Freshwaters
- HabMoS NVC to Annex I

The HabMoS freshwater layer also contains information on freshwater habitats including Annex 1 classification.

These spatial datasets draw from the best available information, with surveys varying in methodology, scope and accuracy. The availability of data will vary between habitat types, with some habitats (e.g. woodlands and saltmarsh) having more comprehensive information than others (e.g. calcareous grasslands). There may be inaccuracies due to the conversion of data from NVC to EUNIS. In some instances (e.g. NVC to Annex 1) the data is incomplete or outdated – (e.g. HabMoS Sand Dune Vegetation Survey 1994-1998). A review of the extent, coverage, and accuracy of these spatial datasets, and their transferability for use in calculations of Biodiversity is thus recommended. An alternative, short-term solution, would be to consult with key stakeholders and ecologists to determine where changes to current distinctiveness scores would be required. Indeed, this process would validate the fitness of strategic significance, and risk multipliers in the Scottish context.

To determine if any terrestrial Scottish habitats of conservation concern are excluded from Metric 3.1, we cross-referenced habitats on the Scottish Biodiversity List and Scottish habitats identified as UK BAP Priority Habitats[30] with Metric 3.1 habitats. Additionally, to account for internationally important habitats in Scotland, we determined if all Annex 1 habitats present in Scotland (Strachan 2017) were included in the Metric's Technical Supplement (Panks et al. 2022).

Six Annex 1 habitats are not mentioned in the Biodiversity Metric 3.1 Technical Supplement (Panks et al. 2022) (Table 12). Except for Machair (an Annex 1 habitat), these habitats could be assigned to UK Hab cateogories (Panks et al. 2022). Machair occurs as a habitat complex and consequently UK Hab categorises it using a combination of habitat codes – including grassland, saltmarsh and sand dune and it additionally falls under the secondary UK Hab code 26 (Butcher, et al. 2020a). Metric 3.1 recommends that habitat complexes are assigned based on the approximate area of each habitat, however, this fails to capture the biodiversity benefits that habitat mosaics provide (e.g. high diversity of niches and microhabitats). A Scottish

[30] JNCC list of UK BAP Priority habitats

metric should therefore include Machair as a habitat in its own right. We would recommend a Very High distinctiveness rating to reflect national and international importance, and requirement for bespoke compensation. The addition of machair would also require the development of condition assessment criteria and appropriate risk multipliers.

Of the remaining Annex 1 habitats not included in the technical guidance, four fell under UK Hab L4 habitats rated to be of High distinctiveness (i.e. Upland calcareous grasslands, Lowland calcareous grasslands and Lowland Heath , see Table 12). The remaining Annex 1 habitat, Siliceous alpine and boreal grasslands, fell under the UK Hab group Upland acidic grassland which is rated as Medium distinctiveness. Juncus squarrosus-Festuca ovina grassland which is on the Scottish Biodiversity List, but is not an Annex 1 habitat, also fell into Upland acidic grasslands. The significance of these two habitats from a Scottish perspective indicates that Metric 3.1's current categorisation of Upland acidic grasslands as Medium distinctiveness may not be appropriate for Scotland. However, it is recognised Upland acid grassland dominates large areas of Scotland and it is typically species poor. Trading rules that integrate distinctiveness and condition would help to avoid grouping habitats of different innate value (see above).

This exercise highlighted that the Annex 1 habitat Caledonian forest (H91C0) which is unique to Scotland is included in Metric 3.1 Technical Supplement. This habitat fell into the broader grouping Native pine woodlands which are categorised to have High Distinctiveness. This Annex 1 habitat is considered Near Threatened and it does not occur elsewhere in the UK or Europe. Native pine woodlands should therefore be upgraded to Very High Distinctiveness to reflect their high conservation value and the requirement for bespoke compensation under a planning framework. Indeed, when adapting the Biodiversity Metric 3.1 for use in the Scottish context SSE Networks have upgraded Native pine woodlands to Very High distinctiveness (Scottish and Southern Electricity Networks 2019).

Arable field margins are classified as Medium distinctiveness despite being a Priority habitat in England as well as Scotland. Arable field margins are key habitats to create ecological connectivity across the wider countryside and provide a wide range of ecosystem services that underpin food production (e.g. pollination and natural pest control). However, they fail to reflect the inherent quality of semi-natural habitats categorised as High or Very High distinctiveness. Thus it is proposed that the current distinctiveness score is appropriate.

Table 12: Terrestrial Annex 1 habitats and their EUNIS codes omitted from the Biodiversity Metric 3.1 technical manual (Panks et al. 2022)

Habitat and extent	Scottish Biodiversity List EUNIS Code (Strachan 2017)	Red list name/ status	Distinc-tiveness
Machairs (H21A0): Unique to NW Scotland and W Ireland. Approximately 60% of the global extent of this habitat is thought to be found in Scotland.	Machair	Machair **Least concern**	n/a
Juniperus communis formations on heaths or calcareous grasslands (H5130). Relatively widespread but local habitat found across Europe. Scattered patches in England and Scotland, very rare in Wales, absent from Northern Ireland.	Lowland calcareous grassland Lowland heathland EUNIS: F3.16#1	Lowland to montane temperate & submediterranean *Juniperus* scrub **Least concern**	High
Siliceous alpine and boreal grasslands (H6150). Restricted distribution in Europe. Extensive areas occur primarily in Scotland, with the habitat also present in N England, N Wales and Northern Ireland.	n/a EUNIS: E4.115# + E4.117 + E4.21 + E4.32 + F2.11	Boreal and arctic acidophilous alpine grassland **Least concern**	Medium
Alpine and subalpine calcareous grasslands (H6170). Largely restricted to Alpine and Boreal Biogeographical regions in Europe. UK largely restricted to the Scottish Highlands. Absent from Northern Ireland and England.	Upland calcareous grassland EUNIS: E4.12 + F2.29#1	Arctic-alpine calcareous grassland **Least concern**	High
Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) (H6210). Scare and threatened in Europe. Occur widely in calcareous substrate in England and Wales, but are restricted in Scotland and Northern Ireland.	Upland calcareous grassland EUNIS: E1.26	Perennial rocky calcareous grassland of subatlantic-submediterran-ean Europe **Vulnerable**	High

Species-rich *Nardus* grassland, on siliceous substrates in mountain areas (H6230). Rare in mainland Europe. Widely found in the UK, particularly in Scotland. Annex 1 description includes *Nardus stricta-Galium saxatile* grasslands which are on the Scottish Biodiversity list.	Upland calcareous grassland EUNIS: E1.72#	Lowland to submontane, dry to mesic *Nardus* grassland **Vulnerable**	High
Scottish Biodiversity List habitat that is not an Annex 1 habitat, nor on the Priority Habitats Inventory (England). EUNIS code cross references this habitat to UK Hab L4 Upland acidic grasslands.	*Juncus squarrosus-Festuca ovina* grassland EUNIS: E3.52 for NVC U6	n/a	Medium
An overview of extent at the UK and European level is indicated (source: JNCC website). Cross links between Annex 1 habitats and the Scottish Biodiversity List are provided (UK Habitat Classification Working Group 2018). Distinctiveness as outlined in Biodiversity Metric 3.1 and Red List status (EU Environment Agency: EUNIS terrestrial habitat classification 2021_1 including crosswalks).			

In addition to the habitats listed in Table 12, Metric 3.1 fails to recognise ancient woodlands or ancient or veteran trees (see above). Most woodlands are categorised as High or Medium distinctiveness which is inappropriate for irreplaceable ancient woodlands. It is recommended that all habitats of conservation concern (i.e. Annex 1 habitats and those on the Scottish Biodiversity List) are included in a Scottish metric and assigned appropriate distinctiveness ratings based on consultation with key stakeholders, including ecologists.

Key insights and recommendations - distinctiveness

- Distinctiveness could be determined using similar/or identical methodologies to those adopted in Metric 3.1.
- **Recommendation 7.** Determine the availability, extent and accuracy of existing spatial datasets and determine their suitability for use in biodiversity calculations.
- **Recommendation 8.** Consult with key stakeholders including ecologists to validate the fitness of distincitveness, strategic significance, and risk multipliers for use in Scotland.
- **Recommendation 3.** All irreplaceable and Annex 1 habitats in Scotland and those on and the Scottish Biodiversity list should be included in a Scottish Metric and be given an appropriate distinctiveness rating.

Habitat condition: The Scottish context

Within this section, we evaluate that applicability of Metric 3.1's habitat condition assessment criteria to Scottish habitats.

The criteria for condition assessments outlined in Metric 3.1 are typically drawn from UK wide standards (i.e. JNCC's Site Condition Monitoring Guidelines; Defra's Hedgerow Survey Handbook: Defra 2007, The Freshwater Biological Association's Habitat Naturalness Assessment) and thus assessment criteria should be applicable to Scottish habitats. Our review of condition criteria found that this was largely the case.

For terrestrial habitats communities of indicator plant species are outlined in the UK Hab definitions; a classification system developed for the entire UK (Butcher et al. 2020b). Negative plant indicators were largely derived from the JNCC's Site Condition Monitoring Guidelines. Depending on habitat, these indicators reflected high nutrient status (e.g. grasslands, orchards, sparsely vegetated land), bracken/gorse encroachment (heathlands), or the presence of non-native species (scrub, woodland). The species listed are appropriate for Scotland, although one of the negative indicators for scrub Alianthus altissma has a restricted range. Saltmarsh species differ between Scotland and England, and the characteristic species for vegetation zones should be refined. For example, Atriplex portulacoides is primarily restricted to more southern areas of Scotland.

For grassland and woodland habitats, condition scoring depends on the number of species present. For example, for a grassland to be of medium distinctiveness it should support nine or more species per m^2 while a woodland parcel in good condition would require five or more native tree or shrub species. Concerns have been raised that these species counts are too high for Scotland, particularly in harsher environments (e.g. higher elevations, or exposed locations). We would recommend consulting experts to ensure that condition criteria are appropriate for the wide range of environmental conditions and to determine if refinement is necessary.

Metric 3.1 uses the MoRPh methodology to assess river condition. Communication with Prof Angela Gurnell indicates "The 13 river types used in England should work fine in Scotland. The main issue is high-energy multi-thread river types, which could be subdivided but that is unlikely to be critical in the present context, where braided, island braided and wandering rivers have sufficiently similar features to be lumped into the same type." Attributes measured in the field assessment are applicable to Scotland, however, the relative weighting of the condition indicators may need refinement through consultation with experts. The MoRPh survey is the only assessment where assessors require formal accreditation. This requirement for accreditation would have to be consiered in Scotland's capacity to deliver.

Indicators for ponds, lakes, intertidal and coastal habitats reflect a range of physical and biological aspects relating to naturalness and water quality which

are deemed appropriate for Scotland. Negative indicators included several invasive species that have not yet been recorded in Scotland (e.g. Zebra mussel, Demon shrimp). These species are, however, listed in The Scotland River Basin District (Status) Directions 2014. Given the ecological consequence of non-native species entering Scottish waterbodies expanding negative indicators to include all species listed under Schedule 3 of Directions 2014 would raise awareness and increase vigilance.

Key insights and recommendations – habitat condition

- **Recommendation 9.** Condition assessments were drawn from UK standards and were thus largely appropriate to Scotland. It is recognised that slight differences may occur, and it is therefore recommended that condition criteria are assessed by habitat experts.

- **Recommendation 15.** Assess Scotland's capacity to deliver on the ground surveys and determine potential skills gap (e.g. surveyors competent in UK Hab, MoRPh River assessment accreditation).

Strategic significance: The Scottish context

This section explores the relevance of applying a strategic multiplier to Scotland. We identify the appropriateness of local strategies to identify action, indicate limitations, and explore wider spatial datasets that could help underpin decision making at the local and regional level.

In helping to prioritise where habitats are created, strategic multipliers provide a vehicle to help Scotland realise it's ambition to create nature networks that link nature-rich habitats through corridors and stepping stones. In Metric 3.1 this multiplier provides an uplift for habitats with medium to high strategic significance (i.e. biodiversity units are multiplied by 1.1 and 1.15 respectively). Given the importance of ecological connectivity to ecosystem resilience, these values appear quite low and it is recommended that the appropriateness of all Metric 3.1 multipliers are assessed by key stakeholders, including ecologists. Any change in multipliers should also take into account how the different multipliers interact to avoid perverse outcomes (see above).

As in England, strategic significance could be identified through local strategies including Local Biodiversity Action Plans, Local Climate Change Strategies, Catchment Management Plans, Land use strategy (LUS) pilots, and spatial targeting of Agri-Environment and Climate Measures. It is, however, important to note that these strategies are unlikely to have been developed with Biodiversity offsetting/markets in mind. Local plans will, vary in their approach and suitability will differ with respect to the level of detail, spatial extent and habitats considered. We recommend that local strategies are reviewed to ensure they provide a suitable framework to assign strategic significance and that guidelines are drafted to assist in this process.

Opportunity mapping can help to spatially target habitat creation to optimise connectivity and such mapping could provide an important resource when

determining strategic significance (see Landscape structure: The Scottish context). As with Metric 3.1, allowing strategic significance to draw on ecological expertise would allow for greater flexibility in determining what is desirable in a local area.

Key insights and recommendations – strategic significance

- **Recommendation 10.** Undertake a review of local strategies to ensure they provide a suitable vehicle to assign strategic significance and that guidelines are drafted to assist in this process. Strategic multipliers should be included in this review.

- Spatial datasets such as opportunity mapping could underpin the development of a standardised reference to spatially target habitat creation.

Accounting for risk: Scotland

Technical difficulty multipliers: The Scottish context

Here we explore the fitness of technical difficulty multipliers for use in Scotland; determining where risks are likely to be similar and where they are most likely to differ. We explore if an average risk multiplier per habitat is appropriate for Scotland and consider means of refinement to include site specific risks.

Metric 3.1 gives each habitat an average value for technical difficulty in habitat creation and an alternative value for enhancement based on key factors that influence risk, expert opinion and the literature (ENTEC 2011; ENTEC/AMEC 2013, AMEC 2016 – and references there in). Habitat creation multipliers are broad, with only four levels of classification (i.e. Low, Medium, High and Very High) making them easier to assign. For example, irreplaceable habitats (e.g. limestone pavements, Blanket bogs and Aquifer fed naturally fluctuating water bodies) are given a Very High difficulty rating reflecting their irreplaceable nature, whereas heavily managed habitats (e.g. cereal crops and vegetated gardens), or habitats that naturally regenerate (e.g. gorse scrub), are given a Low rating.

The factors considered for technical risks are comprehensive and relevant in a Scottish context (see Section Technical Difficulty Multiplier: Natural England's Biodiversity Metric 3.1). As in England, semi-natural habitats with specific hydrological and/or salinity requirements (e.g. Wetlands, Lakes, Coastal and Intertidal habitats) are typically more difficult to create and technical risk factors of High to Very High reflect this. Similarly, habitats with specific soil requirements (e.g. nutrient status and pH), are also trickier to create particularly when this deviates from normal conditions (e.g. calcareous grasslands in the uplands where soils tend to be acidic).

While risk multipliers largely appear sensible in the Scottish context some adjustments may be necessary, particularly when conditions and habitats are likely to deviate between Scotland and England. For example, upland habitats,

and in particular woodland habitats are typically more technically difficult to create and enhance in Scotland than in England due to accessibility, exposure, and deer browsing. Furthermore, site conditions are likely to show a greater degree of variation in Scotland and thus an average difficulty rating for each habitat is less applicable. To account for this, a Scottish Metric could alter technical difficulty multipliers (and indeed Temporal multipliers) to reflect site specific risks. To achieve this, an increase in information on site conditions for habitat creation/ enhancement would be required at the Metric input stage. For example, the risk associated with Woodland creation could be reduced at lower elevations and in areas of low deer density. Supporting information could be derived from free source online spatial datasets (e.g. elevation, aspect, exposure, hydrology, deer numbers) and simple drop down menus (e.g. deer fencing/tree guards).

There is the potential to provide flexibility to alter risk multipliers based on local knowledge and professional advice and include justification for any changes. This could take into account the current habitat and its condition and proposed enhancement. For example, enhancing a blanket bog that requires drain blocking will be easier to achieve than where reprofiling peat hags is required. From a planning perspective, such information is likely to be already required for habitat creation/ enhancement management plans and is therefore achievable with minimum additional effort. Increasing flexibility, however, results in lower reproducibility and clear rules would be needed to reduce the risk of 'green-washing' or abuse. In the longer term, technical risk could draw on site-specific factors derived from existing data sources increasing transparency.

It is also important to note that there are considerable technological advancements in habitat creation (e.g. coastal saltmarshes) and enhancement techniques (e.g. peatland). The enhancement of Blanket Bog is given a High rating indicating a high level or risk, and low success rate. Technical multipliers should therefore be assessed relatively frequently (e.g. every five years) to ensure that they continue to be relevant.

Key insights and recommendations – technical difficulty

- **Recommendation 11.** Due to greater variation in environmental conditions across Scotland average risk multipliers based on habitat type are not appropriate in Scotland. Greater flexibility in the assignment of risk multipliers to reflect site conditions is recommended.

- **Recommendation 12.** Explore the potential to integrate spatial datasets to alter risk multipliers to better reflect site specific risks.

Spatial risk multipliers: The Scottish context

This section highlights the appropriateness of applying spatial risk multipliers when offsetting biodiversity in Scotland. It compares assigning this risk based on both administrative boundaries and more natural boundaries that reflect landscape characteristics.

Where offsetting is required, the spatial risk multiplier in Metric 3.1 incentivises off-site habitat creation/enhancement within the same Local Planning Area or National Character Area (although this could favour action at a greater distance than sites in an adjacent LPA or NCA). In the local context this has positive implications for both people and biodiversity and is thus aligned with NPF4. As the Biodiversity Metric uses English Local Authority Areas, National Character Areas and Marine Plan Areas, a Scottish Metric would have to determine what is the most appropriate Scottish equivalent.

In Scotland, Planning Authorities are delivered across 32 council areas and two national park authorities. Scottish local council areas vary greatly in size (from 60km^2 of Dundee City to 25,657km^2 of Highlands). English Local Planning Authorities (i.e. borough and district councils and unitary authorities) are more consistent in size reflecting urban areas and population size. Urban local authorities are comparable in size in both Scotland and England, but more rural English local authorities are generally smaller than those in Scotland[31]. Disparity between the size of Scottish local authority areas brings into question if this approach could result in an imbalance, with developers in the Highlands having greater choice in potential offset sites.

Rather than take administrative boundaries, English National Character Areas, and Scottish Landscape Character Types allow us to categorise landscapes based on both natural (landscape structure, geology, biodiversity, soils) and human components (e.g. land use, urbanisation, cultural services). Through including natural components of landscapes, they provide a more biodiversity centric approach than administrative boundaries. English National Character Areas are generally larger than Scottish Landscape Character Types (Figure 11). In comparison to local authority areas, Scottish Landscape Character Types have less variation in size across Scotland and consequently provide a more just framework to apply a Spatial Risk Multiplier. Furthermore, this would ensure that offset sites occur in a similar landscape type. In following more natural boundaries, Landscape Character Types also align better with landscape scale initiatives providing opportunity to align biodiversity offsets with such initiatives (e.g. Regional Land Use Partnerships, Landscape Enterprise Networks).

Alternatively, a novel and more precise way to account for spatial risk could be factoring the exact distance between the site of habitat loss and habitat creation as a direct multiplier on habitat units delivered. This would allow spatial risk to be accounted for as a continuous numerical multiplier rather than a discrete category where off-site is accounted for the same regardless of distance from the site of habitat loss and habitat creation.

[31] See for example: Office for National Statistics map of UK Local Authority Districts, Counties and Unitary Authorities

Key insights and recommendations – spatial risk

- Spatial risk multipliers are in line with the aims of NPF4 to enhance biodiversity in a way that reduces inequalities.
- In following natural landscape boundaries, Landscape Character Types are more aligned to landscape scale initiatives.
- **Recommendation 13.** Explore means of assigning spatial risk that is appropriate to Scotland (e.g. Landscape Character Types or simply distance between the site of habitat loss and creation).

Temporal risk multipliers: The Scottish context

This section explores the fitness of temporal risk multipliers for application in Scotland, highlighting where these may deviate from England. The appropriateness of an average temporal multiplier is considered, as is the potential to include site specific factors to refine temporal risks.

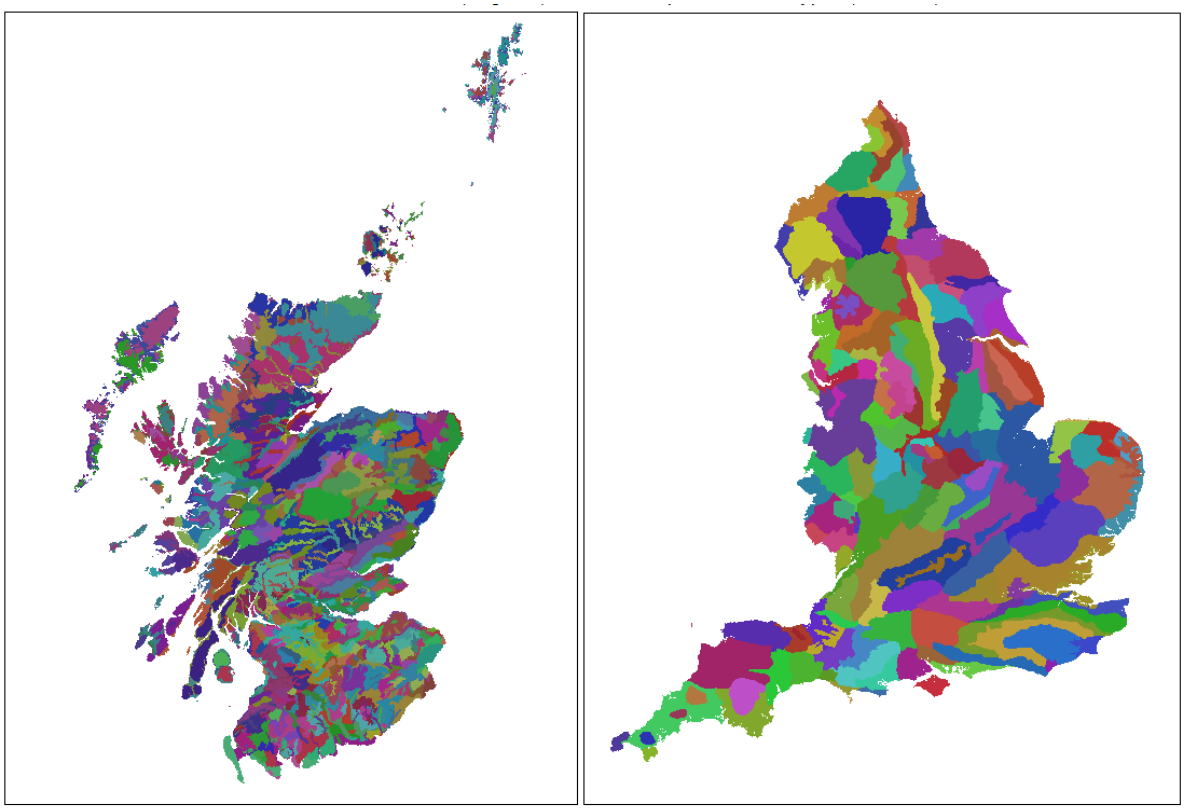


Figure 11: Landscape Character Types Scotland and National Character Areas England (sources: NatureScot and Natural England)

The Biodiversity Metric 3.1 assigns each habitat a Temporal risk multiplier based on an estimate of the average time it takes for the habitat to reach a target condition. It is acknowledged that in many cases the actual time taken for habitat creation deviates from this average time. As with the technical multiplier, deviations depend on environmental factors relating to the site, the habitat condition, and proposed management, which are not currently accounted for within Metric 3.1.

When compared to England the time a habitat takes to develop in Scotland will vary depending on habitat type and also geographical location. As with the technical difficulty multiplier, variation in environmental conditions across Scotland brings into question the appropriateness of an average time for a habitat to reach a target condition. Variation in elevation, exposure and soil conditions will significantly impact the time habitats take to develop. For example, woodlands and shrub habitats are likely to take longer to reach target condition in Scotland due to harsher environmental conditions, particularly in upland exposed situations. Wetland habitats, on the other hand, may reach their target condition in less time in Scotland due to increased rainfall.

As with difficulty multipliers site specific factors such as exposure, aspect and elevation could be taken into account using existing spatial datasets. Additionally, techniques used to enhance or create a habitat can significantly impact on the time taken to reach target condition. When converting a raised bog from a coniferous plantation, flattening ridges in addition to tree removal and blocking ditches will result in a quicker restoration period.

Key insights and recommendations – temporal risk

- As with other risk multipliers an average multiplier for each habitat is not appropriate given the high degree of varation in environmental conditions across Scotland.

- **Recommendation 8.** Consult with key stakeholders including ecologists to validate the fitness of distincitveness, strategic significance, and risk multipliers for use in Scotland.

Landscape structure: The Scottish context

This section seeks to determine potential refinements to the Biodiversity Metric 3.1 to better account for landscape structure, and configuration. It explores options to include ecological connectivity as a multiplier.

Biodiversity is strongly driven by landscape structure, with the type and quality of habitats, their spatial configuration and ecological connectivity all coming into play. Spatially targeting habitat creation and enhancement plays an important role in achieving Scotland's vision to protect at least 30% of land and seas for nature by 2030 (30 x 30 target) and establish Nature Networks across Scotland.

Habitat connectivity could be addressed through an additional supplementary GIS tool, similar to the connectivity tool included in Biodiversity Metric 2.0. This tool was, however, abandoned as it was deemed over complicated to use. As such, any tool developed to calculate connectivity should need to ensure ease of use as a priority. A more simplified approach also adopted in Metric 2.0 involved assigning High and Very High distinctiveness habitats a higher connectivity score than all other habitats. While this would target the creation of higher quality habitats, acting as stepping stones throughout the

countryside, it does not account for spatial configuration, or habitat type. For example, a woodland habitat may enhance woodland connectivity but could act as a barrier to the dispersal of calcareous grassland or wetland specialists.

Scottish Forestry's priority areas of native woodland expansion provides comprehensive opportunity mapping for woodland creation (see below)[32]. This provides an important resource when determining strategic significance. As with Metric 3.1, allowing strategic significance to draw on ecological expertise would allow for greater flexibility in determining what is desirable in a local area. In the longer term, Scotland wide opportunity mapping for a range of habitats would help optimise benefits gained.

Habitat network analyses can help to identify current connectivity and opportunity areas where habitat creation will enhance connectivity. An Integrated Habitat Network for native woodlands[33] has been created for all of Scotland identifying current native woodland networks and primary and secondary opportunity zones for woodland creation. The resultant spatial data is currently used to help assess applications to the Forestry Grant Scheme (FGS). For the Central Scotland Green Network area, NatureScot has created an Integrated Habitat Network[34] for bogs and heaths, woodlands, grasslands and wetlands identifying primary and secondary opportunity areas for habitat creation. Additionally, at a broader scale, NatureScot have developed a connectivity indicator for these four habitats over 10 large catchments (Blake and Baarda, 2018).

With the exception of woodlands, opportunity mapping is restricted with respect to both geographical location and habitat type. A metric that heavily draws on such mapping could therefore prioritise woodland creation at the expense of poorly mapped habitats (e.g. species rich grasslands). Additional mapping – for example Buglife's B-Lines[35] could help target the creation of pollinator friendly habitats to provide connectivity across Scotland.

Where existing connectivity mapping is available, a connectivity score multiplier could be applied uplifting the biodiversity units of a habitat parcel where it is located in a primary or secondary opportunity zone, or on a B-Line. However, care would have to be taken not to disadvantage areas where integrated habitat networks, and opportunity areas, have not been identified. In such areas, approaches outlined above could be applied and connectivity uplifts given to strategic location based on proximity of habitats to existing habitat parcels, and expert judgement - as with the strategic multiplier.

[32] Scottish Forestry's Open Data portal

[33] Available via Scottish Forestry's Open Data portal

[34] NatureScot's Central Scotland Green Network map viewer

[35] Buglife's B-Lines

Developing a set of rules and guidance would help to ensure expert judgement replicable and transparent.

For aquatic habitats, connectivity uplifts could be provided for actions that remove barriers to fish migration. For example, through creating by-pass channels or pass-overs allowing fish to navigate weirs and dams. Furthermore, to target action where it is most valuable additional uplifts could be applied to surface waters (i.e. lochs, rivers, and estuaries) identified to be under pressure (available from SEPA's Water Environment Hub[36]).

Key insights and recommendations – landscape structure and systems

- **Recommendation 14.** Existing habitat network models can help identify opportunity areas to target habitat creation to optimise connectivity. Where such modelling has not been conducted more simplistic approaches could be applied.

- **Recommendation 17.** Scotland wide opportunity mapping for a range of habitats of conservation concern would optimise the benefits gained.

Results: Metric 3.1 across sectors

Introduction

The Metric 3.1 is designed specifically for use in the Planning and Development Sector. This section therefore explores how well suited Metric 3.1 to use outside of the Planning and Development sector. We will evaluate its fitness for use across three policy areas; Agriculture, Conservation and Biodiversity Monitoring, and Natural Capital Markets. We will focus on the needs of different sectors and the policy and legal frameworks that underpin requirements. This section focusses specifically on where adaptions to Metric 3.1 would be requied to ensure fitness for use outside of the Planning and Development sector. With strategic significance and risk multipliers standardised across sectors, no further adaptions would be required and they are not considered further.

Trading rules, irreplaceable habitats, and distinctiveness: Across sectors

Above we highlight that because Metric 3.1 is primarily designed for the Planning and Development sector irreplaceable and Annex 1 habitats are not adequately distinguished and accounted for. In this sector these habitats are identified during the initial Ecological/Environmental Assessment and require bespoke compensation in line with existing policy and legislation. If a Scottish Metric was applied to other sectors all irreplaceable habitats and Annex 1 habitats would need to be correctly valued. For example, currently Metric 3.1

[36] SEPA's Water Environment Hub

does not include ancient woodland as a habitat in its own right, such information would be crucial to undertake a natural capital of an estate. For consistency, it is recommended that all habitats of conservation concern are 1included within a Scottish metric. The section above on trading rules in the Scottish context considers approaches to developing trading rules.

Key insights and recommendations – trading rules

- **Recommendation 3.** Properly accounting for irreplaceable and Annex 1 habitats would be an essential requirement if Metric 3.1 was to be fit for purpose outside of the Planning and Development sector.

Habitat classification: Across sectors

UK Hab is the primary system to classify terrestrial habitats in Metric 3.1. This system is widely used by ecologists and directly relates to UK Biodiversity Plan Priority Habitats and thus the terminology is familiar to most sectors. Furthermore, UK Hab typically provides more user-friendly descriptions of habitats to non-experts than EUNIS – for example, UK Hab L4 Modified grassland relates to EUNIS L3 Permanent and mesotrophic pastures and aftermath-grazed meadows.

While EUNIS is widely used across Europe, and by NatureScot, participants from both the Conservation and Biodiversity Monitoring sector and Planning and Development sector expressed concerns in adopting EUNIS over UK Hab. For example, one comment from the Planning and Development stakeholder group was “It is important to stick with a classification approach that ecologists are familiar with - many have already switched to using UK Hab as standard. Very unusual for ecological consultants to use EUNIS, so would recommend avoiding a change to EUNIS”. This is supported by the findings of our online stakeholder poll which indicated that UK Hab was the preferred classification system for three out of four sectors; with the agricultural sector indicating that none of the classification systems were appropriate (although there was a poor response to this question) (Annex 5 Figure 19Figure 19b). To increase uptake in the agricultural sector, consideration should be given to also including an alternative habitat classification system that this sector are more familiar with (e.g. classifications used in Farm Environment Maps[37]).

Providing flexibility in the classificaiton system used, would help meet the different needs across sectors. Crosslinking different classification systems is, however, complex, and can result in habitats being misclassified (see above). There is therefore a need to ensure that crosslinks between different classification systems give sensible results.

[37] Agri-Environment Climate Scheme Farm Environment Table Template, 2023

Key insights and recommendations – habitat classifications

- **Recommendation 18.** A Scottish tool with different interfaces to allow users to switch between classification systems would provide flexibility. However, it is recognised that crosslinking different classification systems can be problematic.

Habitat Condition: Across Sectors

Here we explore how appropriate habitat condition criteria are across our policy sectors. Additionally we cross reference Metric 3.1 condition assessments with other assessments currently being developed in Scotland.

The criteria used to assess habitat condition will vary between sectors. The Conservation sector are likely to use the tool for site condition monitoring of statutory sites designated through UK legislation and international agreements. This monitoring would require specialist ecological input and would need to align directly with JNCC's Common Standards Monitoring - thus requiring greater detail than is captured in Metric 3.1. The agricultural sector, on the other hand, would favour participatory approaches that engage land managers and promote adaptive management. For this sector, condition assessments would need to be easily undertaken by non-experts following basic training, yet they should still accurately reflect habitat quality. NatureScot's Piloting an Outcomes Based Approach in Scotland (POBAS) could provide important insights into how this balance can be met. For rivers the MoRPh citizen science component could provide appropriate assessment criteria for the agricultural sector.

Even within a sector the appropriate level of detail will vary depending on the tool use. Use in the Natural Capital sector may vary from robust baselining of biodiversity to enable the selling of biodiversity units, or alternatively a cruder approach could be adopted using remote sensed data to provide a rough estimate of Natural Capital stocks. Similarly, in the agricultural sector a baseline biodiversity audit is likely to focus on type and extent of habitats - in such instances average habitat condition scores could be applied as with Natural England's Small Site Metric 3.1. Whereas when dealing with Outcome Based Approaches to Agri-environment and Climate Schemes, more detailed assessments would be required to accurately reflect habitat quality.

With respect to the agricultural sector, condition assessment criteria align relatively well with forthcoming assessments (i.e. habitat score cards under development in POBAS and NatureScot's Natural Capital Assessment trial). For example, criteria for Grasslands of Low Distinctiveness are similar to NatureScot's Natural Capital Assessment. The later, however, also includes additional criteria relating to soil health and grassland management. Similarly, the criteria for Hedgerows also overlap with NatureScot's POBAS scorecard with respect to hedgerow structure, however, there are differences. Metric 3.1 includes criteria relating to the vegetation at the base of the hedgerow while NatureScot's scorecards include aspects relating to management (e.g. cutting frequency and inclusion of bird boxes). In some instances, condition criteria do

not align well with forthcoming assessments. For example, criteria to assess Heathland condition deviate considerably from those in NatureScot's Natural Capital Assessment. It is important to note that the above NatureScot assessments are in development and may change based on trials and feedback.

Metric 3.1 does not provide any condition criteria for Arable or Horticultural land, including field margins, intensive orchards and temporary grass and clover leys. Arable field margins are included in the Scottish Biodiversity List highlighting their importance to biodiversity. Furthermore, these habitats provide ecosystem services that underpin food production (e.g. pollination services, natural pest regulation). The inclusion of condition criteria for Arable and Horticultural land would be fundamental for the agricultural sector and these could align with POBAS scorecards, and NatureScot's Natural Capital Assessment. The food production value of arable and horticultural land will help to ensure that increasing the biodiversity potential of this habitat will not result in direct competition with semi-natural habitats.

Key insights and recommendations – habitat condition

- **Recommendation 19.** Different condition assessment criteria would be required to meet the needs of different sectors and uses within a sector. In some instances, the use of average condition scores may provide an alternative to on the ground assessments.
- **Recommendation 20.** Provide guidance and training to support sectors in tool use and in conducting on the ground surveys.

Building on Metric 3.1: Across sectors

Our stakeholder workshop indicated that ecological connectivity was the most important landscape aspect to consider for the Planning sector and alongside ecosystem health it was also of primary importance to the Natural Capital and Conservation sectors (Annex 5 Figure 19c). Enhancing ecological connectivity and promoting habitat diversity will require key stakeholders to work together to co-design landscapes that work for biodiversity and people. A common framework will help to align different policy sectors, allowing different funding streams to be integrated to ensure benefits are maximised.

Stakeholder workshops highlighted that farmland cannot simply be viewed as individual land parcels and agriculture very much adopts whole systems approaches. A diversity of different management practices impact on biodiversity including crop rotation, use of agro-chemicals, tillage practices, frequency and timing of operations, drainage and grazing management. These factors influence habitat condition and can enhance both spatial and temporal heterogeneity within the landscape. Metric 3.1 does not consider management practices and rotation, but they are considered in NatureScot's POBAS and Natural Capital Assessments. To ensure that a Scottish metric meets the requirements of the agricultural sector, system-based aspects and criteria to assess the condition of cropland should be included.

Workshops also identified ecosystem health as a priority to all sectors and indicator/priority species as a priority to the Conservation sector (Table 2). Future development of a Scottish metric should consider how these aspects could be incorporated.

Key insights and recommendations – landscape structure and systems

- **Recommendation 21**. Account for system based approaches to meet the end needs of the agricultural sector.

- **Recommendation 22**. Consider how aspects relating to species and ecosystem health could be incorporated within a Scottish metric**.**

Metric 3.1 Appraisal: Conclusions

The need to develop a standard means to account for biodiversity in Scotland is recognised across stakeholder groups. Metric 3.1 provides a potential framework that has undergone significant testing and reviews in England. With refinement, Metric 3.1 is largely applicable for use in the Planning Sector in Scotland and several companies are using adapted versions of Metric 3.1 in Scotland to them to account for biodiversity during site development. Current users provide key insights into useability and potential adaptions. With strong alignment between Planning and Natural Capital, following adaptions this metric would be fit for purpose for both sectors.

To ensure that multipliers and habitat condition assessments are appropriate for use in Scotland, we would recommend these are comprehensively reviewed by a team of stakeholders including ecologists with experience of specific habitat types. The integration of different multipliers can result in inappropriate results. For example, incentivising the creation of poorer quality habitats, or penalising action to restore a low distinctive habitat to a higher distinctive habitat. Industry have also indicated that, when integrated, the risk multipliers can be over cautious. In an example considering intertidal habitats, West et al (2022) found that 10% BNG required substantially larger areas of habitat creation in comparison to compensation for habitat loss under the Habitats Regulations where a simple ratio of area of habitat created to habitat lost of 2:1 was considered acceptable. There is therefore a need to review how risk multipliers interact, to ensure that the biodiversity units calculated are appropriate and incentivise the creation of good quality habitats. We therefore recommend that any Scottish metric is tested by practitioners, exploring a range of realistic scenarios and case studies to ensure that it is fit for purpose.

With respect to future improvements, risk multipliers in Metric 3.1 are currently set as average values based on habitat type. It is recognised that environmental conditions vary considerably across Scotland, and that site specific factors such as elevation, deer densities, soil type, hydrology could be taken into account. Additionally, aspects relating to implementation and management plans for habitat creation and/or enhancement could also be considered when accounting for risks.

For use outside of the planning sector, it would be essential that all irreplaceable and Annex 1 habitats are included and correctly valued in a Scottish metric. If future uses in Scotland, were to expand to the Agricultural and Conservation sectors further refinements would be required particularly when it comes to condition assessments. For agriculture these should allow for farmer-friendly participatory monitoring, include condition assessments for cropland and reflect system-based approaches such as rotation, and management.

The outputs derived from a Scottish metric should be widely accessible, however, to meet the needs of different sectors a Scottish tool would have to accommodate different levels of ecological expertise. From more detailed assessment targeted to the planning and conservation sectors, to participatory approaches targeted to the agricultural sector. This could be achieved through different interfaces, or a suite of tools targeted to different sectors and uses. This would allow us to utilise current tools under development (e.g. NatureScot's POBAS scorecards).

There is huge potential for trading of Biodiversity Units between sectors. To foster this a common currency is needed. This could be achieved through having a single metric with different interfaces, aligning the calculation of biodiversity units across tools, or using the biodiversity equivalent of an exchange rate. We need to however consider how sector specific tools could align to provide a common currency for Biodiversity.

Stakeholders in Scotland highlighted the importance of including ecological connectivity in a Scottish metric and this fits with Scottish Government's ambitions to create Nature Networks across Scotland. Connectivity could be integrated within a Scottish metric using opportunity mapping where available, expert judgement and proximity to existing habitats. Additionally, ecosystem health was identified as a priority across sectors and there is a need to identify how this could be integrated into a Scottish metric.

Overall, our findings indicate that with refinements the Natural England Biodiversity Metric 3.1 would meet the needs of the Scottish planning sector. A range of refinements are recommended which vary in ease of implementation and urgency with some recommendations deemed necessary prior to release, while others are deemed desirable in the longterm (

Table 13). Similar to the Natural England Metric 3.1, a Scottish metric would have to be tested and validated and be adaptable, and evolve based on user-feedback. Following release regular consultation and reviews are therefore recommended.

Outside of the planning sector, a suite of sector specific tools would help ensure greater functionality. The metrics that these tools measure should be underpinned by science, and ground truthed, whilst ensuring that growth and development is not unduly stifled. Outputs should be accessible to all and

calculations transparent to prevent the risk of green washing. The metrics adopted should have a means of standardising Biodiversity units across sectors to permit and encourage trading between sectors.

Table 13: Overview of key recommendations including urgency for implementation for use in planning, and if the Metric was to be adapted for different policy sectors. Darker shades indicate the degree of urgency, this may be high (H), medium (I) or long term (E). Information on perceived difficulty of each action is also provided, and darker shades indicate the degree of difficulty, this may be high (H), intermediate (I) or relatively easy (E)

Recommendation		Urgency Planning	Urgency other sectors	Difficulty
Technical requirements				
1	Ensure that the User Guide/Technical Annexes are fit for Scotland	H	H	E
2	Create a list of irreplaceable habitats in Scotland	H	H	E
3	Ensure all irreplaceable and Annex 1 habitats are included and correctly accounted for	H	H	I
4	Identify a solution to ensure that peatlands are correctly accounted (i.e. through consultation with industry and peatland experts)	H	I	I
5	Explore the potential to base trading rules on habitat distinctiveness and condition	I	E	I
6	Ensure crosslinks between Phase 1 and UK Hab are fit for purpose	H	I	E
7	Determine the extent and suitability of existing spatial datasets	H	H	H
8	Determine appropriateness of all multipliers (i.e. distinctiveness, strategic significance, risk multipliers) (e.g. workshops, expert elicitation)	H	H	E
9	Determine appropriateness of habitat condition assessments (i.e. consultation with habitat experts)	H	H	E
10	Review local strategies to ensure they are suitable to assign strategic significance. Provide guidance to assist in adapting local strategies.	I	I	H
11	Allow for flexibility in assigning risk multipliers to reflect site conditions and proposed implementation plans	H	H	E
12	Explore the potential to integrate spatial datasets to alter risk multipliers to better reflect site specific risks	E	E	H
13	Identify an appropriate means of assigning spatial risk in Scotland	H	I	E

Recommendation		Urgency Planning	Urgency other sectors	Difficulty
14	Identify means of integrating ecological connectivity into a Scottish Metric	I	I	I
Supporting requirements				
15	Assess Scotland's capacity to deliver on the ground surveys and determine potential skills gap (e.g. surveyors competent in UK Hab, MoRPh River assessment accreditation).	H	E	I
16	Assess Scotland's capacity to deliver from a regulatory perspective and provide training and clear guidelines	H	E	I
17	Undertake Scotland wide opportunity mapping for a range of habitats to better account for ecological connectivity	E	E	H
Adaptations to increase usability across sectors				
18	Provide different interfaces to allow a range of classification systems to be used	E	H	I
19	Provide condition assessment criteria to meet the needs of different sectors and uses.	E	H	I
20	Provide guidance and training to support sectors in tool use and assessments.	E	H	I
21	Include management/systems aspects to meet the needs of the agricultural sector.	E	H	I
22	Consider how species and ecosystem health could be incorporated	E	E	H

H	Urgency high: prior to release High difficulty	I	Urgency medium <3 years Intermediate difficulty	E	Long term 3+ years Relatively easy

Results: Sense checking workshop

Poll results are integrated into Results: Metric 3.1 Applicability Scotland above. Key findings from the Padlet exercise are summarised below.

What should we avoid in a metric?

The inclusion of species provided some nuance in the comments. It was expressed that a metric should not focus on a single species as this misses out the measurement of broader ecosystem health. Species were considered important, suggesting that multiple species measures or indicators are desirable. Different taxa, however, operate at different spatial scales, with plant communities reflecting site level impacts whereas bird communities reflect landscape level impacts, this adds further complexity with the most appropriate species depending on the scale of impact. Given the urgency of developing a metric to inform decision making, delayed implementation whilst waiting for the ideal species measure should be avoided.

This latter point on urgency related to a broader theme of not immediately seeking perfection in a metric. A metric or tool should be able to evolve over time, reflecting changing guidance and advice. It should also recognise the importance of simpler habitats that can be easily restored or created. This contrasts with 'higher value' more complex habitats that may also be riskier to achieve. The metric should avoid being too prescriptive about how biodiversity uplift can be achieved. Approaches may need to differ across sites with general uplift better than very specific, focussed, improvements. Inflexibility was also raised as an issue with respect ecosystem changing in response to future drivers (e.g. climate change).

While both urgency and a need for flexibility came across as important, it was also recognised that there is a "need for robust sensitivity testing before publishing a metric/suite of metrics. Otherwise unintended consequences are possible". At site level, this may also need to consider what data are readily available or collectable. There is therefore the requirement to balance the urgent need for a metric, particularly within the Planning and Development sector, with ensuring that it is accurate and fit for purpose. The later will be crucial to ensure widespread adoption. Drawing on the experience of practitioners who are already utilising metrics to measure biodiversity net gain in Scotland would help identify potential issues that could be encountered.

The potential of under valuing habitats was raised with respect to both the importance of retaining existing habitat where possible (in a development context) and recognising the value of some degraded habitats with potential high innate biodiversity value such as native woodlands. The biodiversity value of transitional habitats was also mentioned as important, but not considered by existing metrics. In contrast, it was noted that encouraging lower condition or less distinctive habitat creation may encourage cheaper biodiversity credits, and should be avoided. The connectivity of existing

habitats within their local contexts should also be considered. It is also recognised that simplification of landscapes is a key driver of biodiversity declines and there is a potential risk that if “one or two habitats 'gain more points' than others, this could create more homogenous and inappropriate restoration projects”. Connectivity should also be included, avoiding a focus on site level action. It was recognised that this may not be immediately possible, but part of future updates to a metric as nature networks are developed. Consideration should therefore be given to ensure a landscape perspective is taken which focuses on spatially targeting a diversity of measures to optimise benefits gained.

Complexity was raised by several participants. A metric should be understandable and transparent to all users, not just ecological specialists. This was raised with respect to ensuring that the metric is understandable for planners who will be tasked with decision making based on the metric outputs. In contrast, it should not be too simplified, preventing it from capturing ecological processes and changes. Clearly it is important to get the balance right between ensuring that a metric is robust and that it provides a reliable and quantifiable way to measure biodiversity, against making sure that it is user-friendly with outputs that are meaningful to non-experts.

Linked to that, it should be possible to ‘unpack’ and ‘look under the hood’ to interrogate and analyse these processes, ideally in a way that does not exclude lay-persons understanding. This ties in with the findings of our first stakeholder workshop with all sectors prioritising the need for a metric to clear, concise and transparent. Transparency will be critical to avoid abuse and our stakeholder workshop highlighted concerns with respect to ‘greenwashing’ and ‘gaming’.

Pros and cons: Risks associated with habitat creation

Habitat creation risks can be considered in terms of both the length of time required to achieve target condition and the impacts of how those risks are treate within a metric. These are summarised in Table 14. Longevity was raised as a concern from multiple perspectives with long-term management, monitoring and protection of habitats at risk particularly given changing tenure of both the site and adjacent areas. To ensure that changes in land use have positive effects for biodiversity outcomes should be monitored in the long term and action taken where shortfalls are identified. Climate risks could also be included in longer term assessments.

Standardisation of approaches to assigning risk was seen as both a potential pro and a con. If there is flexibility over risk factors, there is the potential for abuse. For example, from a developer’s perspective altering risk multipliers to reflect a lower risk of habitat creation would result in a higher allocation of biodiversity units. There is also the potential to have standard multipliers as with Metric 3.1, but allowing greater flexibility to change these multipliers with justification given. However, any change would need verification to assess appropriateness and this would require additional resourcing from decision

makers. Standardisation of assigning risk multipliers would help to prevent abuse and mitigate the need for additional verification. However, inflexibility means that risks cannot reflect site specific contexts but here changes could be made where supporting evidence is available. Standardisation also risks the use of similar approaches resulting in more readily achievable habitat types and measures.

There is the potential to assign some risk factors based on existing spatial datasets (e.g. elevation, aspect, soil type, deer numbers, hydrology) or simple drop down menus that could be easily verified (e.g. presence of deer fencing). Additional environmental information was also suggested. Indicators of soil health and condition could inform wider habitat condition.

The approach taken to assign risk should also not discourage action that is likely to yield the greatest benefits for biodiversity, even if these benefits take a while to come to fruition. Creation of more distinctive and better-quality habitats may be avoided due the higher risks and longer time frames associated with habitat creation. This was noted with respect to the current Metric 3.1 risk multipliers for peatland restoration and woodland creation. Consideration is needed to determine how risk multipliers integrate, to ensure that a metric incentivises the creation of good quality, highly distinctive habitats.

Pros and cons: Having a single metric across all sectors

The key themes that emerged from this question were around simplicity and standardisation, reflecting the complexity of ecological processes, and the needs of different sectors. These are summarised in Table 14

Standardisation was considered to have the advantage of providing consistency and comparability across sectors and applications allowing for a standardised means of trading or monetising biodiversity. Potentially, this would also aid understanding across end-users, allow for cross-sector training and cost-efficiency in governance. One stakeholder comment indicated “a single metric, used by all developers, planning authorities and other stakeholders in planning decisions, is required to ensure it is widely understood and applied to provide clarity and certainty for all users”. Furthermore, a standardised approach would enable use to expand beyond development to encompass wider land use change.

However, it was also recognised that needs differ across sectors – “no one-size-fits all”. The relative value or importance of habitats may vary across sectors, with other key differences including the scales of application and the skill levels of those undertaking assessment. Developers are more likely to engage ecological specialists, whilst the agriculture sector may rely on self-completion by farmers. Indeed, raising awareness of biodiversity through participatory monitoring and facilitating adaptive management to improve outcomes are key to the agricultural sector.

There was concern that adopting a single metric for all sectors could result in a lowest common denominator approach that may be oversimplified or general. One participant expressed the following concern “If one metric is designed to do too many things it will often dilute the primary purpose. Does it measure biodiversity, or food production, of people connection to nature (which can be detrimental to wildlife)”.

The complexity of biodiversity and ecosystem functions was also reflected on as a reason why a one-size-fits all metric or approach may not always be appropriate. This included the need to consider wider ecological connectivity.

It was recognised that while a common approach should be taken, that this approach does not necessarily require a single metric. Instead, a standardised approach could be achieved through a suite of metrics tailored to sector needs.

Table 14: Pros and cons of habitat creation risks and a single metric

	Pro	Con
Risks associated with habitat creation	• Standardisation – flexibility in assigning risk multipliers can reflect site specific contexts • Flexibility could encourage creation or restoraiton of more distinctive habitats	• Longevity – changing land tenure on site and adjacent areas • Long term monitoring required • Standardisation – flexibility in assigning risk multipliers could result in abuse (over claiming units) • Inflexibility could encourage creation or restoration of lower distinctivness habitats
Single metric	• Consistency and comparability across sectors • Aid end-user understanding • Cost-efficiency in governance and training	• Differing sector needs • Varying importance of habitats across sectors • Differing scales of development and skill levels across sectors

- Lowest common denominator approach
- May not capture the complexity of biodiversity

What is important with respect to ecosystem health?

The main themes identified from this question were around ecosystem health. A healthy ecosystem can be characterised as having a high level of functioning (and thus capacity to deliver ecosystem services) and with the ability to withstand and spring back from external pressures. Ecosystem functioning was associated with terms such as integrity of ecosystem processes, condition and species richness and diversity. This indicates a broad-based measure is needed. Ecosystem health is closely related to functionality, with terms used including the 'degree of naturalness' and having a presence of taxa across trophic levels. Baselining was also mentioned as being necessary to understand what is healthy for a particular system.

Resilience was mentioned with respect to future environmental changes such as climate change. The need for long-term thinking to ensure "genuine uplift and long-term sustainability" was recommended. Biodiversity provides an insurance against environmental change, helping to safeguard the delivery of ecosystem services. In particular, the importance of soil biodiversity in underpinning ecosystem functioning was highlighted. Several comments recognised that habitats provide a range of ecosystem services including carbon storage, flood management, biodiversity, connectivity and heat regulation. With land being finite, we should capitalise on multi-functionality through stacking of ecosystem service delivery. Thought however needs to be given to how emerging markets (e.g. carbon and biodiversity) can be integrated and governed to ensure additionality whilst supporting multi-functionality (e.g. through a biodiversity uplift to carbon credits).

Linked strongly to resilience is the restoration of ecological connectivity and the creation of Nature Networks across Scotland. Enhancing connectivity facilitates dispersal, increasing genetic mixing between populations and reducing risks associated with inbreeding depression. Furthermore, connectivity facilitates movement through the wider countryside helping species meet their resource requirements and adapt to environmental pressures, including climate change.

Conclusions: Sense checking workshop

While requirements of a tool will differ across sectors, stakeholder workshops conducted as part of this project highlight some common ground. All sectors prioritised a tool that is meaningful to all sectors and that provides a clear, concise and transparent means of accounting for biodiversity. Stakeholders

also put value on a tool that is scientifically robust and comparable across habitats and sectors.

The workshop highlighted the need for a standardised framework to account for biodiversity, with this need being particularly urgent for the Planning and Development sector. The urgency for a Scottish metric must, however, be balanced with a requirement to ensure that the metric is fit for purpose across Scotland. While it is recognised that perfection is not required from the onset, it is recognised that launching a metric with fundamental flaws could alienate stakeholders, reducing uptake. Flexibility and adaptability could provide key strengths in a Scottish metric, particularly given the breadth of environmental conditions experienced in Scotland. However, with greater flexibility comes the potential for abuse and an increased workload associated with the need to validate any changes made.

To optimise the impacts, consideration should be given to expanding beyond the site level to consider landscape structure and configuration. Enhancing landscape diversity and ecological connectivity is key to ensuring positive effects on biodiversity, and long-term monitoring will be critical to verify impacts and guarantee extended legacy. Furthermore, adopting a landscape approach can help to ensure actions are spatially targeted to optimise not just biodiversity outcomes but promote multi-functional land use. Consideration should be given to identify how ecosystem service markets can be integrated and governed to supporting multi-functionality whilst ensuring additionality.

All sectors prioritised the need for biodiversity metrics to be clear, concise and transparent and adopting a standardised framework to biodiversity accounting would ensure consistency and comparability across sectors. It is however recognised that different sectors require different things from a metric with respect to ecological expertise, complexity and level of detail. Consequently, while a standardised framework is beneficial, a single metric is unlikely to be the best way to achieve this. A single tool is unlikely to meet the demands of all sectors and stakeholders expressed concerns that this will result in an oversimplified metric which does not accurately reflect biodiversity or ecosystem health. Thus, it is proposed that a suite of tools tailored to the needs of different sectors is preferable. These tools should, however, be underpinned by a common framework to ensure that the outcomes are comparable, and to facilitate cross-sector trading.

Recommendations

In this section we will summarise the findings of our review of existing metric and tools, the detailed review of the Biodiversity Metric 3.1 and stakeholder consultations in terms of recommendations for the biodiversity measurement approach for Scotland. This will be split between an overall approach and specific adaptations to Biodiversity Metric 3.1.

It was evident from the overall metric review that there is no one-size-fits all approach to measuring biodiversity. In particular, the tools use a variety of ways to measure biodiversity that are not always comparable or adequately capture the full range biodiversity functions in terms of habitats, species and ecosystem health or functioning. Many of the tools reviewed use proxy measures of biodiversity based on established or modelled relationships between habitat disturbance or land use intensity and species abundance.

1. Recommendation for an overall biodiversity framework

There were both consensus and divergencies in priorities across the four policy areas. To meet the needs of all four sectors, a biodiversity measurement approach or metric will need both common features and some degree of flexibility in its application.

As no single metric or tool meets the needs of all sectors, we recommend that a common framework is developed. This framework should be flexible with respect to the metric or metrics selected, and the tool or protocol used to measure the chosen metric/s. The framework should enable outputs to be tailored to end-use, allow for benefits to be quantified through baselining/benchmarking and permit trading between sectors where desirable.

Our suggested framework is summarised in Figure 1313 and 14. In terms of the four policy sectors considered in this report we would place farm biodiversity audits as requiring the least stringent or robust measurement of biodiversity depending on their relationship to policy and payments. This should still be meaningful but targeted towards participatory monitoring which is achievable with basic training and resources. For example, habitat condition assessment could be qualitative rather than quantitative. More complex approaches would be appropriate for higher tiers of farm payments including outcome based approaches. When qualitative approaches are used, there is a need to demonstrate clear alignment with more quanitative measures.

In contrast, high integrity ecosystem markets such as biodiversity credits would require more robust quantification using a broader selection of indicators to fully capture biodiversity.

Applications to planning and development may fall within this spectrum using a common approach such as an adjusted Biodiversity Metric 3.1, the level of detail and precision required might reflect the scale or impact of development

being considered. Impact in this respect could include the distinctiveness or significance of habitats and ecosystems affected by development.

Biodiversity monitoring and reporting has a role in informing and recording indicator data across a range of applications including the three other policy sectors. The degree of complexity of monitoring metrics within the framework would reflect the purpose for collection, who is collecting and the priority of the habitat, species or ecosystem.

The development of monitoring metrics and their associated tools should be an iterative process, involving testing and refinement following feedback to ensure the tools evolve.

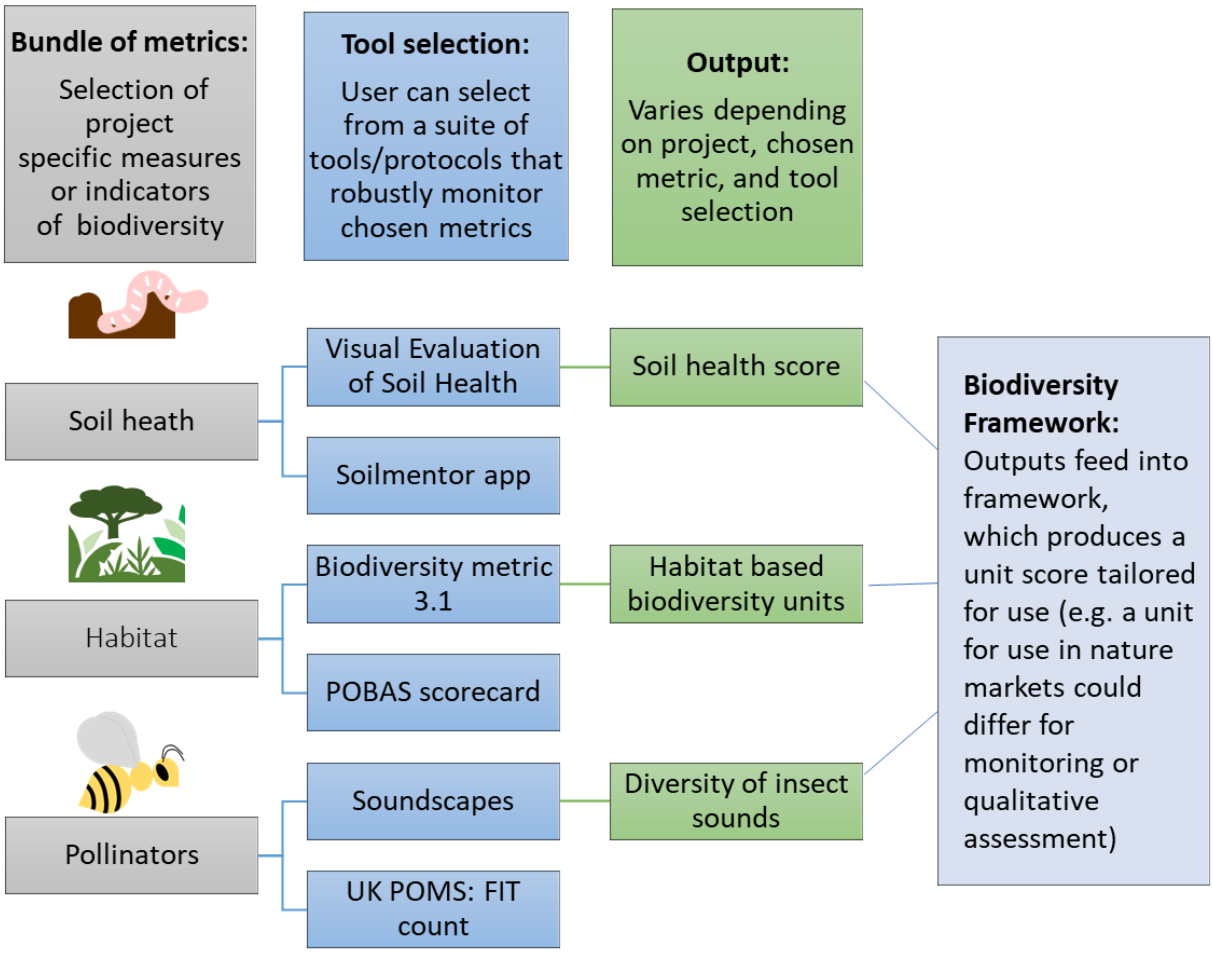


Figure 12: Potential framework that adopts a flexible approach to the choice of biodiversity metric/s and the tools to monitor these metrics

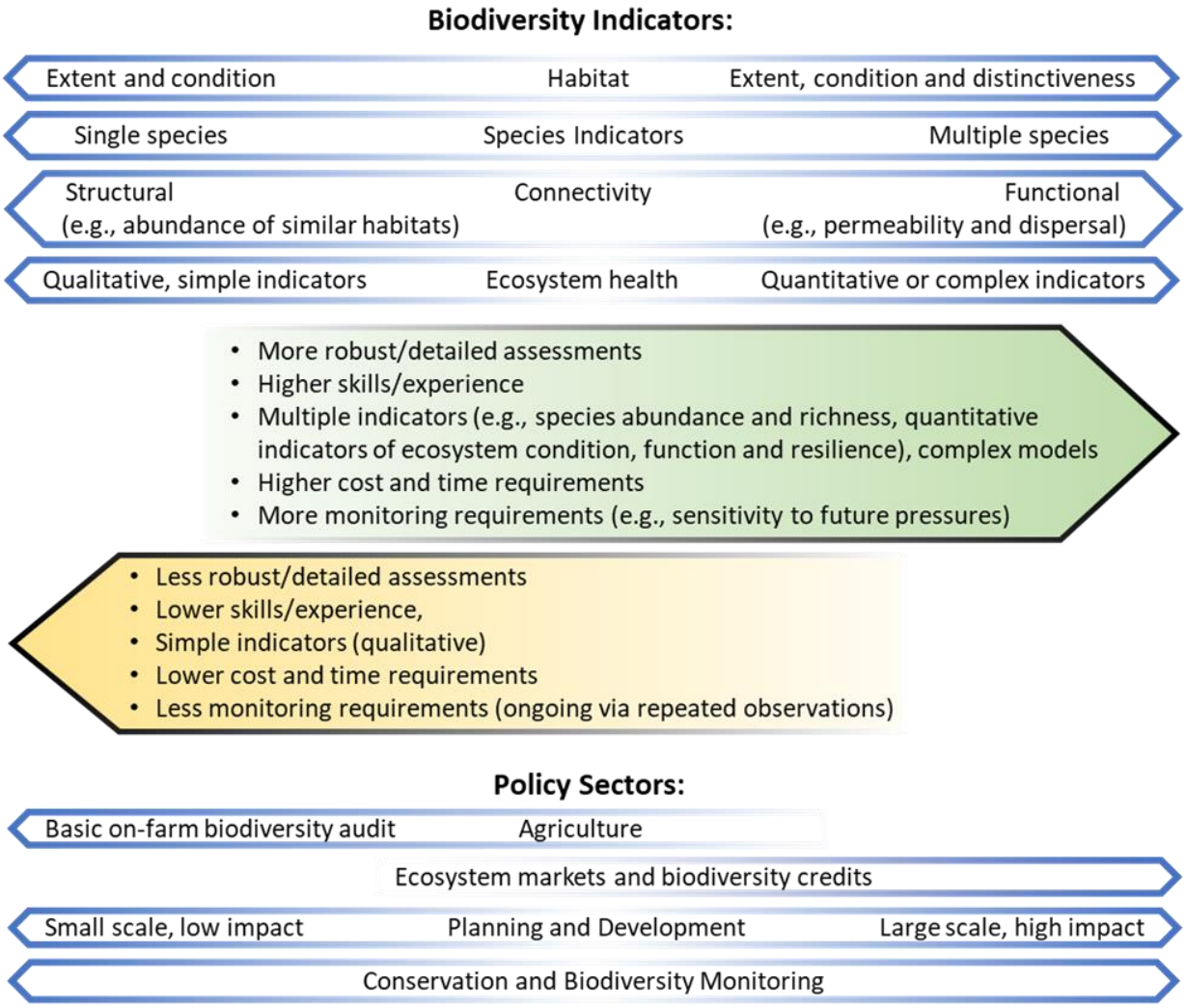


Figure 13 Biodiversity metric framework illustrating increasing complexity of assessment from left to right across the range of biodiversity indicators (top) and policy sectors (bottom).

The main recommendations related to an overall framework are:

i. To meet the needs of all four sectors, a framework, or standard, is needed that integrates multiple metrics or tools to monitor biodiversity.

ii. This framework needs to provide consistent results, while allowing flexibility in its application so metrics and tools within the framework could be tailored depending on different user or policy needs.

iii. Priority biodiversity indicators include the extent, condition and distinctiveness of habitats; species; ecological connectivity; presence of irreplacable habitat; and ecosystem health and function (see Recommendations 2, 3 and 4 below)

iv. It is important that the approach to biodiversity metrics be accessible, understandable, and flexible in how it is applied across different uses or spatial scales (see Recommendation 6).

v. Biodiversity metrics for Scotland should be clear, concise and transparent, and scientifically robust in terms of measurability (see Recommendation 6).

vi. Biodiversity metrics for Scotland may benefit from certain elements from existing metrics, but existing metrics do not address the full list of priority criteria identified by stakeholders.

vii. With refinement, Biodiversity Metric 3.1 could be adapted for planning and development use, and as part of a wider set of metrics within a biodiversity framework (see Recommendation 8).

2. Habitat and Species Metrics

i. Habitat based metrics should be included, and should characterize extent and condition, and ideally some indication of significance or distinctiveness.

ii. Irreplaceable habitats should be identified and assessed accordingly within the metric (e.g. through the use of strict trading rules, see Recommendations 8.v. and 8.viii below).

iii. Use of different habitat classification systems should be flexible to meet the needs, skills, and training of end-users. Appropriate correspondence tables should be used or developed to allow translation between classifications (e.g. UK Hab to EUNIS). See also Recommendation 8.vi.

iv. Assessments of habitat condition whilst drawing on a common framework should be tailored to meet the needs of different end-users and the objectives of the scenario.

v. Species-based metrics should reflect the presence of indicator species and the diversity of species or taxa. The choice of species should reflect the context in which a metric is being used.

3. Connectivity Metrics

i. Connectivity should be included in the framework. Current metrics include this in different ways, including the modelling based on surrounding land uses and habitat permeability, the presence of features such as linear corridors between habitat patches, or the extent of similar habitats in the surrounding area.

ii. NatureScot have developed a connectivity indicator for Scotland (Blake and Baarda, 2018). However, this is currently produced for four

habitats38 over 10 large catchments and it may therefore be necessary to expand the range of habitats included and to calculate connectivity at smaller scales, for example to reflect development site contexts. In such instances, existing habitat network modelling (e.g. Buglife's B-Lines, NatureScot's Opportunity mapping) could help target habitat creation to optimise connectivity.

iii. Further research is recommended to determine appropriate connectivity measures across different habitat and land use contexts and scales.

4. Ecosystem function, health, and integrity Metrics

i. Ecosystem integrity, functionality or health should be included. Scotland's Environment[39] outlines three broad elements included in the Scottish ecosystem health indicators: condition, function, and resilience.

The Scottish ecosystem health indicators may not be appropriate for application in a Scottish biodiversity metric or framework as they reflect a range of nationally available data and report at national scale. But indicators could be selected to reflect condition, health and resilience.

We recommend that suitable ecosystem health indicators should be identified for different habitats and land uses reflecting these three elements. Soil health indicators should be included where appropriate.

ii. Ecosystem health and diversity in an agricultural context should consider the wider system. For example, taking a whole farm approach that includes crop diversity, rotations, management intensity, and abundance of semi-natural or landscape features (these are included in some metrics as indicators of connectivity).

5. Monitoring

i. Chosen metrics or indicators should be amenable to ongoing monitoring or repeated estimation and reflect current and future pressures. This means they should be sensitive to and able to reflect changing impacts.

ii. Scoring systems for future biodiversity should also be sensitive to changing pressures (e.g. climate change, disease and pest risks).

6. Scientific robustness and transparency

i. Chosen metrics or indicators should have a robust scientific basis and provide meaningful measures of biodiversity and/or ecosystem function. They should be clear, concise and transparent, ensuring a standardised

[38] Fen/marsh/swamp, heathland, semi-natural woodland, semi-natural grassland

[39] Scotland's Environment: Ecosystem health indicators

framework that allows interrogation to reduce the risk of green-washing or gaming.

ii. The methodology used to estimate biodiversity units should be accessible and published to aid transparency and understanding. This does not preclude the use of proprietary models and tools. Indicator data should ideally be open access. This would aid replicability and ongoing improvement of biodiversity metrics.

iii. Metrics should avoid oversimplification and the requirement to use experienced and trained staff may be unavoidable in some cases. However, light touch approaches, including use of citizen science and participatory monitoring, may be appropriate for applications such as farm biodiversity audits. Guidance and training should be appropriate for the range of users and applications.

iv. Comparability across sectors and habitats would allow for biodiversity uplift to be confirmed across applications. This would also aid tradability.

7. Wider ecosystem services

Wider ecosystem services benefits should be considered. Stakeholders commented on the desirability to include wider ecosystem service benefits within a biodiversity metric framework. We note that this has been captured to some extent by Natural England's Environmental Benefits of Nature (EBN) tool[40]. The EBN tool is designed to work alongside the Biodiversity Metric 3.1 and provides a qualitative assessment of the impact of net gain actions across a range of 18 ecosystem services, evaluated at 1, 10 and 30 years from implementation. Review of the EBN was outside the scope of this study, but it may be adjusted to reflect Scottish circumstances and applications.

8. Recommendations for adjusting the Biodiversity Metric

Our review of Natural England's Biodiversity Metric 3.1 identified a number of recommendations to ensure it is fit for purpose in Scotland. These are listed in

Table 13 and are summarised below.

The Biodiversity Metric was designed for application in the planning and development sector to explore options to deliver BNG. As such it is not fully applicable to other policy sectors considered in this report. With refinement it would be appropriate for planning and development, and as part of a wider set of metrics. It's user friendly output and familiarity to developers and consultants is beneficial.

[40] Natural England's The Environmental Benefits from Nature Tool - Beta Test Version

i. Ensure that the User Guide/Technical Annexes are fit for Scotland

ii. Create a list of irreplaceable habitats in Scotland. The list of irreplaceable habitats should reflect Scottish circumstances. These should be determined via consultation with industry, regulatory bodies, and ecologists.

iii. Ensure all irreplaceable and Annex 1 habitats are included and correctly accounted for. All Scottish habitats on Annex 1 and the Scottish Biodiversity list should be included in a Scottish Metric and be given a Very High Distinctiveness rating.

iv. Identify a solution ot ensure that peatlands are correctly accounted for (i.e., through consultation with industry and peatland experts). Consultation should help identify a solution for dealing with peatlands in large scale upland developments.

v. Explore the potential to base trading rules on habitat distinctiveness and condition.

vi. Ensure crosslinks between Phase 1 and UKHab are fit for purpose. The UK Hab classification system was favoured by stakeholders as this reflects a known nomenclature and existing experience and training of ecologists. However, not all ecologists are trained in UK Hab, and this nomenclature is not commonly used by the agricultural sector. A Scottish Tool with different interfaces that allow users to switch between classification systems would provide flexibility. However, it is recognised that crosslinking different classification systems can be problematic.

vii. Determine the extent and suitability of existing spatial datasets. Review the accuracy of existing spatial datasets and determine their suitability for use in biodiversity calculations.

viii. Determine appropriateness of all multipliers (i.e., distinctiveness, strategic significance, risk multipliers) (e.g., workshops, expert elicitation). Habitat distinctiveness could be determined using similar/or identical methodologies to those adopted in Metric 3.1. A gap analyses is recommended to determine where spatial data is lacking. Distinctiveness ratings are largely applicable to Scotland, there are, however, instances where these are not appropriate and these should be reviewed by a panel of experts.

With respect to strategic significance, spatial datasets such as opportunity mapping could underpin the development of a standardised reference to spatially target habitat creation. Local strategies have not been formulated with biodiversity accounting in mind, and consequently local authorities may have to review such strategies to ensure suitability.

Due to the variation in environmental conditions across Scotland, average risk multipliers based on habitat type are inappropriate. Greater flexibility in the assignment of risk multipliers to reflect site conditions is recommended. Existing spatial datasets and information on proposed actions could be used to refine risk multipliers.

Spatial risk multipliers are in line with the aims of NPF4 to enhance biodiversity in a way that reduces inequalities. With respect to Scotland, spatial risk multipliers based on Landscape Character Types are more appropriate than those based on Local Authority boundaries. In following natural landscape boundaries, Landscape Character Types are more aligned to landscape scale initiatives. Consideration should also be given to a simple approach that calculates connectivity as an addition to spatial risk.

Consideration should be given to how different risk multipliers (i.e. spatial, temporal and technical difficulty) interact to ensure that the biodiversity units calculated are accurate and incentivise the creation of good quality habitats. We recommend working with practitioners to test a range of realistic scenarios and case studies to ensure that the metric is fit for purpose.

ix. Determine appropriateness of habitat condition assessments (i.e., consultation with habitat experts). Habitat condition assessment approaches were drawn from UK standards and are largely appropriate to Scotland. It is recognised that slight differences may occur, and it is therefore recommended that condition criteria are assessed by habitat experts.

x. Review local strategies to ensure they are suitable to assign strategic significance. Provide guidance to assist in adapting local strategies.

xi. Allow for flexibility in assigning risk multipliers to reflect site conditions and proposed implementation plans.

xii. Explore the potential to integrate spatial datasets to alter risk multipliers to better reflect site specific risks.

xiii. Identify an appropriate means of assigning spatial risk in Scotland.

xiv. Identify means of integrating ecological connectivity into a Scottish Metric (see Recommendation 3 above). Ecological connectivity is considered important to most sectors and should be included in a Scottish metric. Habitat network modelling can help identify opportunity areas to target habitat creation to optimise connectivity. Where such modelling has not been conducted more simplistic approaches could be applied.

xv. Assess Scotland’s capacity to deliver on the ground surveys and determine potential skills gap (e.g. surveyors competent in UK Hab, MoRPh River assessment accreditation).

xvi. Assess Scotland's capacity to deliver from a regulatory perspective and provide training and clear guidelines (e.g. UK Hab training, accreditation to conduct MoRPh River assessments).

xvii. Undertake Scotland-wide opportunity mapping for a range of habitats to better account for ecological connectivity.

xviii. Provide different interfaces to allow a range of classification systems to be used.

xix. Provide condition assessment criteria to meet the needs of different sectors and uses. There are differences between existing condition assessments and a standardised approach would help align policy sectors. However, it is recognised that the detail required, and the approach taken, will differ between sectors.

xx. Provide guidance and training to support sectors in tool use and assessments.

xxi. Include management/systems aspects to meet the needs of the agricultural sector. Agriculture takes a systems-approach to land management and consequently aspects relating to management, rotation and spatial/temporal dynamics are important to include to meet the end needs of this sector.

xxii. Consider how species and ecosystem health could be incorporated (see Recommendation 4 above).

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Annex 1: Assessment criteria

EU Business @ Biodiversity metric assessment criteria

This annex summarises the tools and approach assessment criteria identified in the Biodiversity Measurement Navigation Wheel for Business v2.0 (Lammerant et al., 2022)[1]. The criteria are typically descriptive rather than intended to form the basis of a comparison on critical assessment. However, they can be used as the basis for developing criteria for assessing a biodiversity assessment tool or metric for Scotland. The approach is focused on business use, so requires further expansion to reflect policy and other end-users. Conversely, the scope of business uses (from products, site, to company and global impacts) may be broader than that required for a Scottish metric. Similarly, the approach has also been applied to ecosystem services tools which go beyond the scope of the current project.

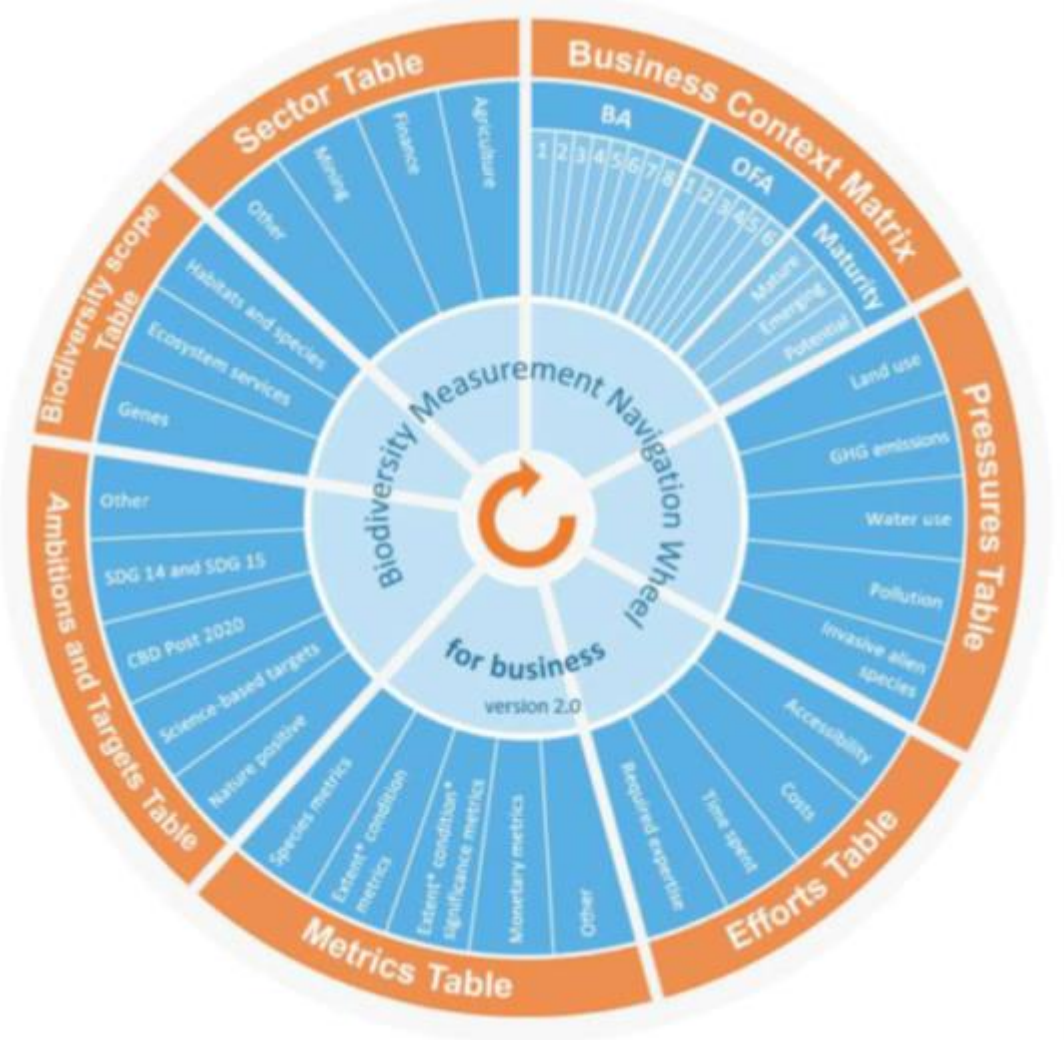

Figure 14 Biodiversity Measurement Navigation Wheel for Business v2.0 (Lammerant et al., 2022)

Business context matrix

Combines business applications and organisational focus areas with maturity level

Business application table

Entries with an * reflect applications relevant to a Scottish metric

BA 1: Assessment of current biodiversity performance*	This is a very common business application. A company might do this just to demonstrate that it's doing well in terms of biodiversity performance, or simply to know its current level of performance. It could be part of BA 3 (tracking progress to targets), 4 (comparing options) or 7 (assessing risks and/or opportunities).
BA 2: Assessment of future biodiversity performance*	A company might be interested in assessing future biodiversity performance as a result of, for instance positive impact actions (e.g. restoration actions and/or actions that reduce pressures on biodiversity) or changes in its activities.
BA 3: Tracking progress to targets*	Companies that have set targets on biodiversity performance will need to track progress periodically. There are many categories of targets (see Biodiversity Ambitions Table in section 2.3.3).
BA 4: Comparing options	A company might want to compare the impact of different options on biodiversity. Although the focus of the biodiversity measurement tools is on measuring biodiversity impacts, any decisions will also rely on economic considerations. While some tools have explicitly integrated an economic indicator, other tools provide useful input for an internal cost benefit analysis. This BA can inform different levels of decision. Some examples of this BA: • Which site offers least harm to biodiversity values? • Which mitigation measures offer best result in terms of both ecological and economic terms? • Which product scores best considering both biodiversity performance and economic return? • Which investments in biodiversity conservation or restoration score offer the best value for money? • Which supply chains are riskier from a biodiversity point of view? • Which companies within a sector are performing best (according to rating agencies)? • Which sectors are performing best in terms of biodiversity (for investment decisions by FIs)?
BA 5: Assessment / rating of biodiversity	Third party assessment based on biodiversity criteria and fed with external data (into the absence of company data). This can be applied to compare company biodiversity performance across a sector. This is typically a BA applied

performance by third parties, using external data*	by many financial institutions or by data providers to these FI
BA 6: Certification by third parties*	Third party certification based on auditing of a clearly established methodological approach.
BA 7: Screening and assessment of biodiversity risks and opportunities	Biodiversity measurement approaches can be used, for instance in case of due diligence assessments as part of mergers and acquisitions, or assessment undertaken by investors to differentiate between investment options, either based on the biodiversity performance or return on investment of different companies. This might also be undertaken by FI to assess biodiversity risk and inform pricing credit. This application often, but not always, overlaps with BA 4.

Organisational focus areas

The following organisational focus areas are included:

- Product/service
- Site/project
- Supply chain
- Corporate
- Portfolio/sector
- Country/region

Maturity levels

- Potential
- Emerging
- Mature

Pressures table

The following biodiversity pressures are identified. These reflect material impacts on biodiversity that may be due to business activities or reflect dependencies on biodiversity (i.e. adverse impact of climate change on biodiversity used by business).

These may be useful for understanding biodiversity issues in specific policy contexts such as on-farm biodiversity audits or for biodiversity reporting. They may also inform potential risks in developing net gain or habitat restoration projects, e.g. sites that are at greater vulnerability to one or more pressures.

- Land/sea use change
- Direct exploitation
    - Biological resource use (e.g. overfishing)
    - Water use
- Invasive alien species
- Pollution
    - Atmospheric nitrogen deposition
    - Nutrient emissions to water
- Climate change
- Other (e.g. habitat fragmentation, human encroachment, erosion, disturbance, pesticide use)

Biodiversity ambitions

This table includes relevant biodiversity targets:

- CBD post-2020 biodiversity targets
- Science based targets for nature
- No net loss/net gain
- Sustainable Development Goals
- ISO 14001, EMAS
- Voluntary standards at sector level or product level
- Voluntary biodiversity assessments and reporting frameworks
- Voluntary biodiversity agreements
- Regulating and permitting requirements
- Financial institutions requirements
- Site to landscape level commitments
- Specific corporate-level biodiversity commitments or engagements

The report does not carry out an assessment of the tools against these. Instead, the consequences of each target for tool selection is discussed with suitable tools either described or named where relevant.

Biodiversity scope

This table assesses whether the tools cover the following elements:

- Habitats/species
- Ecosystem services
- Genes

Only one tool (B-INTACT) measured genes and only qualitatively.

Biodiversity metrics

A number of biodiversity metrics are listed, these can either be generic (number of species, habitat extent), specific or applied by a particular approach (e.g. scores or indices), or potential approaches (i.e. were not used by any of the assessed approaches). The biodiversity metrics table (Table 15) also notes the resulting unit of biodiversity, its key points, uses and scale of analysis.

Table 15 Typology of metrics, what measured and example uses (source: Lammerant et al., 2022)

Type of metric	Commonly used metric	Unit of biodiversity	Used for	Scale of analysis
Species metrics	Number of individuals	Number of individuals of any one species	Simple easily communicated compensation for impacts to key species	Project or site scale
	STAR (Species Threat Abatement and Restoration metric)	Globally threatened species	Compare potential threat abatement and restoration actions, set science-based targets, and track progress over time.	Any scale
Extent * Condition metrics	Habitat hectares; quality hectares	Ecosystems	Measuring losses and gains within the same ecosystem type; used by many offset schemes	Project or site scale
	Mean Species Abundance (MSA)	All species	Impact assessment and LCA using GLOBIO model	Product, corporate or global scale
	Potentially Disappeared Fraction (PDF)	All species	Impact assessment and LCA using ReCiPe model	Product, corporate or global scale
Extent (or area) * Condition (or quality) * Significance metrics	Biodiversity Intactness Index (BII)	All Species	Impact assessment and LCA using the PREDICTS model	Product, corporate or global scale
	Biodiversity Impact Metric (BIM)	All species	Supply chain assessments and impact assessments	Product, corporate or global scale
	Site Biodiversity Condition Class	Habitats	Monitoring progress of quarry rehabilitation	Site scale
	BNGC score	Biodiversity value per m^2	Measuring losses and gains within the same ecosystem type. Can be used to refine MSA model scores. Can be used to underpin ‘nature positive’ investment as offsets for achieving ‘no net loss’ or ‘nature positive ambitions’	Site or project scale
	Biodiversity scoring system	Biodiversity units (BU)	Calculate the losses and gains in biodiversity unit value resulting from changes or actions which affect biodiversity, such as from development or	Site or project scale

Type of metric	Commonly used metric	Unit of biodiversity	Used for	Scale of analysis
			changing the conservation management of a land holding	
Thematic metrics	Examples: Deforestation free commodities or supply chains; surface of regenerated or restored land; palm oil free etc.	km^2 or %	To demonstrate compliance with specific biodiversity targets	Product, supply chain and corporate scale
	Agrobiodiversity Index (ABDI)	Agro-biodiversity	Sustainable agriculture	Site to corporate scale
Financial metrics	Environmental Profit and Loss accounts (EP&L)	Ecosystem services	LCA	Product, site, corporate or global scale
Combined state, pressure and response metrics (dashboard)	No single quantitative metric, with score cards used to identify risk areas. Appreciation of progress (e.g. colour codes, arrows…)	Habitat/ species/ population/ biodiversity management unit (BMU)	Monitoring progress to target	Site and project scale

Level of effort

This table relates to the level of expertise, accessibility, and costs of applying a tool or approach.

- Accessibility
  - Full open source
  - Open source with support
  - Commercial
- Required expertise
  - Internal – available within company
  - External – external expertise most probably required
  - External but training possible
- Costs
  - External – high/medium/low

- Other – high/medium/low
- No costs

Sector applicability

This reflects the commonly occurring sectors where the tools and approaches have been applied:

- Agriculture
- Mining
- Financial institutions
- Other

Summary and recommendations for Scottish metric criteria

Business application table

Activities related to assessing current and future performance with respect to biodiversity, including third party verification are relevant to applications of a Scottish metric

Organisational focus area

Applications to different scales including project, site, region or national are relevant to a Scottish metric. Some sector-specific tools (e.g. developments of Agrecalc) would fall into supply chain. Corporate could be applied to a land holding as a business entity.

Maturity level

Relevant to a development of a Scottish metric.

Pressures table

The pressures relate to factors that may impact on biodiversity (rather than ES impacts of the business use of land/resources). These are not included in tools such as the Biodiversity Metric 3.0 at present, but could be important in determining the future outcomes of habitat restoration (e.g. vulnerability of restored peatland to future climate change). This could take the form of additional multipliers when scoring habitat recreation/restoration. Suggest discussion of revision/refinement and additional pressures relevant to Scottish users, e.g. disaggregating climate impacts such as changes to temperature, precipitation, disease risk.

Biodiversity ambitions

These are inherent in the policy drivers for the project but could include flexibility for changing objectives and targets. The current table is descriptive with tools mentioned where directly linked (e.g. Biodiversity Metric 3.0 and net gain).

Biodiversity scope

Useful in assessing tools against policy areas, and identifying potential adjustments to Biodiversity Metric 3.0.

Biodiversity metric

Current species-based metrics (number of individuals, globally threatened species) may not be appropriate across all applications. Does not include number or diversity of species. Species-based metric may impact on repeatability, e.g. resources and timing of repeated surveying. Habitat extent metrics are more widely used.

Level of efforts

Important element for assessing tools. Impact of effort requirements will vary across sectors/applications and scales. Flexibility will be important for a Scottish metric that can be scaled and widely applied.

Sector applicability

Currently includes agriculture, but could be expanded to include habitats/sectors relevant to Scotland, e.g. peatland restoration, woodland creation.

Annex 2 Criteria interpretation

Table 16: Overview of criteria alongside definitions as agreed through discussion with key stakeholders. Criteria sources are also provided.

Broad category	Evaluation criteria	Description of criteria	Source/ Developed from
Habitats and Species	Genetic	Genetic diversity within a species, low genetic diversity can result in low resilience to environmental change. Tools evaluating genetic diversity within populations are too constrained to provide a useful means of calculating biodiversity as a whole.	Business @ Biodiversity
	Abundance of priority species	Number of individuals of a priority species (e.g. red list species). For most species a complete census is not feasible, and an estimate is derived from a standardised sampling protocol. Estimates can vary, particularly for mobile species, and can show significant temporal variation. Focus on monitoring priority species can result in trade-offs between species.	Project proposal Business @ Biodiversity
	Species richness	The number of species present. This is often targeted to a particular taxon or functional group (e.g. the number of species of vascular plants or insect pollinators) and many standard protocols encompass both identifying and quantifying species. This involves using standardised methodology and data can feed into the UK biodiversity indicators. As with metrics relating to species abundance these metrics can show significant temporal variation.	Project proposal Business @ Biodiversity
	Indicator species	Here the focus is on indicator species that reflect habitat quality – indicators could be both positive or negative. For example, plant species associated with high quality species rich grasslands, or invertebrates that reflect water quality. Constraining the species list to indicator species can reduce the level of ecological expertise required in addition to time in the field.	Project proposal Business @ Biodiversity

Broad category	Evaluation criteria	Description of criteria	Source/ Developed from
	Ecosystem health/ function	Measurement of the health of an ecosystem and its ability to function and provide ecosystem services.	Stakeholder/ steering group workshops
	Functional/or response diversity	Here information on species occurrence is integrated with information on the traits of the species present. Response diversity focusses on a wide suite of traits and measures the ability of a community to respond to environmental change. Functional diversity focusses on traits related to a particular ecosystem function (e.g. pollination services). Functionally diverse communities are perceived to promote ecosystem resilience under environmental change, ensuring the ecosystem processes in question persists. Metrics related to functional or response diversity are reliant on the existence of comprehensive trait databases which are lacking for many taxa.	
	Irreplaceable habitats	The occurrence of habitats of conservation concern (e.g. Annex 1 habitats) or irreplaceable habitats (e.g. Raised bog)	Stakeholder/ steering group workshops
	Habitat extent	The total area of habitat/habitats. This measure is easily upscaled from site to landscape level, and could draw on spatial data derived from remote sensing. However, the value of habitats to biodiversity varies considerably depending on their condition.	Business @ Biodiversity N**atural England Biodiversity** Metric 3.1
	Habitat extent and condition	The total area of habitat/habitats alongside a measure of their condition (i.e. habitat quality). Condition is usually based on collection of a variety of metrics relating to habitat structure and in some instances the occurrence of key indicator species and management information. Collecting on the ground data on habitat condition provides more detailed information on the biodiversity value of habitats. However, on the ground collection of data requires more	Business @ Biodiversity Natural England Biodiversity Metric 3.1

Broad category	Evaluation criteria	Description of criteria	Source/ Developed from
		time for baseline and follow-up monitoring.	
	Habitat extent, condition and distinctivene-ss	In addition to encompasses extent and condition this metric recognises that not all habitats are equal with respect to their biodiversity value. Distinctiveness of a habitat provides a measure of habitat rarity and importance and may be dependent on its rarity (at national, international level), proportion protected, and priority status (national, international level). Once underlying scores on distinctiveness have been derived, this metric would involve similar effort to metrics based on habitat extent and condition.	Business @ Biodiversity Natural England BiodiversityMetric 3.1
	Ecological connectivity	This metric takes into account the spatial arrangement of habitats in the landscape. Restoring ecological connectivity is a key priority to ensure that nature can thrive in the face of environmental change. Enhancing connectivity between habitats through the creation of corridors and stepping stones is fundamental to the Scottish government's ambitions of creating a Nature Network. In the Central Scotland Green Network area, network modelling has spatially identified opportunity areas for some habitats where the creation of new habitat will optimise connectivity. However, this mapping is geographically constrained.	Stakeholder/ steering group workshops
	Accounts for current and future pressures	Allows for risks and pressures to be quantified. For example, vulnerability of a habitat to climate change/invasive species, time delay in establishing a habitat, risks associated with establishing different habitats. Many of these pressures will vary with both habitat and geographical location.	Business @ Biodiversity
	Includes ongoing monitoring	Enables long-term monitoring of habitats or species. For most sectors it can be assumed that persistence and/or	Project proposal

Broad category	Evaluation criteria	Description of criteria	Source/ Developed from
		improvement is a desired outcome and thus ongoing monitoring is important.	
Effort and ease of use	Cost of use	Costs associated with baseline and follow-up monitoring – particularly as biodiversity outcomes may require monitoring over a long period of time – e.g. 30 years	Business @ Biodiversity
	Expertise	Level of ecological or technical expertise required. Requirement for outputs of the metric to be widely accessible to all – should this expertise reflect on the ground surveying. Having high level of expertise gives reliability in natural capital markets but is disadvantageous where participatory monitoring is beneficial. Perhaps natural capital is not so much about expertise but this is covered in robustness of the metric below?	Invitation to tender/ Project proposal
	Time requirements	Time taken to undertake baselining and subsequent monitoring	Business @ Biodiversity
	Scalable spatial	Transferable across spatial scales – from field to farm to catchment (here habitat-based measures are likely to be more appropriate)	Invitation to tender
	Financially viable to implement at scale, across sectors	This could include ability to use existing data (e.g. publicly available GIS data, remote sensing) for large scale projects. Potential to align monitoring with existing or forthcoming schemes	Project proposal
	Open access	Tool and the data that underpins the tool is freely available	Project team
Useability and comparability	Clear, concise, and transparent	Measurements are clear and straightforward. Clear how the resultant measurements were derived on the ground and how these relate to biodiversity impacts. This reduces the likelihood of abuse.	Invitation to tender

Broad category	Evaluation criteria	Description of criteria	Source/ Developed from
	Replicable	The measures taken are reliable and will provide consistent results – e.g. across a relevant time span or between evaluators (i.e. replicable)	Invitation to tender/ Project proposal
	Scientifically robust: reflects ecosystem functions	Measurements taken provide a true reflection of biodiversity outcomes (e.g. ecosystem health, habitat quality)	Invitation to tender
	Comparable	Transferable to different scenarios and to different land uses – for example monitoring the impact of a moorland restoration project or the impact of building a new housing estate. Should this encompass trading and/or offsetting?	Invitation to tender
	Saleable	Quantifiable biodiversity units are created allowing for the development of a verifiable biodiversity market. Facilitates commercialisation of Nature.	Invitation to tender/ Stakeholder/ steering group workshops
	Tradeable	Changes in one habitat can be compared to and traded for changes in another (i.e. offsetting or net gain).	Stakeholder/ steering group workshops
	Meaningful to all key stakeholders and scenarios they may want to use a metric	Stakeholders can clearly interpret the output of the metric with respect to biodiversity outcomes. This information can then assist stakeholders to make decisions and evaluate actions. This could be tricky – conservation bodies are likely to require more detailed means of evaluating than for example agri-environment schemes.	Invitation to tender
	Aligns with monitoring (existing or future)	Aligning monitoring with existing or future action will reduce costs associated with long-term monitoring and will add bonus to existing/future monitoring (e.g. SEPA water quality, Farm Biodiversity audit).	Project proposal
	Aligns with current (or	Aligning with future policy objectives at the local, regional and national level. Need to encompass key strategies – 30x30 target and establishing a nature	Project team

Broad category	Evaluation criteria	Description of criteria	Source/ Developed from
	future) policy objectives	network. This should be cross sector and align with SDG additionally. This highlights the benefits of multi-functionality. Raises questions on how this could be achieved (stacking, bundling) – re additionality.	
	Maturity of tool	Is the tool potential, emerging or mature. How long has the tool been available and what level of adoption has it?	Business @ Biodiversity

Annex 3 Assessment Criteria Workshop Results

Habitat and species

Our assessment of criteria split habitat and species-based metrics into their constituent elements. The aim being to explore the relative priority for different approaches across the policy areas. Habitat based metrics can be of differing levels of complexity ranging from habitat extent; both extent and condition; or interacting extent, condition and significance (or distinctiveness). Similarly, species-based metrics could comprise of number of individuals; indicator species; or priority species (e.g. set nationally or IUCN Red List). Where species are not the explicit basis of the metric, they may be included in habitat condition assessments, for example in terms of richness (number of species) or as indicators of good or poor condition. We also initially included 'genes' as category for the metric, this is more complex and genetic tools such as environmental DNA (eDNA) can be used to help detect the presence of particular species (e.g. when surveying may be difficult), to estimate the diversity of species (e.g. soil microorganisms). However, eDNA may be considered a means of estimating species richness, or detecting the presence of indicator species, rather than a metric in its own right. The discussion during the steering group workshop determined that this category should instead reflect genetic diversity within a population of a species (i.e. through gene sequencing), with high genetic diversity typically indicating greater resilience to environmental change.

Further criteria included whether the metric includes **ongoing monitoring** of habitats and species or **accounts for current and future pressures**, for example, this might include the impacts of climate change, and emergence of new pests and diseases.

Table 17 and Figure 15 summarises the results of the criteria assessment for habitats and species metrics. Criteria were sorted into three categories from highest to lowest priority based on the relative placement of sticky notes on the target. Habitat based metrics that combined **habitat extent, condition and distinctiveness** were prioritised across all policy areas except for *natural capital markets*. A comment from the *Conservation and Biodiversity Monitoring* group noted that this metric was important as it is practical and achievable.

Table 17 Sorting of criteria for *Habitats and Species* by policy area. (SG) indicates criteria that were added by participants in the steering group, and (SW) indicates criteria that were added by participants in the stakeholder workshops.

Policy Area	High Priority	Medium Priority	Low Priority
Agriculture	• Habitat connectivity (SG) • Ecosystem health (SG) • Includes ongoing monitoring of habitat or species • Habitat: extent * condition * distinctiveness • Presence of irreplaceable habitat (SG)	• Priority Species based e.g., red list • Accounts for current and future pressure (e.g., climate change risks) • Indicator species based: denote quality • Functional diversity (SG) • Species based e.g., number species	• Genetic Diversity • Habitat : extent * condition • Habitat: extent
Conservation and Biodiversity Monitoring	• Ecosystem health (SG) • Adaptability over time (SW) • Priority Species based e.g., red list • Habitat: extent * condition * distinctiveness • Indicator species based: denote quality • Presence of irreplaceable habitat (SG)	• Accounts for current and future pressures (e.g., climate change risks) • Functional diversity (SG) • Species Based e.g., number of species • Habitat connectivity (SG) • Habitat: extent * condition • Genetic diversity	• Habitat Extent • Includes ongoing monitoring of habitats or species • Species: indicator species
Planning and Development	• Habitat connectivity (SG) • Ecosystem health (SG) • Accounts for current and future pressures (e.g., climate change risks) • Habitat: extent * condition • Habitat: extent * condition * distinctiveness	• Habitat extent • Priority species based e.g., red list • Presence of irreplaceable habitat (SG) • Functional diversity (SG) • Indicator species based: denote quality • Habitat classification (SW)	• Genetic Diversity • Species based e.g., number of species

Policy Area	High Priority	Medium Priority	Low Priority
Natural Capital Markets	• Ecosystem health (SG) • Functional diversity (SG) • Presence of irreplaceable habitat (SG) • Includes ongoing monitoring of habitats or species • Species based e.g., number of species	• Indicator species based: denote quality • Priority species based: e.g., red list • Habitat connectivity (SG) • Habitat: extent * condition	• Genetic diversity • Habitat: extent * condition * distinctiveness • Accounts for current and future pressures (e.g., climate change risks)

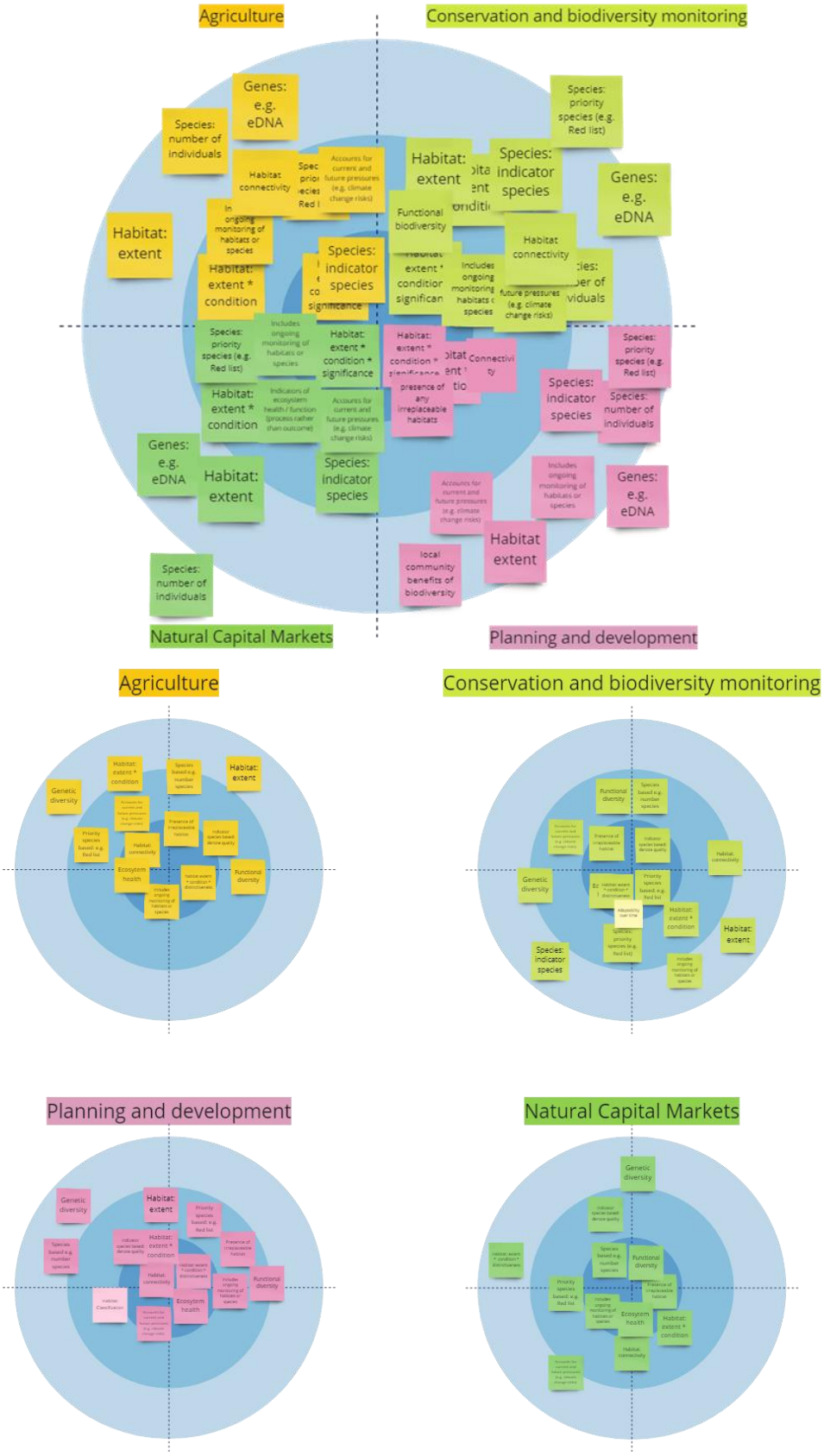

Figure 15: Priority sorting of criteria for Habitats and Species by policy area in the a) steering group and b) stakeholder workshops

The presence of irreplaceable habitats (e.g. ancient woodland) was added during the steering group workshop, this also proved to be of high priority across three of the policy areas (i.e. excluding Planning and Development). Clearly irreplaceable habitats are of high importance to the Planning and Development sector and their presence is accounted for in decision making. Such habitats are, however, protected through legislation and in requiring bespoke compensation and are not tradeable. This could account for this sector giving irreplaceable habitats a lower priority.

Agriculture and Natural Capital Markets prioritised ongoing monitoring. Ecosystem health and functioning was added in the steering group workshop, this was split into ecosystem health and functional diversity for the second workshop. Ecosystem health was given a high priority by all areas, with functional diversity generally considered as of medium priority. It was commented that some measure of below ground functional diversity would be useful across different habitats. Planning and Development was focused on habitat extent and condition to a greater extent than the other policy areas.

Habitat connectivity was added by the steering group participants and rated as high or medium priority across policy areas. Discussions indicated the importance of connectivity in establishing nature networks across Scotland. The lack of interaction of different habitats (e.g. agriculture and forestry) was noted indicating that connectivity needs to be considered beyond the local abundance of similar habitats.

Habitat extent (in contrast to also including condition and distinctiveness) was given a lower priority across each of the policy areas. **Genetic diversity** was also given a low priority across three areas (i.e. excluding *Conservation and Biodiversity Monitoring*).

Effort and ease of use

The assessment of required effort and ease of use is summarised in Table 18 and Figure 16. Most of the metrics are open access, using publicly available data and methods. Some have an open access methodology, but charge for access to data (IBAT and STAR). Others such as NARIA use proprietary models. However, open access metrics may still require expertise in understanding the data or undertaking the biodiversity impact calculations. For tools such as Biodiversity Metric 3.1, use of the tool such as a spreadsheet user-interface may not require specific expertise, but there may be expertise required in the collection of underlying data such as habitat condition assessment.

Most of the metrics were able to be scaled either in terms of their spatial scale or without entailing disproportionate costs. The IBAT and STAR tools are partially scalable in financial terms as assessments over larger or more numerous sites entail larger data purchase fees. The BMS and BPT metrics

Table 18 Sorting of criteria for *Effort and Ease of Use* by policy area. (SW) indicates criteria that were added by participants in the stakeholder workshops.

Policy Area	High Priority	Medium Priority	Low Priority
Agriculture	• Open Access (e.g., data and functionality) • Scalable: Spatial (e.g., field to landscape) • Time requirements • Expertise: ecological expertise required • Cost of use	• Scalable: Financially Viable	
Conservation and Biodiversity Monitoring	• Confidence/Reliability in the Metric (SW) • Scalable: Spatial (e.g., field to landscape) • Scalable Financially viable • Adaptability over time (SW) • Open Access (e.g., data and functionality)	• Cost of Use • Time requirements • Expertise: Ecological expertise required	
Planning and Development	• Expertise: ecological expertise required • Time requirements • Open Access (e.g., data and functionality)	• Scalable: spatial (e.g., field to landscape) • How it can be supported by other public data sources e.g., a national nature network) • Time requirement – habitat creation and monitoring	• Scalable: Financially Viable
Natural Capital Markets	• Additionality (SW) • Scalable: Spatial (e.g., field to landscape) • Scalable: Financially Viable • Open Access (e.g., data and functionality)	• Time requirements • Expertise: ecological expertise required	

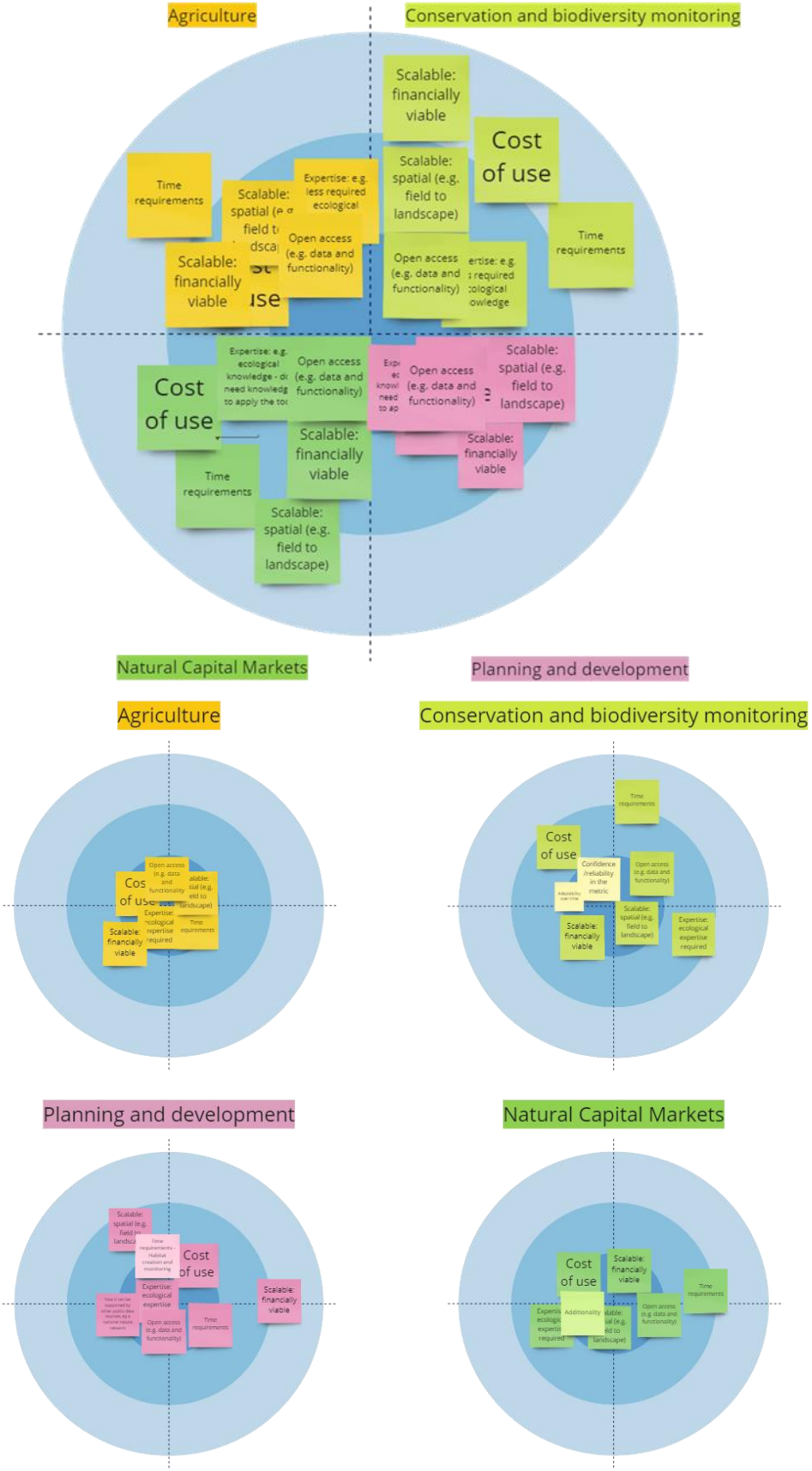

Figure 16: Priority sorting of criteria for effort and ease of use by policy area in the a) steering group and b) stakeholder workshops

are designed to be used at farm level, consequently there was no information on scaling costs, and spatial scalability was limited as the indicators used in these tools may be location specific.

Very few of the metrics provided information on the time requirements or costs of use. BPT provides an estimate of per farm assessment costs. BIRS is intended to be both time and cost efficient. The IBAT and STAR website provide information on subscription costs for access to their datasets.

Useability and comparability

The third exercise considered broad criteria relating to useability and comparability. By useability we mean the outcomes of a metric or tool in terms of addressing end-user needs rather than the use of the metric itself to calculate a measure of biodiversity. The results of the Miro board sorting are show in Table 19.

Clear, concise and transparent was the only criterion that was given the highest priority across all policy areas. Scientifically robust in terms of measurability was given the highest priority in three of the policy areas (i.e. excluding Conservation and Biodiversity Monitoring). There was a contrast with respect to tradeable and saleable between the Planning and Development and Natural Capital Markets groups on one hand and the Agriculture and Conservation and Biodiversity Monitoring groups on the other. The former group gave a high priority to saleable. This was a further criterion added with respect to Natural Capital Markets in the steering group workshop and is distinct from tradeable in that it relates to the potential to sell biodiversity 'units' rather than trading biodiversity gains in one habitat or area for loss elsewhere (e.g. a net gain calculation). It should be noted that the high priority given to both tradeable and particularly saleable by the Planning and Development group does not reflect Scottish planning policy as set out in National Planning Framework 4. Net gain or nature positive development requires some degree of comparability between different habitat types, i.e. the impacts of development on one habitat type needs to be compared to compensating action in another. Whereas there is an active debate in policy regarding the fungibility of nature with respect to ecosystem markets, in that different habitats are not comparable. This reflects unease around commodification. Where comparability is required is with respect to ecosystem level outcomes.

Table 19 Sorting of criteria for *Useability and Comparability* by policy area. (SG) indicates criteria that were added by participants in the steering group, and (SW) indicates criteria that were added by participants in the stakeholder workshops.

Policy Area	High Priority	Medium Priority	Low Priority
Agriculture	• Scientifically robust: measurable • Meaningful to all stakeholders • Scientifically robust: reflects ecosystem function • Clear, concise, transparent • Aligns with current (or future) policy objectives	• Comparable across all habitats and sectors • Aligns with monitoring (existing or future)	• Tradeable • Saleable (SG) • Maturity: e.g., potential, emerging or mature
Conservation and Biodiversity Monitoring	• Meaningful to all stakeholders (needs to be well communicated) (SW) • Maturity: e.g., potential, emerging or mature • Clear concise and transparent	• Scientifically robust: measurable • Scientifically robust: reflects ecosystem function • Adaptability over time (SW) • Comparable across habitats and sectors • Saleable (SG)	• Aligns with monitoring (existing or future) • Aligns with current (or future) policy objectives • Tradeable
Planning and Development	• Saleable (SG) • Tradeable • Aligns with current (or future) policy objectives • Clear concise and transparent • Comparable across habitats and sectors • Scientifically robust: measurable • Maturity: e.g., potential, emerging, or mature	• Scientifically robust: reflects ecosystem function • Meaningful to all stakeholders • Aligns with monitoring (existing or future)	
Natural Capital Markets	• Saleable (SG) • Clear, concise, transparent • Scientifically robust: measurable • Meaningful to all stakeholders • Comparable across habitats and sectors • Scientifically robust: reflects ecosystem function	• Tradeable • Maturity: e.g., potential, emerging, or mature • Aligns with monitoring (existing or future) • Aligns with current (or future) policy objectives	

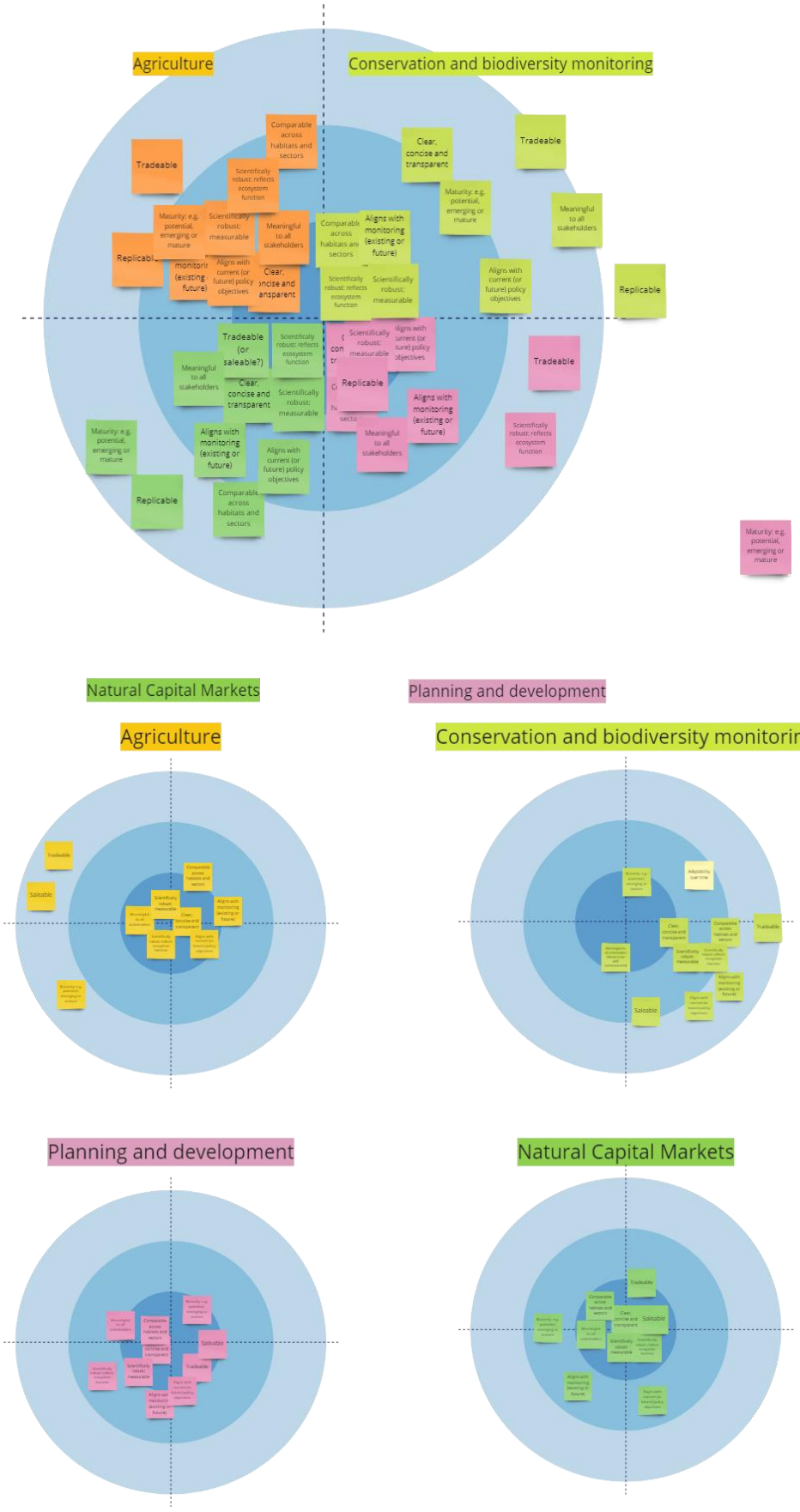

Figure 17: Priority sorting of criteria for useability and comparability by policy area in the a) steering group and b) stakeholder workshops

Annex 4: List of reviewed biodiversity metrics and tools

Name	Developer	Application	Short description
Agrobiodiversity Index	Alliance Bioversity International and International Centre for Tropical Agriculture (Alliance BICIAT)	Agriculture - country, company or project level Species, varieties, landscape complexity and functional diversity	Composite index to evaluate agriculture at country, company or project levels. 22 indicator types are identified covering consumption, production and conservation (3 pillars) over status, action and commitment (3 categories). Users identify appropriate data for each indicator.
Biodiversity Credits	Wallacea Trust		Assessment of biodiversity uplift projects, requires a basket of at least 5 metrics relevant to the site context: • reflect the conservation objectives for the ecoregion and habitats included in the submitted site, • include at least one habitat or floral composition metric (for terrestrial sites), • include metrics covering all ecosystem services likely to be affected by the proposed management plan (such as air quality, water quality, soil quality, pollination value), • include a minimum of five metrics for any project. (For some projects more than the minimum will be required to encompass all conservation objectives and the ecosystem services likely to be impacted), • not include carbon sequestration

Name	Developer	Application	Short description
Biodiversity Footprint for Financial Institutions (BFFI)	PRé, CREM and ASN Bank	Life Cycle Analysis Uses ReCiPe Species richness used for biodiversity Damage to diversity described as the fraction of species lost in comparison with undisturbed area.	Potentially Disappeared Fraction (PDF) per unit area per year is used to express the area (m2) where all biodiversity is lost per year due to impacts. Results can be expressed in biodiversity loss per unit of revenue or investment (e.g. m2 loss per €)
Biodiversity Footprint Methodology (BFM)	Plansup and Wageningen Environmental Research	Production chain impacts Mean species abundance * habitat area	Mean Species Abundance scores are interacted with habitat area to determine the area that would be equivalent to complete loss of biodiversity (i.e. no natural habitat vs pristine habitat).
Biodiversity Impact Metric (BIM)	University of Cambridge	Agriculture commodity impacts Area * biodiversity loss * impact Based on MSA	Measures the impact of production of agricultural commodities allowing comparison of different sourcing options (intensity and location)
Biodiversity Intactness Index	Natural History Museum	Biodiversity monitoring and scenario analysis	Combines information on species (birds, mammals, plants, fungi and insects) abundance in undisturbed and disturbed sites with measures of human pressures (land use change and intensification, human population growth and landscape simplification) to estimate the percentage of the original ecological community still intact. The BII is averaged across areas (countries, regions or global) to give the remaining biodiversity across that area.

Name	Developer	Application	Short description
Biodiversity Indicator and Reporting System (BIRS) Holcim	IUCN	Habitat restoration (quarries) Extent * condition * significance	Combined assessment of land holdings of mining company (whether actively exploited or not)
Biodiversity Indicators for Site-based Impacts (BISI)	UNEP-WCMC, Conservational International and Fauna & Flora International	Development/net gain Habitat (area) or species (population) impact relative to undisturbed state depending on biodiversity focus -	Tool to measure and monitor the impact of company activity on biodiversity. Three stage approach: 1) screen for sites of biodiversity significance; 2) common framework (pressure - state - response) for assessment of site level indicators; 3) aggregate site level indicators to business unit and corporate levels
Biodiversity Metric 3.1	Defra and Natural England	Development/net gain Extent * condition * distinctiveness * strategic significance	Tool to identify the biodiversity impacts of development projects and calculate the net gain outcomes from mitigating actions including habitat creation or enhancement
Biodiversity Monitoring System (BMS)	Global Nature Fund, Lake Constance Foundation, Agentur AUF! (Germany), the Fundación Global Nature (Spain), Solagro and agoodforgood (France), and Instituto Superior Técnico (Portugal)	Agricultural management 25 habitats, species and management indicators	Biodiversity impact evaluation of farms based on a range of indicators covering different economic, environmental and social factors. Aimed at use by food companies and retailers to monitor supplier performance. Biodiversity focus is the protection of insects and insect responsible sourcing

Name	Developer	Application	Short description
Biodiversity Net Gain Calculator (BNGC)	Arcadis	Impact of business site operations Extent * condition * significance	Tool designed to allow companies to evaluate biodiversity impacts of on site operations
Biodiversity Performance Tool (BPT)	Global Nature Fund, Lake Constance Foundation, Agentur AUF! (Germany), the Fundación Global Nature (Spain), Solagro and agoodforgood (France), and Instituto Superior Técnico (Portugal)	Agricultural management 78 biodiversity indicators	Biodiversity assessment at farm level based on 23 indicators of natural and semi-natural habitats and ecological structures; 49 indicators of agricultural practices; and 7 indicators of social issues. Biodiversity focus is the protection of insects
BioScope	See ReCiPe	Life Cycle Analysis Species loss due to different land use	
Corporate Biodiversity Footprint (CBF)	Iceberg Data Lab	Life Cycle Analysis Mean species abundance – measure relative to undisturbed state	Biodiversity assessment at corporate level to identify the impacts of business activities in terms of pressures applied in mean species abundance calculation
Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)	Natural Capital Finance Alliance	Biodiversity module focuses on agriculture and mining Recommends combination of Mean Species Abundance and STAR Screening using IBAT	Biodiversity impact assessment for agricultural and mining sectors

Name	Developer	Application	Short description
Global Biodiversity Score® (GBS®)	CDC Biodiversité	Production chain impacts Mean species abundance * habitat area	Biodiversity assessment at corporate level to identify the impacts of business activities in terms of pressures applied in mean species abundance calculation
Global Impact Database (GID)	Impact Institute	Mean species abundance * habitat area Potentially Disappeared Fraction * m2 (ecosystem intactness per unit area)	Biodiversity impacts assessment as part of a wider impact assessment of investment portfolios also including social and human capitals. Impacts can also be monetised
Integrated Biodiversity Assessment Tool (IBAT)	UNEP-WCMC, IUCN, BirdLife International, Conservation International	Key Biodiversity Areas (KBA) Species Threat Abatement and Restoration metric (STAR)	Assessment of biodiversity related opportunities and risks for business
LIFE Methodology (LIFE)	Institute of Life	Biodiversity Pressure Index combining waste, water, energy, land use (MSA-based) and GHG	Assessment of business impacts on biodiversity and ecosystem services using calculation of the Biodiversity Pressure Index (BPI). This is a composite index comprising pressures including: waster generation, water use, energy use, land use, GHG emissions
Natural Asset Recovery Investment Analytics (NARIA)	CreditNature		Outcomes focussed assessment of ecosystem integrity intended to inform sealable nature tokens

Name	Developer	Application	Short description
Norwegian Nature Index	Norwegian Environment Agency	Biodiversity monitoring	Composite index of 260 indicators representing species, groups of species and indirect biodiversity over 7 terrestrial and marine ecosystems. For each species a value between 0 (disappeared) and 1 (little affect), these are then weighted based on expert judgement of their importance to the condition of biodiversity. Indicator values are based on either monitoring, modelling or expert judgement. Underlying indicator indices can be explored at species, ecosystem or thematic level. Regional level results are also displayed.
Product Biodiversity Footprint (PBF)	I-Care & Consult and Sayari	LCA Potentially Disappeared Fraction of species (PDF)	Incorporates MEA drivers of biodiversity impact (habitat change, pollution, climate change, overexploitation and invasive alien species) into LCA of product impact
ReCiPe	RIVM	LCA Potentially Disappeared Fraction of species (PDF)	Potentially Disappeared Fraction (PDF) per unit area per year is used to express the area (m2) where all biodiversity is lost per year due to impacts.
Species Threat Abatement and Restoration metric (STAR)	UNEP-WCMC, IUCN, BirdLife International, Conservation International	Species conservation status * proportion of species range in area of interest	Assessment of biodiversity related opportunities and risks for business
SSE Biodiversity Project Toolkit	SSE Networks	Adaptation of Biodiversity Metric 3.1	Adapted Biodiversity Metric for energy infrastructure net gain calculations. Broadly similar list of habitats, although coastal and inter-

Name	Developer	Application	Short description
			tidal habitats are not included
The Biodiversity Integrated Assessment and Computation Tool (BINTACT)	UN Food and Agriculture Organisation (FAO)	Agriculture, Forestry and Other Land Use (AFOLU) sector Mean species abundance – measure relative to undisturbed state	Mean Species Abundance scores are interacted with habitat area to determine the area that would be equivalent to complete loss of biodiversity (i.e. no natural habitat vs pristine habitat). Benefit transfer using ESVD suggested to provide monetary value for biodiversity changes

Annex 5 Biodiversity Metric 3.1

Rules and Principles underpinning Metric 3.1

Metric 3.1 provides a means of informing decision making. However, the metric has its limitations, and it is important that use adheres to the following principles and rules as outlined in the accompanying Users Guide (Panks et al. 2022).

Principles

Principle 1: The metric does not change the protection afforded to biodiversity. Existing levels of protection afforded to protected species and habitats are not changed by use of this or any other metric. Statutory obligations will still need to be satisfied.

Principle 2: Biodiversity metric calculations can inform decision-making where application of the mitigation hierarchy and good practice principles conclude that compensation for habitat losses is justified.

Principle 3: The metric's biodiversity units are only a proxy for biodiversity and should be treated as relative values. While it is underpinned by ecological evidence the units generated by the metric are only a proxy for biodiversity and, to be of practical use, it has been kept deliberately simple. The numerical values generated by the metric represent relative, not absolute, values.

Principle 4: The metric focuses on typical habitats and widespread species; important or protected habitats and features should be given broader consideration.

- Protected and locally important species needs are not considered through the metric, they should be addressed through existing policy and legislation.
- Impacts on protected sites and irreplaceable habitats are not adequately measured by this metric. They will require separate consideration which must comply with existing national and local policy and legislation. Data relating to these can be entered into the metric, to give an indicative picture of the biodiversity value of the habitats present on a site, but this should be supported by bespoke advice.

Principle 5: The metric design aims to encourage enhancement, not transformation, of the natural environment. Proper consideration should be given to the habitats being lost in favour of higher-scoring habitats, and whether the retention of less distinctive but well-established habitats may sometimes be a better option for local biodiversity.

- Habitat created to compensate for loss of natural or semi-natural habitat should be of the same broad habitat type (e.g. new woodland to replace lost woodland) unless there is a good ecological reason to do otherwise (e.g. to restore a heathland habitat that was converted to woodland for timber in the past).

- Although the metric does not explicitly consider the biodiversity value provided by individual species, consideration should be given to locally relevant species interests when creating or enhancing habitats.

Principle 6: The metric is designed to inform decisions, not to override expert opinion. Management interventions should be guided by appropriate expert ecological advice and not just the biodiversity unit outputs of the metric. Ecological principles still need to be applied to ensure that what is being proposed is realistic and deliverable based on local conditions such as geology, hydrology, nutrient levels, etc. and the complexity of future management requirements.

Principle 7: Compensation habitats should seek, where practical, to be local to the impact. They should aim to replicate the characteristics of the habitats that have been lost, taking account of the structure and species composition that give habitats their local distinctiveness.

- Where possible compensation habitats should contribute towards nature recovery in England by creating ‘more, bigger, better and joined up’ areas for biodiversity.

- Through the strategic significance and spatial risk factors the biodiversity metric 3.1 places greater reward for habitat creation where it is strategically important and locally relevant.

Principle 8: The metric does not enforce a mandatory minimum 1:1 habitat size ratio for losses and compensation but consideration should be given to maintaining habitat extent and habitat parcels of sufficient size for ecological function. A difference can occur because of a difference in quality between the habitat impacted and the compensation provided. For example, if a habitat of low distinctiveness is impacted and is compensated for by the creation of habitat of higher distinctiveness or better condition, the area needed to compensate for losses can potentially be less than the area impacted. The metric calculates losses and gains by size as well as by biodiversity unit value or percentage. Note: consideration should be given to whether reducing the area or length of habitat provided as compensation is an appropriate outcome.

Rules

Rule 1: Where the metric is used to measure biodiversity change, biodiversity unit values need to be calculated both prior to the intervention and post-intervention for all parcels of land / linear features affected.

Rule 2: Compensation for habitat losses can be provided by creating new habitats, or by restoring or enhancing existing habitats. Measures to enhance existing habitats must provide a significant and demonstrable uplift in distinctiveness and/or condition to record additional biodiversity units.

Rule 3: 'Trading down' must be avoided. Losses of habitat are to be compensated for on a 'like for like' or 'like for better' basis. New or restored habitats should aim to achieve a higher distinctiveness and/or condition than those lost. Losses of irreplaceable or very high distinctiveness habitat cannot adequately be accounted for through the metric.

Rule 4: Biodiversity units generated by biodiversity metric 3.1 are unique to this metric and cannot be compared to unit outputs from versions 3.0, 2.0, the original Natural England metric, or any other biodiversity metric. Furthermore, the three types of biodiversity units generated by this metric (for area, hedgerow and river habitats) are unique and cannot be summed, traded or converted.

Rule 5: It is not the area/length of habitat created that determines whether ecological equivalence or better has been achieved but the net change in biodiversity units. Risks associated with creating or enhancing habitats mean that it may be necessary to create or enhance a larger area of habitat than that lost, to fully compensate for impacts on biodiversity.

Rule 6: Deviations from the published methodology of biodiversity metric 3.1 need to be ecologically justified and agreed with relevant decision makers. While the methodology is expected to be suitable in the majority of circumstances it is recognised that there may be exceptions. Any local or project-specific adaptations of the metric must be transparent and fully justified.

Multiplier categories and values

Table 20: Overview of the different multipliers used for components of Metric 3.1 highlighting levels and scores given to each level.

Component	Multiplier categories and numerical values					
Distinctiveness	Very High (8)	High (6)	Medium (4)	Low (2)	Very low (0)	
Condition	Good (3)	Fairly Good (2.5)	Moderate (2)	Fairly Poor (1.5)	Poor (1)	N/A
Strategic multipliers	High (1.15)	Medium (1.1)	Low (1)			
Technical Difficulty Creation	Low (1)	Medium (0.67)	High (0.33)	Very High (0.1)		
Technical Difficulty Enhancement	Low (1)	Medium (0.67)	High (0.33)			
Spatial risk terrestrial	Compensation inside LPA or NCA, or deemed to be sufficiently local, to site of biodiversity loss (1)		Compensation outside LPA or NCA of impact site but in neighbouring LPA or NCA (0.75)		Compensation outside LPA or NCA of impact site and beyond neighbouring LPA or NCA (0.5)	
Spatial risk rivers and streams	Within the waterbody (1)		Outside of the waterbody (0.75)		Outside of catchment (0.5)	
Spatial risk intertidal habitats	Intertidal habitats - Compensation inside same Marine Plan Area, or deemed to be sufficiently local, to site of biodiversity loss (1)		Intertidal habitats - Compensation outside same Marine Plan Area but in neighbouring Marine Plan Area (0.75)		Intertidal habitats - Compensation outside Marine Plan Area of impact site and beyond neighbouring Marine Plan Area (0.5)	

Scenario testing: Woodland creation

Table 21: Scenario testing - Example of where multipliers could incentivise the creation of less distinctive or poorer quality woodland habitats (example for on-site habitat creation).

Habitat	Area	Distinctiveness	Condition	Strategic significance	Time to target condition (years)	Temporal multiplier	Difficulty multiplier	Biodiversity units
Other woodland; broadleaved	2	Medium 4	Good 3	Formally identified in local strategy 1.15	30+	0.320	Low 1	**8.83**
Other woodland; broadleaved	2	Medium 4	Moderate 2	Formally identified in local strategy 1.15	15	0.586	Low 1	**10.78**
Other woodland; broadleaved	2	Medium 4	Fairly Poor 1.5	Formally identified in local strategy 1.15	7	0.779	Low 1	**10.75**
Lowland mixed deciduous woodland	2	High 6	Moderate 2	Formally identified in local strategy 1.15	30+	0.320	High 0.33	**2.91**

Scenario testing: Conversion of Coniferous Woodland to a Raised bog: Enhancement versus creation

Enhancement of Other Coniferous woodland into Lowland raised bog. Showing habitats units delivered of 4.32.

	Baseline habitats		Post development/ post intervention habitats: Proposed Habitat (Pre-populated but can be overridden)		Change in distinctiveness and condition		Area (hectares)	Distinctiveness	Condition	Strategic significance	Temporal risk multiplier		Difficulty risk	Habitat units delivered
Baseline ref	Baseline habitat		Proposed Broad Habitat	Proposed habitat	Distinctiveness change	Condition change				Strategic significance	Standard or adjusted time to target condition	Final time to target condition/years	Final difficulty of enhancement	
1	Woodland and forest - Other coniferous woodland		Wetland	Lowland raised bog	Low - V.High	Lower Distinctiveness Habitat - Good	1	V.High	Good	Area/compensation not in local strategy/ no local strategy	Standard time to target condition applied	30+	High	4.32

Removal of coniferous woodland, losing 2.00 habitat units. Creation of lowland raised bog, creating 0.77 habitat units. Resulting in a net loss of 1.23 habitat units.

	Habitats and areas			Distinctiveness	Condition	Strategic significance	Suggested action to address habitat losses	Ecological baseline	Retention category biodiversity value					
Ref	Broad Habitat	Habitat Type	Area (hectares)	Distinctiveness	Condition	Strategic significance		Total habitat units	Area retained	Area enhanced	Baseline units retained	Baseline units enhanced	Area habitat lost	Units lost
1	Woodland and forest	Other coniferous woodland	1	Low	Poor	Area/compensation not in local strategy/ no local strategy	Same distinctiveness or better habitat required ≥	2.00	0	0	0.00	0.00	1.00	2.00
2														

Post development/ post intervention habitats									
Broad Habitat	Proposed habitat	Area (hectares)	Distinctiveness	Condition	Strategic significance	Temporal multiplier		Difficulty	Habitat units delivered
			Distinctiveness	Condition	Strategic significance	Standard or adjusted time to target condition	Final time to target condition/years	Final difficulty of creation	
Wetland	Lowland raised bog	1	V.High	Good	Area/compensation not in local strategy/ no local strategy	Standard time to target condition applied	30+	Very High	0.77

Figure 18: Scenario testing - example of where enhancement to new habitat results in a greater number of units that the removal and then creation of a new habitat (forest to bog example).

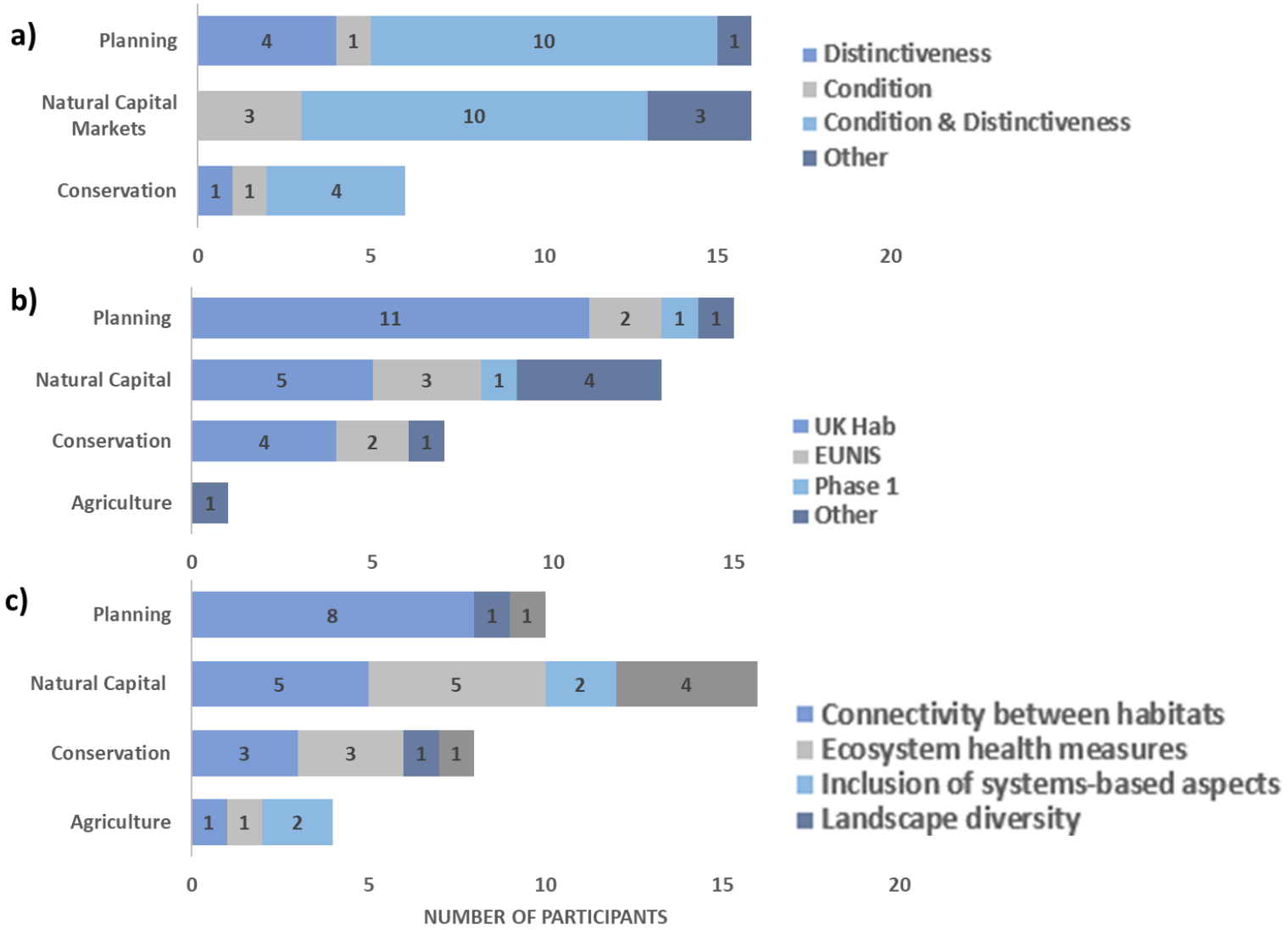

Figure 19: Results from Stakeholder Polls. An administrative error meant that the first poll was not distributed to the agricultural sector

Correspondence tables: EUNIS, UK Hab and Metric 3.1 habitat classifications

Grasslands & Lands Dominated by Forbs, Mosses Or Lichens

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
E1 Dry Grassland (~1000 Ha)					G1 and g2	Lowland dry acid grassland Upland acid grassland Bracken Upland calcareous grassland Lowland calcareous grassland
	E1.2 Perennial calcareous grassland and basic steppes				G2	Lowland Calcareous grassland
		E1.26 Sub-Atlantic semi-dry calcareous grassland (CG2 CG7 CG10*) **[H6210]**			G2a5 or gsb7	Lowland Calcareous grassland
	E1.7 Closed non-Mediterranean dry acid and neutral grassland				g1a or g1b	Lowland dry acid grassland Upland dry acid grassland
		E1.71 Nardus stricta swards (U5*)			g1b6	Upland dry acid grassland
					g1a or g1b	Lowland dry acid grassland

		E1.72 Agrostis - Festuca grassland			Upland dry acid grassland
			E1.72# Species-rich Nardus grassland, on siliceous substrates in mountain areas (CG10* CG11 U4c U5c) **[H6230]**	G2b6	Upland calcareous grassland
			E1.72x Other Agrostis - Festuca grassland (U4* CG10*)	G2b or g1b or g1a	Upland calcareous grassland Upland acid grassland Lowland dry acid grassland
		E1.73 Deschampsia flexuosa grassland (U2)		G1b6	Upland acid grassland
	E1.9 Open non-Mediterranean dry acid and neutral grassland, including inland dune grassland			g1a	Lowland dry acid grassland
		E1.92 Perennial open siliceous grassland (U1*)		g1a6	Lowland dry acid grassland
	E1.B Heavy-metal grassland			s1c	Sparsely vegetated land – Calaminarian grassland
		E1.B1 Atlantic heavy-metal grassland (CG10* CG13* OV37 non-NVC) **[H6130]**		s1c5	Sparsely vegetated land – Calaminarian grassland
					Acid grassland

E2 Mesic grasslands (~1179000 Ha)				g1 or g2 or g3 or g4	Calcareous grassland Neutral grassland Modified grassland
	E2.1 Permanent mesotrophic pastures and aftermath-grazed meadows			g1 or g2 or g3 or g4	Acid grassland Calcareous grassland Neutral grassland Modified grassland
		E2.11 Unbroken pastures (MG5 MG6*)		g1 or g2 or g3 or g4	Acid grassland Calcareous grassland Neutral grassland Modified grassland
			E2.111 Ryegrass pastures (MG6*)	G4	Modified grassland
			E2.112 Atlantic Cynosurus-Centaurea pastures (MG5)	G3c6	Other neutral grassland
		E2.12 Ditch-broken pastures (MG6*)		g3c5 secondary code 25	Other neutral grassland
		E2.13 Abandoned pastures (non-NVC)		g3c5 or g3c8	Other neutral grassland
	E2.2 Low and medium altitude hay meadows			g3	Neutral grassland
		E2.21 Atlantic hay meadows (MG1 MG2)		g3c (g3c5 if Arrhenatherum dominated)	Other neutral grassland
		E2.24 Boreal and sub-boreal meadows (MG3) **[H6520]**		g3c	Other neutral grassland

	E2.6 Agriculturally-improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns (MG7)			g4 or c1b	Modified grassland Cropland – Temporary grass and clover leys
	E2.8 Trampled mesophilous grasslands with annuals (OV12, OV19-23)			secondary code 17	Sparsely vegetated land – Ruderal/Ephemeral
E3 -Seasonally wet and wet grasslands				secondary code 119	
	E3.4 Moist or wet eutrophic and mesotrophic grassland			g3 or g4 119	Neutral grassland Modified grassland
		E3.41 Atlantic and sub-Atlantic humid meadows (M22 M23b MG8 MG9)		g3c8 14 15	Other neutral grassland
		E3.42 Juncus acutiflorus meadows (M23a)		g3c8 14 15	Other neutral grassland
		E3.44 Flood swards and related communities (MG10-13 OV28)		g3c8 14 15	Other neutral grassland
	E3.5 Moist or wet oligotrophic grassland				
		E3.51 Molinia caerulea meadows and related communities		f2b	Wetland – Purple moor grass and rush pasture
			E3.511 Calcicline purple moorgrass meadows (M26) **[H6410]**	f2b5	Wetland – Purple moor grass and rush pasture
			-E3.512 Acidocline purple moorgrass meadows (M25*)	g1b6	Upland acid grassland
		E3.52 Heath Juncus meadows and humid Nardus stricta swards (U5b U6)		g1b6	Upland acid grassland
				g	Grassland

E4 Alpine and subalpine grassland (~531000 Ha)	E4.1 Vegetated snow-patch				secondary code 126	
		E4.11 Boreo-alpine acidocline snow-patch grassland and herb habitats			g1b secondary code 126	Upland acid grassland
			E4.115 Boreal moss snowbed communities		g1b secondary code 126 176	Upland acid grassland
				E4.115# Polytrichastrum-Kiaeria snowbed (U11) [H6150*]	g1b5	Upland acid grassland
				E4.115x Rhytidiadelphus-Deschampsia snowbed (U13b)	g1b6 secondary code 126 176	Upland acid grassland
			E4.116 Boreo-alpine Deschampsia- Anthoxanthum communities (U13a)		g1b6 secondary code 126	Upland acid grassland
			E4.117 Boreo-alpine herb-rich acid snowbed communities (U14) **[H6150*]**		g1b5 secondary code126	Upland acid grassland
		E4.12 Boreo-alpine calcicline snow-patch grassland and herb habitats (CG12) **[H6170*]**			g2b5 secondary code 126	Upland calcareous grassland
		E4.12€ Alpine and subalpine calcareous grasslands (CG12 CG13* CG14) (includes E4.12, F2.29#1) **[H6170]**			g2b5 secondary code 126	Upland calcareous grassland
		E4.14 Boreo-alpine fern snowbed grassland (U18*) [**H8110***]			s1a5	Sparsely vegetated land – Inland rock outcrop and scree habitats

	E4.2 Moss and lichen dominated mountain summits, ridges and exposed slopes			
		E4.21 Oroboreal Carex bigelowii-Racomitrium moss-heaths (U9-10) [**H6150***]	g1b5 secondary code 176	Upland acid grassland
		E4.22 Rock pavement lichen communities (non-NVC)	s1a or s1b or s1c or s1d	Sparsely vegetated land - Inland rock outcrop and scree habitats Sparsely vegetated land - Limestone pavement Sparsely vegetated land - Calaminarian grasslands Sparsely vegetated land - Other inland rock and scree
		E4.23 Rock pavement, plateau and summital moss heaths (non-NVC)	s1a or s1b or s1c or s1d secondary code 175	Sparsely vegetated land - Inland rock outcrop and scree habitats Sparsely vegetated land - Limestone pavement Sparsely vegetated land - Calaminarian grasslands Sparsely vegetated land - Other inland rock and scree
	E4.3 Acid alpine and subalpine grassland		g1b	Upland acid grassland
		E4.32 Oroboreal acidocline grassland (U7-8) [**H6150***]	g1b5	Upland acid grassland

		E4.32€ Siliceous alpine and boreal grasslands (U7-12 U14) (includes E4.115#, E4.117, E4.21, E4.32, F2.11) [**H6150**]	g1b5	Upland acid grassland
E5 Woodland fringes and clearings and tall forb stands (79000 Ha)			secondary code 16 and/or 165	
	E5.1 Anthropogenic herb stands		c1 or u1a secondary code 17	Cropland Urban - Open Mosaic Habitats on Previously Developed Land
	E5.2 Thermophile woodland fringes			
		E5.22 Mesophile fringes (non-NVC)	g1 or g2 or g3	Acid grassland Calcareous grassland Neutral grassland
	E5.3 Pteridium aquilinum fields		g1c	Grassland - Bracken
		E5.31 Sub-Atlantic Pteridium aquilinum fields (U20 W25*)	g1c	Grassland - Bracken
	E5.4 Moist or wet tall-herb and fern fringes and meadows		f2	Wetland
		E5.41 Screens or veils of perennial tall herbs lining watercourses (non-NVC)	f2d secondary code 16 or 17, 48 (for non-native)	Wetland Sparsely vegetated land - Ruderal/Ephemeral
		E5.42 Tall-herb communities of humid meadows (M27 M28)	f2 or g1 with secondary codes 14 or 15, 16 or 17 150, 178-181, or	Wetland Acid grassland Sparsely vegetated land - Ruderal/Ephemeral

			t2a7 for upper saltmarsh	
	E5.5 Subalpine moist or wet tall-herb and fern stands			
		E5.59 Oro-boreal tall-herb communities (U17) [**H6430**]	s1a9	Grassland - Tall herb communities (H6430)
		E5.5B Alpine and subalpine fern stands (U19 non-NVC)	g1b secondary codes 16, 120	Upland acid grassland
		E5.5x Luzula sylvatica-Vaccinium myrtillus tall-herb community (U16)	g1b secondary codes 15, 156,	Upland acid grassland

Coastal habitats (B)

EUNIS Level 2	**EUNIS Level 3**	**EUNIS Level 4**	**EUNIS Level 5**	**EUNIS Level 6**	**UK Hab code**	**Biodiversity Metric habitat**
B1 Coastal dunes and sandy shores					s3	Sparsely vegetated land - Coastal sand dunes Sparsely vegetated land - Coastal vegetated shingle
	B1.1 Sand beach driftlines				s3a	Sparsely vegetated land - Coastal sand dunes
		B1.12 Middle European sand beach annual communities (SD2* non-NVC)			S3a	Sparsely vegetated land - Coastal sand dunes
					T2h	

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	Biodiversity Metric habitat
	B1.2 Sand beaches above the driftline	B1.21 Unvegetated sand beaches above the driftline			T2h	
		B1.23 Boreo-arctic sand beach perennial communities (SD5*)			T2h	
	B1.3 Shifting coastal dunes				S3a	Sparsely vegetated land - Coastal sand dunes
		B1.31 Embryonic shifting dunes (SD2* SD4 SD5*) [**H2110**]			S3a5	Sparsely vegetated land - Coastal sand dunes
		B1.32 White dunes (SD5* SD6) [**H2120**]			S3a6	Sparsely vegetated land - Coastal sand dunes
	B1.4 Coastal stable dune grassland (grey dunes)				S3a	Sparsely vegetated land - Coastal sand dunes
		B1.41 Northern fixed grey dunes (SD7-8 SD9* SD10-12 CG10*) [**H2130***]			S3a7	Sparsely vegetated land - Coastal sand dunes
		B1.41€ Fixed dunes with herbaceous vegetation (`grey dunes`) (SD7 SD8 SD9* SD10-12 SD19 CG10*) (includes B1.41, B1.47) [**H2130**]			S3a7	Sparsely vegetated land - Coastal sand dunes
		B1.47 Dune fine-grass annual communities (SD19) [**H2130***]			S3a7	Sparsely vegetated land - Coastal sand dunes
		B1.4x Species-poor Ammophila-Arrhenatherum dune grassland (SD9* non-NVC)			S3a	Sparsely vegetated land - Coastal sand dunes
	B1.5 Coastal dune heaths				S3a	Sparsely vegetated land - Coastal sand dunes
		B1.51 Empetrum brown dunes (H11b) [**H2140**]			S3a8	Sparsely vegetated land - Coastal sand dunes

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	Biodiversity Metric habitat
		B1.52 Calluna vulgaris brown dunes (H11a/c H10) [**H2150**]			S3a9	Sparsely vegetated land - Coastal sand dunes
	B1.6 Coastal dune scrub				s3a secondary code10	Sparsely vegetated land - Coastal sand dunes
		B1.61 Coastal dune thickets (SD18, W23*)			s3a secondary code10	Sparsely vegetated land - Coastal sand dunes
		B1.62 Salix arenaria mats (SD16* SD12*) [**H2170**]			s3a7 secondary code 28	Sparsely vegetated land - Coastal sand dunes
		B1.63 Dune Juniperus thickets (non-NVC) [**H2250**]			s3a4	Sparsely vegetated land - Coastal sand dunes
	B1.8 Moist and wet dune slacks (includes B1.81-B1.86) [**H2190**]				s3a3	Sparsely vegetated land - Coastal sand dunes
		B1.81 Dune-slack pools (A10* A11* A13* A16* A22* other) [**H2190***]			s3a3	Sparsely vegetated land - Coastal sand dunes
		B1.82 Dune-slack pioneer swards (SD13) [**H2190***]			s3a3	Sparsely vegetated land - Coastal sand dunes
		B1.83 Dune-slack fens (SD14-15 non-NVC) [**H2190***]			s3a3	Sparsely vegetated land - Coastal sand dunes
		B1.84 Dune-slack grassland and heaths (SD16* SD17) [**H2190***]			s3a3	Sparsely vegetated land - Coastal sand dunes
		B1.85 Dune-slack reedbeds, sedgebeds and canebeds (S4* S19* other) [**H2190***]			s3a3 or f2e secondary code 138	Sparsely vegetated land - Coastal sand dunes Wetland - Reedbeds

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	Biodiversity Metric habitat
		B1.86 Coastal dunes: wet dune slacks: dominated by shrubs or trees (W1* W2* W4* W6*) [**H2190***]			s3a3 secondary code 10 or 11	Sparsely vegetated land - Coastal sand dunes
	B1.9 Machair (SD8* SD17* MG11* OV4* non-NVC) [**H21A0**]				secondary code 26	
B2 Coastal shingle					s3b	Sparsely vegetated land - Coastal vegetated shingle
	B2.1 Shingle beach driftlines				s3b	Sparsely vegetated land - Coastal vegetated shingle
		B2.12 Atlantic and Baltic shingle beach drift lines (SD2* SD3* MC6* non-NVC) [**H1210**]			s3b6	Sparsely vegetated land - Coastal vegetated shingle
	B2.2 Unvegetated mobile shingle beaches above the driftline				s3	Sparsely vegetated land - Coastal sand dunes Sparsely vegetated land - Coastal vegetated shingle
	B2.3 Upper shingle beaches with open vegetation (SD1 SD3* non-NVC) [**H1220***]				S3b5	Sparsely vegetated land - Coastal vegetated shingle
	B2.4 Fixed shingle beaches, with				Sb3	Sparsely vegetated land - Coastal vegetated shingle

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	Biodiversity Metric habitat
	herbaceous vegetation	B2.41 Euro-Siberian gravel bank grasslands (MG1* non-NVC) [**H1220***]			s3b5	Sparsely vegetated land - Coastal vegetated shingle
		B2.4# Other herbaceous vegetation of fixed coastal shingle (CG10* MC5* MC8* MC9* U1* U4* U20* non-NVC) [**H1220***]			s3b5	Sparsely vegetated land - Coastal vegetated shingle
		B2.4€ Perennial vegetation of stony banks (see component types) (includes B2.3, B2.4, B2.5, B2.6) [**H1220**]			s3b5	Sparsely vegetated land - Coastal vegetated shingle
	B2.5 Shingle and gravel beaches with scrub (H10* W22* W23* W24* other) [**H1220***]				s3b5 secondary code 10	Sparsely vegetated land - Coastal vegetated shingle
	B2.6 Shingle and gravel beach woodland (W1* W9* W11* non-NVC) [**H1220***]				s3b5 secondary code 10 or 11	Sparsely vegetated land - Coastal vegetated shingle
B3 Rock cliffs, ledges and shores, including the supralittoral					s2	Sparsely vegetated land - Maritime cliff and slopes
	B3.1 Supralittoral rock (lichen or splash zone)				t1e	
	B3.2 Unvegetated rock cliffs, ledges, shores and islets				s2	Sparsely vegetated land - Maritime cliff and slopes
	B3.3 Rock cliffs, ledges and shores, with angiosperms				s2a	Sparsely vegetated land - Maritime cliff and slopes
		B3.31 Atlantic sea-cliff communities (MC1-3 MC5 MC6* MC7-10 MC12 H7 H8* H10* CG10* MG1*			s2a5	Sparsely vegetated land - Maritime cliff and slopes

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	Biodiversity Metric habitat
		U20* W21* W22* W23* W24* W25* other) [**H1230***]				
		B3.31€ Vegetated sea cliffs of the Atlantic and Baltic coasts (various) (includes B3.31, B3.4) [**H1230**]			s2a5	Sparsely vegetated land - Maritime cliff and slopes
	B3.4 Soft sea-cliffs, often vegetated (various) [**H1230***]				s2a6	Sparsely vegetated land - Maritime cliff and slopes

Mires, Bogs and Fens (D)

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UKHab code	DEFRA Biodiversity Metric Definition
D1 Raised and Blanket bogs					F1	
	D1.1 Raised bogs				F1b	Wetland - Lowland raised bog
		D1.11 Active, relatively undamaged raised bogs (M18* M19* M1* M2*) [**H7110**]			F1b	Wetland - Lowland raised bog
		D1.12 Damaged, inactive bogs			F1b5	Wetland - Lowland raised bog
			D1.12# Degraded raised bogs still capable of natural regeneration (M3* M15* M16* M17* M18* M19* M20* M25* other) [**H7120**]		F1b6	Wetland - Lowland raised bog

			D1.12x Damaged, inactive bogs not capable of restoration within 30 years (various)	F1b7	Wetland - Lowland raised bog
	D1.2 Blanket bogs (includes D1.21, D1.22, D1.24) [**H7130**]			F1a	Wetland - Blanket bog
		D1.21 Hyperoceanic low-altitude blanket bogs, typically with dominant Trichophorum (M1* M2* M3* M15* M17* M18* M25*) [**H7130***]		F1a5	Wetland - Blanket bog
		D1.22 Montane blanket bogs, Calluna and Eriophorum vaginatum often dominant (M1* M2* M3* M15* M19* M20*) [**H7130***]		f1a5 secondary code 13	Wetland - Blanket bog
		D1.24 Wet bare peat and peat haggs on blanket bogs [**H7130***]		f1a5 secondary code 127 or 85 where peat has been cut	Wetland - Blanket bog
D2 Valley mires, poor fens and transition mires				f2a f2c	Wetland - Fens (upland and lowland)
	D2.1 Valley mires			f2a f2c secondary code 187	Wetland - Fens (upland and lowland)
		D2.11 Acid valley mires (M21)		f2a f2c secondary code 187	Wetland - Fens (upland and lowland)
	D2.2 Poor fens and soft-water spring mires			f2a f2c secondary codes 183 or 184 or185	Wetland - Fens (upland and lowland)
		D2.22 Carex nigra, Carex canescens, Carex echinata fens (M6-7)		f2f secondary code 186	

		D2.2C Soft water spring mires (M31-33 M35-36)	f2f secondary code 186	
	D2.3 Transition mires and quaking bogs		f2a8 or f2c8	Wetland - Fens (upland and lowland)
		D2.31 Carex lasiocarpa swards (M4* M5* M9*) [**H7140***]	f2a8 or f2c8 secondary code 178 and 179 or 180 and 187	Wetland - Transition mires and quaking bogs (H7140)
		D2.3 Transition mires and quaking bogs D2.31 Carex lasiocarpa swards (M4* M5* M9*) [H7140*] D2.32 Carex diandra quaking mires (M9*) [**H7140***]	f2a8 or f2c8 secondary code 178 and 179 or 180 and 188	Wetland - Transition mires and quaking bogs (H7140)
		D2.33 Carex rostrata quaking mires (M4* M5* M8 M9*) [**H7140***]	f2a8 or f2c8 secondary code 179 or 181	Wetland - Transition mires and quaking bogs (H7140)
		D2.33€ Transition mires and quaking bogs (Annex I) (includes D2.31-33, D2.39, D2.3#) [**H7140**]	f2a8 or f2c8 secondary code 178 and 179 or 180 and 188	Wetland - Transition mires and quaking bogs (H7140)
		D2.37 Rhynchospora alba quaking bogs (M1* M2*) [**H7150**]	f2a8 or f2c8 secondary code 24	Wetland - Transition mires and quaking bogs (H7140)
		D2.39 Menyanthes trifoliata and Potentilla palustris rafts (S27 non-NVC) [**H7140***]	f2a8 or f2c8 secondary code 178 and 179 or 180 or 181 or 182 and 186	Wetland - Transition mires and quaking bogs (H7140)

		D2.3# Hypericum elodes-Potamogeton polygonifolius soakway (M29*) [**H7140***]	f2a8 or f2c8 secondary code 178 and 179 or 180 and 186	Wetland - Transition mires and quaking bogs (H7140)
D4 Base-rich fens and calcareous spring mires			f2a or f2c	Wetland - Fens (upland and lowland)
	D4.1 Rich fens, including eutrophic tall-herb fens and calcareous flushes and soaks		f2a or f2c	Wetland - Fens (upland and lowland)
		D4.12 Schoenus ferrugineus fens (M10*) [**H7230***]	f2a7 or f2c7 secondary code 14 or 15 and 169 and 175	Wetland - Fens (upland and lowland)
		D4.15 Carex dioica, Carex pulicaris and Carex flava fens (M10*) [**H7230***]	f2a7 or f2c7 secondary code 14 or 15 and (169 and 175) or (171 and 183) or 184	Wetland - Fens (upland and lowland)
		D4.15€ Alkaline fens (includes D4.12, D4.15, D4.19, D4.1C) [**H7230**]	f2a7 or f2c7 secondary code 171	Wetland - Fens (upland and lowland)
		D4.17 Carex saxatilis fens (M12) [**H7240***]	f2c5 secondary code 14 or 15	
		D4.19 British Carex demissa - Saxifraga aizoides flushes (M11*) [**H7230***]	f2a7 or f2c7 secondary codes 14 or 15 and 171 and 186	Wetland - Fens (upland and lowland)

		D4.1C Carex rostrata alkaline fens (M9*) [**H7230***]	f2a7 or f2c7 secondary code 14 or 15 and 171 and 186 or 183	Wetland - Fens (upland and lowland)
		D4.1I Tall herb fens (S25*)	f2a or f2c 16 secondary code 174	Wetland - Fens (upland and lowland)
		D4.1N Hard water spring mires (M37 M38) [**H7220**]	f2a6 or f2c6	Wetland - Fens (upland and lowland)
	D4.2 Basic mountain flushes and streamsides, with a rich arctic-montane flora		f2c	
		D4.24 British mica flushes (M10* M11* M34) [**H7240***]	f2c5	
		D4.24€ Alpine pioneer formations of the Caricion bicoloris-atrofuscae (M10* M11* M12 M34) (includes D4.17, D4.24) [**H7240**]	f2c5	

Montane habitats

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
F2 Artic, alpine and subalpine scrub					h1c	Heathland and shrub - Mountain heaths and willow scrub
	F2.1 Subarctic and alpine dwarf willow scrub				h1c5	Heathland and shrub - Mountain heaths and willow scrub
		F2.11 Boreo-alpine acidocline snow-patch Salix herbacea scrub (U12) [**H6150***]			g1b5	Grassland - Upland acid grassland
		F2.1# Sub-Arctic Salix spp. scrub (W20) [**H4080**]			h1c6	Heathland and shrub - Mountain heaths and willow scrub
	F2.2 Evergreen alpine and subalpine heath and scrub				h1c	Heathland and shrub - Mountain heaths and willow scrub
		F2.25 Boreo-alpine and arctic heaths (H10* H12* H13-15 H16* H17 H18* H19-20 H21* H22*) [**H4060**]			h1c5	Heathland and shrub - Mountain heaths and willow scrub
		F2.29 Dryas octopetala mats				
			F2.29#1 Dryas mats not on limestone pavement (CG13* CG14) [**H6170***]		g2b5	Grassland - Upland calcareous grassland
			F2.29#2 Dryas mats on limestone pavement (CG13*) [**H8240***]		s1b5	Sparsely vegetated land - Limestone pavement

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
	F2.3 Subalpine deciduous scrub				h1c	Heathland and shrub - Mountain heaths and willow scrub
		F2.32 Subalpine and oroboreal Salix brush			h1c	Heathland and shrub - Mountain heaths and willow scrub
			F2.323 Northern British willow brush (non-NVC)		w1h5 secondary code 37	Woodland and forest - Other woodland; mixed
F3 Temperate and Mediterranean – montane scrub						
	F3.1 Temperate thickets and scrub					
		F3.11 Medio-European rich-soil thickets (W21* W22*)			h3d, s3a7 secondary code 10	Heathland and shrub - Bramble scrub Sparsely vegetated land - Coastal sand dunes
		F3.13 Atlantic poor soil thickets (W24* W25*)			h3d	Heathland and shrub - Bramble scrub
		F3.14 Temperate Cytisus scoparius fields (W23*)			h3e	Heathland and shrub - Gorse scrub
		F3.15 Ulex europaeus thickets (W23*)			h3e	Heathland and shrub - Gorse scrub
		F3.16 Juniperus communis scrub			secondary code 22	
			F3.16#1 Juniperus communis formations on heaths or		g2a or h1a secondary code 22	Grassland - Lowland calcareous grassland

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
			calcareous grasslands (W19*) [**H5130**]			Heathland and shrub - Lowland Heathland
			F3.16#2 Juniperus communis scrub in native pinewoods (W19*) [**H91C0***]		w2a5	Woodland and forest - Native pine woodlands
		F3.17 Corylus thickets			h3b6	Heathland and shrub - Hazel scrub
			F3.17#1 Corylus thickets on calcareous rocky slopes (W9*) [**H9180***]		w1b5	Woodland and forest - Upland mixed ashwoods
			F3.17#2 Corylus thickets on limestone pavement (W9*) [**H8240***]		s1b5 secondary code 10	Sparsely vegetated land - Limestone pavement
			F3.17x Corylus thickets not on calcareous rocks (W11*)		h3b6	Heathland and shrub - Hazel scrub
F4 Temperate shrub heathland					h1	
	F4.1 Wet heaths				h1a or h1b	Heathland and shrub - Lowland Heathland Heathland and shrub - Upland Heathland
		F4.11 Northern wet heaths (M15* M16*) [**H4010**]			h1a7 or h1b6	Heathland and shrub - Lowland Heathland Heathland and shrub - Upland Heathland

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
		F4.13 Molinia caerulea wet heaths (M25*)			f2b or g1 (secondary codes 14 or 15)	Wetland - Purple moor grass and rush pastures
	F4.2 Dry heaths (includes F4.21-F4.25) [**H4030**]				h1a5 or h1b5 or s2a (coastal)	Heathland and shrub - Lowland Heathland Heathland and shrub - Upland Heathland Sparsely vegetated land - Inland rock outcrop and scree habitats
		F4.21 Submontane Vaccinium - Calluna heaths (H12* H18* H21* H22*) [**H4030***]			h1a5	Heathland and shrub - Lowland Heathland
		F4.22 Sub-Atlantic Calluna - Genista heaths (H9 H16*) [**H4030***]			h1a5	Heathland and shrub - Lowland Heathland
		F4.23 Atlantic Erica – Ulex heaths (H8*) [**H4030***]			h1a5	Heathland and shrub - Lowland Heathland
		F4.25 Boreo-Atlantic Erica cinerea heaths (H7* H10*) [**H4030***]			h1a5	Heathland and shrub - Lowland Heathland
F9 Riverine and fen scrubs						
	F9.2 Salix carr and fen scrub				w1d	Woodland and forest - Wet woodland
		F9.21 Grey willow carrs (W1 W2* W3* W5*)			w1d	Woodland and forest - Wet woodland

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
		F9.22 Sphagnum willow carrs (W4*)			w1d	Woodland and forest - Wet woodland
		F9.23 Bay willow carrs (W3*)			w1d	Woodland and forest - Wet woodland
	F9.3 Southern riparian galleries and thickets				g3 secondary codes 16 or 17, 48	Neutral grassland
		F9.35 Riparian stands of invasive shrubs (non-NVC)				

Woodland, Forest and Other Wooded Land (G)

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
G1 Broadleaved deciduous woodland					w1	
	G1.1 Riparian and gallery woodland, with dominant Alnus, Betula, Populus or Salix				w1d	Woodland and forest - Wet woodland
		G1.11 Riverine Salix woodland (W6*) [**H91E0***]			w1d5	Woodland and forest - Wet woodland
	G1.2 Mixed riparian floodplain and gallery woodland				w1d	Woodland and forest - Wet woodland
		G1.21 Riverine Fraxinus - Alnus woodland, wet at high but not at low water (W2* W5* W6* W7*) [**H91E0***]			w1d5 secondary code 119	Woodland and forest - Wet woodland
		G1.21€ Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae,			w1d5	Woodland and forest - Wet woodland

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
		Salicion albae) (W2* W5* W6* W7*) (includes G1.11, G1.21) [**H91E0**]				
	G1.4 Broadleaved swamp woodland not on acid peat					
		G1.41 Alnus swamp woods not on acid peat (W2* W3* W5* W6* W7*)			w1d	Woodland and forest - Wet woodland
	G1.5 Broadleaved swamp woodland on acid peat					
		G1.51 Sphagnum Betula woods			w1d secondary codes 163, 127	Woodland and forest - Wet woodland
			G1.51# Birch bog woodland (W4* M17* M18*) [**H91D0***]		w1d6	Woodland and forest - Wet woodland
			G1.51x Other sphagnum Betula woods (W2* W4*)		w1d secondary codes 163, 127	Woodland and forest - Wet woodland
		G1.52 Alnus swamp woods on acid peat (W4*)			w1d secondary code 127	Woodland and forest - Wet woodland
	G1.6 Fagus woodland				w1c	Woodland and forest - Lowland beech and yew woodland
		G1.62 Atlantic acidophilous Fagus forests (W15)			w1c5	Woodland and forest - Lowland beech and yew woodland
	G1.8 Acidophilous				w1a	Woodland and forest - Upland oakwood

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
	Quercus-dominated woodland	G1.81 Atlantic Quercus robur - Betula woods (W16*)			w1a or w1f7	Woodland and forest - Upland oakwood
		G1.83 Atlantic Quercus petraea woods (W11* W17*) [**H91A0***]			w1a5	Woodland and forest - Upland oakwood
		G1.83€ Old sessile oak woods with Ilex and Blechnum in the British Isles (W11* W17*) (includes G1.83, G1.91#) [**H91A0**]			w1a5	Woodland and forest - Upland oakwood
	G1.9 Non-riverine woodland with Betula, Populus tremula or Sorbus aucuparia				W1f	Woodland and forest - Lowland mixed deciduous woodland
		G1.91 Betula woodland not on marshy terrain			w1f secondary code 119 or 120	Woodland and forest - Lowland mixed deciduous woodland
			G1.91#1 Atlantic Betula - Quercus petraea woodlands (W11* W17*) [**H91A0***]		w1a5	Woodland and forest - Upland oakwood
			G1.91#2 Betula woodland in native pinewoods (W11* W17*) [**H91C0***]		w2a5	Woodland and forest - Native pine woodlands
			G1.91x Other dry Betula woodlands (W10* W11* W16* W17*)		w1e	Woodland and forest - Upland birchwoods
		G1.92 Populus tremula woodland (W11*)			w1g7	Woodland and forest - Other woodland; broadleaved

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
	G1.A Meso- and eutrophic Quercus, Carpinus, Fraxinus, Acer, Tilia, Ulmus and related woodland				w1	
		G1.A1 Quercus-Fraxinus-Carpinus betulus woodland on eutrophic and mesotrophic soils (W10*)			w1f7	Woodland and forest - Lowland mixed deciduous woodland
		G1.A2 Non-riverine Fraxinus woodland			w1	
			G1.A2#1 Fraxinus woodland of slopes, screes and ravines (W7* W8* W9*) [**H9180***]		w1b5	Woodland and forest - Upland mixed ashwoods
			G1.A2#1€ Tilio-Acerion forests of slopes, screes and ravines (W7* W8* W9*) (includes F3.17#1, G1.A2#1) [**H9180**]		w1b5	Woodland and forest - Upland mixed ashwoods
			G1.A2#2 Fraxinus woodland on limestone pavement (W9*) [**H8240***]		s1b5 secondary code 10	Sparsely vegetated land - Limestone pavement
			G1.A2x Other non-riverine Fraxinus woodland (W8*)		w1b6 or w1f	Woodland and forest - Upland mixed ashwoods Woodland and forest - Lowland mixed deciduous woodland
	G1.C Highly artificial broadleaved deciduous forestry plantations				w1h secondary code 36	Woodland and forest - Other woodland; mixed

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
	G1.D Fruit and nut tree orchards				c1	
		G1.D4 Fruit orchards				
			G1.D4x1 Traditionally managed orchards		g1 or g2 or g3 secondary code 21	
			G1.D4x2 Intensively managed orchards		c1d	Cropland - Non-cereal crops
G3 Coniferous woodland					w2	
	G3.4 Pinus sylvestris woodland south of the taiga				w2a	Woodland and forest - Native pine woodlands
		G3.41 Caledonian forest (W18*) [**H91C0***]			w2a5	Woodland and forest - Native pine woodlands
		G3.41€ Caledonian forest (Annex I) (W18* W19* W11* W17*) (includes F3.16#2, G1.91#2, G3.41) [**H91C0**]			w2a5	Woodland and forest - Native pine woodlands
		G3.4F European Pinus sylvestris reforestation (W18*)			w2b	Woodland and forest - Other Scot's Pine woodland
	G3.D Boreal bog conifer woodland					
		G3.D1 Boreal Pinus sylvestris bog woods (W18* M18* M19*) [**H91D0***]			w1d6 secondary code 343	Woodland and forest - Wet woodland
		G3.D1€ Bog woodland (W4* W18* M17* M18* M19* other) (includes G1.51#, G3.D1) [**H91D0**]			w1d6 secondary code 342	Woodland and forest - Wet woodland

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
	G3.F Highly artificial coniferous plantations				w2c secondary code 36	Woodland and forest - Other coniferous woodland
		G3.F1 Native conifer plantations (W18*)			w2c secondary codes 36 47	Woodland and forest - Other coniferous woodland
		G3.F2 Exotic conifer plantations (non-NVC types)			w2c secondary codes 36 48	Woodland and forest - Other coniferous woodland
G4 Mixed deciduous and coniferous woodland					w1h	Woodland and forest - Other woodland; mixed
	G4.F Mixed forestry plantations				w1h5 or w1h6 secondary code 36	Woodland and forest - Other woodland; mixed
G5 Lines of trees, small anthropogenic woodlands, recently felled					w	
	G5.1 Lines of trees				w1g6 secondary code 341 or 342 or 343 and 47 and/or 48	Woodland and forest - Other woodland; broadleaved

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
woodland, earlystage woodland and coppice	G5.7 Coppice and early-stage plantations				coppice w1f or w1g or w1h secondary code 51 or 52: early stage lantations w1f w1g or w1h or w2c secondary code 56	Woodland and forest - Lowland mixed deciduous woodland Woodland and forest - Other woodland; broadleaved Woodland and forest - Other woodland; mixed
	G5.8 Recently felled areas				w1f or w1g or w1h or w2c secondary code 53	Woodland and forest - Felled

Inland Unvegetated or sparsely vegetated Habitats (H)

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
H1 Terrestrial underground caves, cave systems, passages and waterbodies					overlying habitat with secondary code 23	
	H1.1 Cave entrances				Not included	
	H1.2 Cave interiors				Not included	
	H1.3 Dark underground passages				Not included	
	H1.5 Underground standing waterbodies				Not included	
	H1.6 Underground running waterbodies				Not included	
	H1.7 Disused underground mines and tunnels				Not included	

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
H2 Screes					s1a	Sparsely vegetated land - Inland rock outcrop and scree habitats
	H2.3 Temperate-montane acid siliceous screes				s1a	Sparsely vegetated land - Inland rock outcrop and scree habitats
		H2.31 Alpine siliceous screes (U21* non-NVC) [**H8110***]			s1a5	Sparsely vegetated land - Inland rock outcrop and scree habitats
		H2.31€ Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani) (U18* U21* non-NVC) (includes E4.14, H2.31 and H5.11#1) [**H8110**]			s1a5	Sparsely vegetated land - Inland rock outcrop and scree habitats
	H2.4 Temperate-montane calcareous and ultra-basic screes (OV38* OV40* non-NVC) [**H8120***]				s1a6	Sparsely vegetated land - Inland rock outcrop and scree habitats
	H2.4€ Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii) (OV38* OV40* non-NVC) (includes H2.41 and H5.11#2) [**H8120**]				s1a6	Sparsely vegetated land - Inland rock outcrop and scree habitats
H3 Inland cliffs, rock pavements and outcrops					s1	
	H3.1 Acid siliceous inland cliffs				s1a	Sparsely vegetated land - Inland rock outcrop and scree habitats
		H3.1# Siliceous rocky slopes with chasmophytic vegetation (U18* U21* non-NVC) [**H8220**]			s1a8	Sparsely vegetated land - Inland rock outcrop and scree habitats

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
		H3.1C Disused siliceous quarries			s1a secondary code 105 and 135	Sparsely vegetated land - Inland rock outcrop and scree habitats
	H3.2 Basic and ultra-basic inland cliffs				s1a	Sparsely vegetated land - Inland rock outcrop and scree habitats
		H3.25 Alpine and sub-mediterranean chasmophyte communities (OV39* OV40* nonNVC) [**H8210**]			s1a7	Sparsely vegetated land - Inland rock outcrop and scree habitats
	H3.4 Wet inland cliffs				s1	
		H3.42 Northern wet inland cliffs (U15 non-NVC)			s1 secondary code 120	
	H3.5 Almost bare rock pavements, including limestone pavements					
		H3.51 Pavements, rock slabs, rock domes			s1d	
			H3.511 Limestone pavements (OV38* OV39* OV40* CG10* non-NVC) [**H8240***]		s1b5	Sparsely vegetated land - Limestone pavement
			H3.511€ Limestone pavements (Annex I) (CG10* CG13* OV38* OV39* OV40* W9* non-NVC) (includes F2.29#2, F3.17#2, G1.A2#, H3.511) [**H8240**]		s1b5	Sparsely vegetated land - Limestone pavement
			H3.51x Non-limestone rock slabs		s1d secondary code 135	
					s1	

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
H5 Miscellaneous inland habitat with very sparse or no vegetation	H5.1 Fjell fields and other freeze-thaw features with very sparse or no vegetation				s1a	Sparsely vegetated land - Inland rock outcrop and scree habitats
		H5.11 Fjell fields with very sparse or no vegetation			s1a	Sparsely vegetated land - Inland rock outcrop and scree habitats
			H5.11#1 Acidic fell-fields (non-NVC) [**H8110***]		s1a5	Sparsely vegetated land - Inland rock outcrop and scree habitats
			H5.11#2 Basic fell-fields (non-NVC) [**H8120***]		s1a6	Sparsely vegetated land - Inland rock outcrop and scree habitats
	H5.3 Sparsely- or un-vegetated habitats on mineral substrates not resulting from recent ice activity				for burnt secondary code 63	
		H5.31 Clay and silt with very sparse or no vegetation			s1	Sparsely vegetated land
		H5.35 Gravel with very sparse or no vegetation			s1 secondary code 145 or 106 for quarried areas	Sparsely vegetated land
		H5.36 Shallow rocky soils with very sparse or no vegetation			s1	Sparsely vegetated land
		H5.37 Boulder fields			s1d secondary code 135	Sparsely vegetated land
	H5.6 Trampled areas				overlying habitat and secondary	

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
					code 73 (and 58 for animals)	

Cultivated and Artificial Habitats (I&J)

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
I1 Arable land and market gardens					C1	
	I1.1 Intensive unmixed crops				c1b or c1c or c1d	Cropland - Temporary grass and clover leys Cropland - Cereal crops Cropland - Non-cereal crops
	I1.2 Mixed crops of market gardens and horticulture				c1f	Cropland - Horticulture
	I1.3 Arable land with unmixed crops grown by low-intensity agricultural methods (OV1* OV3-4* OV7* OV9-10* OV13*)				c1c or c1d7	Cropland - Cereal crops Cropland - Non-cereal crops
	I1.5 Bare tilled, fallow or recently abandoned arable land (OV1* OV3-4* OV7* OV9- 10* OV13*)				c1c or c1c5 secondary code 77 or 78 or 80 or 34 or 43 or 74	Cropland - Cereal crops Cropland - Cereal crops winter stubble
I2 Cultivated areas of gardens and parks					u1d secondary code 200 or 210 or 211 or 212 or 213 or 214 or 215 or 230 or 231	

J1 Buildings of cities, towns and villages	u1b5	Urban - Developed land; sealed surface
J2 Low density buildings	u1b5 or u1d	Urban - Developed land; sealed surface
J3 Extractive industrial sites	s secondary code 100 or 101 or 105 or 106	
J4 Transport networks and other constructed hard surfaced areas	u1e	Urban - Built linear features
J5 Highly artificial man-made waters and associated structures	r1a or r1b or r1c secondary code 39 or 105 or 362 or r1e	Lakes - Ponds (Non-Priority Habitat)
J6 Waste deposits		

Intertidal habitats

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
A2 Littoral sediment					t2	
	A2.5 Coastal saltmarshes				t2a	Coastal saltmarsh - Saltmarshes and saline reedbeds
		A2.51 Saltmarsh driftlines (SM27-28)			t2a or t2a5	Coastal saltmarsh - Saltmarshes and saline reedbeds
		A2.52 Upper saltmarshes (SM23)			t2a	Coastal saltmarsh - Saltmarshes and saline reedbeds

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
		A2.53 Mid-upper saltmarshes (SM15-20) [**H1330***]			t2a7	Coastal saltmarsh - Saltmarshes and saline reedbeds
		A2.54 Low-mid saltmarshes (SM10 SM13-14) [**H1330***]			t2a7 secondary code 122	Coastal saltmarsh - Saltmarshes and saline reedbeds
		A2.54€ Atlantic salt meadows (Glauco-Puccinellietalia maritimae) (includes A2.53, A2.54, A2.556) [**H1330**]			t2a7	Coastal saltmarsh - Saltmarshes and saline reedbeds
		A2.55 Pioneer saltmarshes			t2a	Coastal saltmarsh - Saltmarshes and saline reedbeds
			A2.551 Salicornia, Suaeda and Salsola pioneer saltmarshes (SM8-9) [**H1310**]		t2a5	Coastal saltmarsh - Saltmarshes and saline reedbeds
			A2.554 Flat-leaved Spartina swards (SM5-6)		t2a (t2a6 for Annex I 1320)	Coastal saltmarsh - Saltmarshes and saline reedbeds
			A2.556 Rayed Aster tripolium pioneer saltmarshes (SM12) [**H1330***]		t2a7	Coastal saltmarsh - Saltmarshes and saline reedbeds
A5 Sublittoral sediment						
	A5.5 Sublittoral macrophyte-					

EUNIS Level 2	EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS Level 6	UK Hab code	DEFRA Biodiversity Metric habitat
	dominated sediment	A5.54 Angiosperm communities in reduced salinity	A5.542 Association with Potamogeton pectinatus (A12*) [**H1150***]		t2g5	
			A5.543 Vegetation of brackish waters dominated by Ranunculus baudotii (A21*) [**H1150***]		t2g5	

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